About The Book

"The latest trends in engineering and technology "as of my last knowledge update in January 2022 include advancements in artificial intelligence and machine learning, the growth of 5G technology, the rise of electric and autonomous vehicles, the development of sustainable and green technologies, and a focus on cybersecurity and data privacy. Additionally, fields like biotechnology, quantum computing, and Internet of Things (IoT) have been rapidly evolving. Keep in mind that the landscape of technology is constantly changing, so it's important to stay updated with the latest developments.

Technological disruption will enable a seamless society and our priority is to remove friction from our lives and close the digital divide. In a seamless society, you can engage and disengage with resources dynamically because you have a common pool of data, and the source of data is so intelligent, it's able to match supply with demand.

9 789385 933882
₹ 1299

LATEST TRENDS IN ENGINEERING & TECHNOLOGY VOL 2

LATEST TRENDS IN ENGINEERING & TECHNOLOGY VOL 2

Dr Vishant Kumar

Latest Trends in Engineering & Technology

Volume 2

Latest Trends in Engineering & Technology

First published in India in 2018 *by*

Lav Kush Colony, Rohta Road, Khadoli Mod, Meerut City, Meerut - 250002

First edition 2018

ISBN : 978-93-85933-88-2

Design and Implementation of Frequency to Voltage Converter (FVC)

Ravi Shankar Bahuguna

Assistant Professor,

Department of Electrical Engineering

JB Institute of Technology, Dehradun

ABSTRACT

This technique is used to convert accurately frequency to voltage, The goal of this conversion is to transform an oscillating signal frequency into a corresponding voltage that can be processed conveniently. this technique based on simple principle of differentiator integrator and divider the design converter provides an accurate output, its output response has input-amplitude independent characteristics

Keyword – FVC

INTRODUCTION

To design and simulate the Frequency to Voltage Converter (FVC) . From the available literature. Using basic fundamental law, a relation was derived between the frequency and voltage for a sinusoidal signal. The complete circuit was designed using different active and passive components and was simulated using Microsim software. Here two very simple methods are proposed for frequency to voltage conversion.

(1) Based on rectification and filtering.
(2) Based on Sample and Hold technique.

Various waveforms and control signals were analysed at different terminals within the circuit using the Microsim Design Lab 8 software for its performance in comparison to the existing techniques. Also circuit was tested for sinusoidal and digital waveforms.

CIRCUIT DESCRIPTION

RECTIFICATION AND FILTERING TECHNIQUE

Fig: (1) shows the bock diagram of proposed FVC which comprised an R-C series network, amplifier, squaring circuit, rectifier and filter circuit with the application of the Ohm's to a series R-C circuit, as frequency of sinusoidal signal increases, the resistance remains constant and reactance of capacitor decreases. As a result, the voltage across the resistance becomes the function of frequency of the applied signal. So, the voltage across the series resistance can be written as:

$$V_R = \left(\frac{V_{in}}{\sqrt{R^2 + \frac{1}{\omega^2 C^2}}} \right) R \qquad \text{(i)}$$

Hence as a sinusoidal signal is fed to the circuit, the voltage drop across the resistor will vary. Each time, a change in input signal frequency, will result a change in the voltage drop across the resistance. The signal across the resistance is further amplified, rectified with the technique of analog multiplication and filtered with the help of filter circuit. Finally, we get a voltage proportion to the frequency of input signal

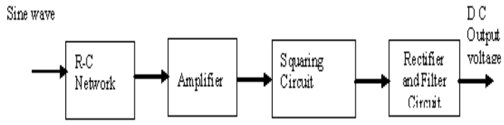


Fig: (1) Block diagram of Proposed FVC

The input to the squaring circuit is a sinusoidal signal. So at its output we get the squared signal. Which can be written as: -

$$Sin\theta . Sin\theta = Sin^2\theta \qquad \text{(ii)}$$

$$Sin^2\theta = \frac{1}{2}(1 - \cos 2\theta) \qquad \text{(iii)}$$

This equation (3) gives a signal which has the frequency equal to the twice the input frequency and its amplitude is varying from '0' to peak value sinusoidally. At no instance its amplitude is becoming negative. In other words, we can say it is the rectification of the input. Also we can say it becomes pulsating D.C. This signal further filtered with the help of a diode, R-C filter and L-R filter. Finally, we get the desired output voltage.

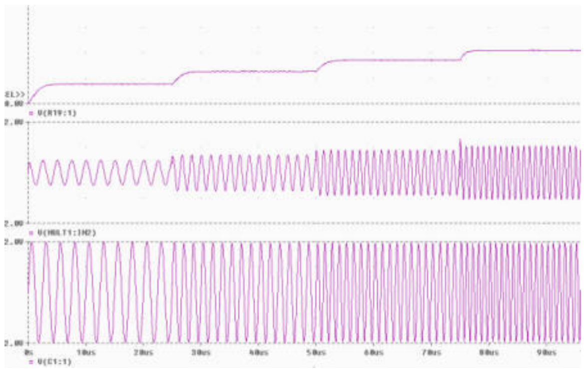


Fig :(2) Different waveform of proposed FVC

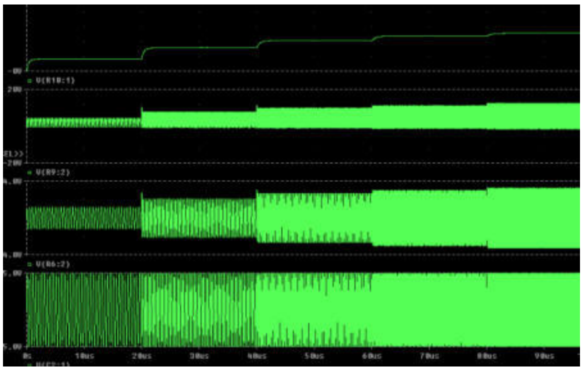


Fig :(3) Different waveform of proposed FVC upto 10MHz

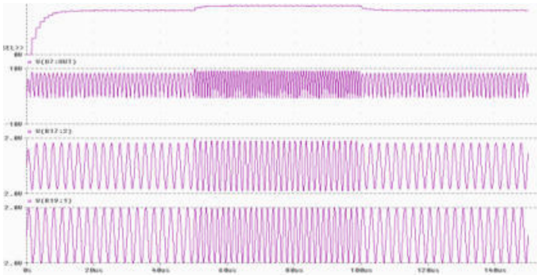


Fig :(4) Output & different waveform of proposed FVC Using S/H technique

BASED ON SAMPLE AND HOLD TECHNIQUE

The block diagram of proposed technique is given below in fig: (5). In this technique upto the stage of analog multiplication the circuit diagram is same as proposed by scheme (1), rectification and filtering technique. After that, as revealed from the equations (ii) and (iii), the R-C network and analog multiplier circuit does the amplitude modulation to the input signal proportional to change in frequency. So, if samples are taken during each pulse at the output of multiplier circuit, we can get the desired output. This is obtained by using the sample and hold circuit

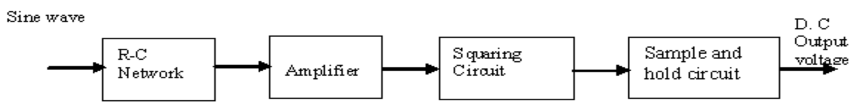


Fig: (5) Block diagram of Proposed FVC using S/H technique

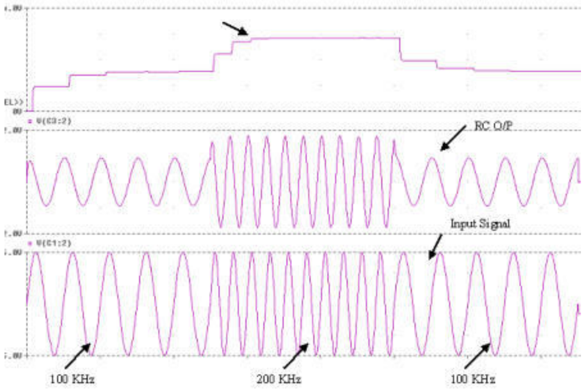


Fig :(6) Output & different waveform of proposed FVC Using integration S/H technique

PROPOSED FVC FOR DIGITAL INPUT SIGNALS

The proposed circuit for FVC was tested on digital input and it reveals from the simulated waveforms that it functions satisfactorily.

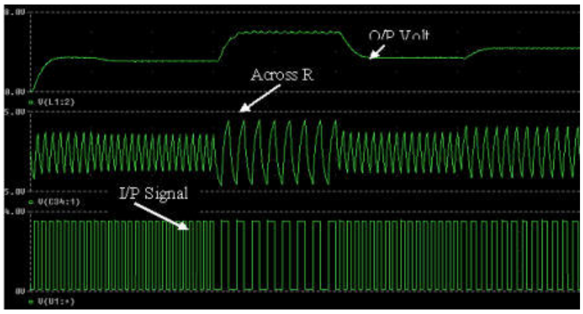


Fig: (7) Various signal for digital input signal for proposed FVC

Therefore, from above three circuit diagram and waveforms, it reveals that our proposed FVC circuit is very simple and gives much better result with less rise time in compare to using existing integrator and counter types. Also operates on both digital and analogy types of signals.

CONCLUSION

The proposed FVC provides both accurate measurements and simple circuit configuration. Its performances using available commercial devices are tested by SPICE simulation. The simulation results are in significant agreement with the theoretical.

REFERENCES

[1] T.L. Floyd and D. Buchla, Basic Operational Amplifiers and Linear Integrated Circuits. New Jersey: Prentice-Hall Inc., 1999, pp.450-457.

[2] A.B. Grebene, Bipolar and MOS Analog Integrated Circuits Design. New Jersey: John Wiley, 2003, pp.615-624.

[3] A.S. Hou, "Design of fast frequency-to-voltage converter using successive-approximation technique," Int. J. Electron., vol. 92, pp. 635- 644, Nov. 2005.

[4] M.K. Mahmood and J.E. Allos, "Fast frequency detection of sinusoidal signals," Int. J. Electronics., vol. 54, No. 6, pp. 825-832, 1983.

[5] M.K. Mahmood, J.E. Allos, and M.A.H. Abdul-karim, "Microprocessor implementation of a fast and simultaneous amplitude and frequency detector for sinusoidal signals," IEEE Trans. Instrum. Meas., vol. 34, no. 3, pp. 413-417, 1985.

[6] H.T. Bui and Y. Savaria, "High-speed differential frequency to voltage converter," in Proc. IEEE North East Workshop Circuits Syst., 2005, pp. 373-376.

[7] A. Djemouai, M.A. Sawan, and M. Slamani, "New frequency-locked loop based on CMOS frequency-to-voltage converter: Design and implementation," IEEE Trans. Circuits Syst. II Analog Digit. Signal Process, vol. 48, pp. 441-449, 2001.

[8] W. Kiranon, P. Wardkein, and C. Loescharataramdee, "Simple frequency/voltage convertor with low output ripple," Electron. Lett., vol. 27, pp. 205-206, 1991.

[9] H.T. Bui and Y. Savaria, "Design of a high-speed differential frequency- to-voltage converter and its application in a 5-GHz frequency-locked loop," IEEE Trans. Circuits and Syst. I, vol. 55, pp. 766-774, 2008.

[10]W.Surakampontorn,Y.Chonbodeechalermroong, and S. Bunjongjit, "An analog sinusoidal frequency-to-voltage converter," IEEE Trans. Instrum. Meas., vol. 40, pp. 925-929, Dec. 1991.

[11] T.Y. Lin, E.M. Drakakis, and A.J. Payne, "Architecture for frequency-to- current conversion," Electron. Lett., vol. 37, pp. 1427-1428, Nov. 2001.

[12] A.S. Sedra and K.C. Smith, Microelectronic Circuits. New York: Oxford University Press, 1991.

Study on Integration of Wind and Solar Energy to Power Grid

Lakhan Singh

Assistant Professor,

Department of Electrical Engineering

JB Institute of Technology, Dehradun

ABSTRACT

Nowadays Renewable Energy plays a great role in power system around the world. It is a demanding task to integrate the renewable energy resources into the power grid. The integration of the renewable resources use the communication systems as the key technology, which play exceedingly important role in monitoring, operating, and protecting both renewable energy generators and power systems. This paper presents about the integration of renewable energy mainly focuse down in dand solar to the grid.

Keywords-Communication Systems, Grid, Renewable Energy, Solar Power, Wind Power.

Introduction

In this paper, it reviews some communication technologies available for grid integration of renewable energy resources. Since most renewable energy sources are intermittent in nature, it is a important task to integrate a significant portion of renewable energy resources into the power grid infrastructure mainly the electricity flow takes place in one direction from the centralized plants to consumers.

When compared to large power plants, are new able energy plant is having less capacity. But as emerging resources renewable energy should be taken into account. By achieving the integration as shown in Fig.1 we can improve monitoring techniques, protection, optimization and the operation. And also, two-way flow of electricity can be employed.

Wind Power Integration

The idea of grid integration connected Wind Turbine Generation Systems have been developed in the last decades to MW size power generation units with advanced control. The power output is not only based on the incoming wind speed but also based on system requirements. In contrast with the past, the WTGS technological developments [1] enable wind farms to be operated according to the Virtual Power Plant (VPP)concept, thus providing necessary support to the primary activities.

Wind energy has become an increasingly significant portion of the generation mix Largescale wind farms are normally integrated into power transmission networks so that the generated electric power can be delivered to load centers in remote locations whereas the Small scales wind farms can be integrated into power distribution networks to meet local demands.

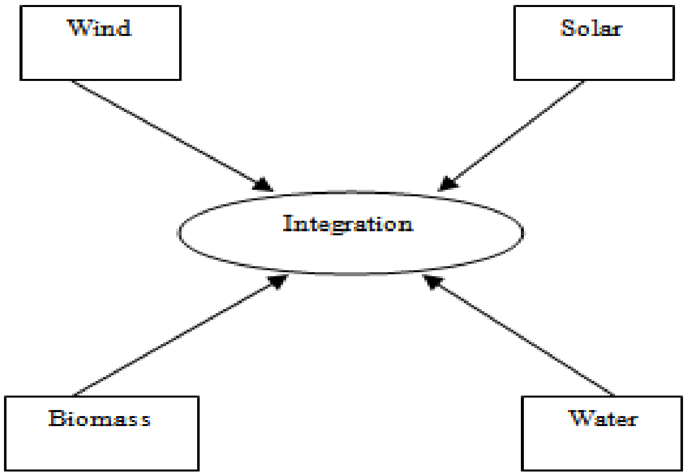


Fig.1Renewableenergyintegration

Communication systems are the basic tool that transmits the measured information and control signals between wind farms and power systems. A Proper communication system can explore the wind potentials and facilitate farm controls, helps in peak load and providing voltage support for power systems. Fig. 2 shows the grid integration of the windfarm. It can be seen that a modern power system is composed of communication networks. Energy flows through the power grid to meet customer demand, while information flows through the communication system to monitor the system status, control the dynamic energy flows presented in the grid, and transfer the information collected from an internet of smart devices for sensing and control across the power grid. From the wind farm the data are given to control center through the SCADA communication where the control, monitoring, operation is done and connected to transmission system.

Integration

Grid operators, both in transmission and distribution, have developed grid codes for connecting WTGS and the wind turbine manufacturers have responded to these requirements by developing advanced functionalities in the field of WTGS control and electrical system design Essential grid code requirements are discussed below.

Frequency control

Several grid codes require the participation of wind farms in primary and secondary frequency control, including frequency response capability and limitation of both ramp rates and active power output. The requirements are expected to become stricter at higher wind power integration levels in order to avoid exceed power gradients of conventional power plants responsible for primary and secondary frequency control. Some operators also require that WTGS should stay connected and in operation at a wider frequency band in order to contribute to frequency restoration and stable power systems operation.

Grid Codes of Wind

Voltage control The individual WTGS have to control their own terminal voltage to a constant value by means of an automatic voltage regulator, allowing that modern wind farms have capability to control the voltage at the Point of Common Coupling(PCC)to a pre-defined set-point of grid voltage.

Expanded reactive power capabilities can bring advantages for system operators because it offers the possibility of better balancing the reactive power demand.

Fault Ride-Through capability WTGS must remain connected during and after severe grid disturbances, ensuring fast restoration of active power to pre-fault levels as soon as the fault is cleared and inject reactive current in order to support the grid voltage during disturbances and to provide fast voltage recovery after fault clearing.

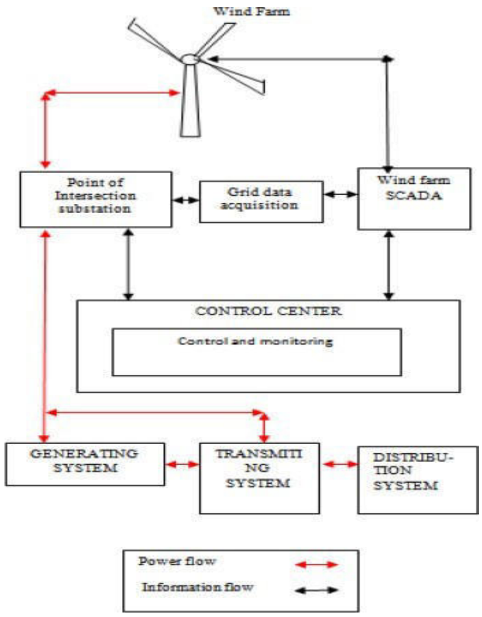


Fig. 2. Grid integration of a wind farm

Solar Energy Integration

The first application of photovoltaic power was as a power source for space satellites. Mostly the photovoltaic modules are used for utility-interactive power generation. Grid connected solar systems are typically classified as three categories residential, commercial, and utility scales. Residential scale is the smallest type of installation and refers to all installations less than 10kW usually found on private properties.

The commercial capacity ranges from 10kW to100kW, which are commonly found on the roof of a commercial building. Utility scale is designed to theinstallationsabove100kw, which are traditionally ground-based installations on fields. In this technique using integrate communication systems the photovoltaic panel, voltage current and temperature of each module was collected and the information is sent to the monitoring interface. The solar power monitoring can be classified as three categories: system level, string-level, and module-level. The system will monitor the status of solar modules, solar strings, and solar inverters based on the IEEE802.15.4-2003Zig Bee standard. Either star or mesh topology can be used. With this wireless monitoring capability, each solar module status is visible.

Wind and Solar Energy Integration

The combination of wind and solar energy leads to reduced local storage requirements. The combination of complementary and multilevel energy storage technologies, where a super capacity or fly wheel provides cache control to compensate for fast power fluctuations and to smoothen the transients encountered by a battery with higher energy capacity.

Micro grids or hybrid energy systems have been shown to bean effective structure for local interconnection of distributed renewable generation, loads, and storage. Recent research as considered the optimization of the operation on one hand and the usage of dc to link the resources on the other. A schematic of the dc micro grid with the conventions employed for power is given in Fig.4.

The dc bus connects wind energy conversion system (WECS), PV panels, multilevel energy storage comprising battery energy storage system (BESS) and super capacitor. The WECS is connected to the dc bus via an ac–dc converter. PV panels are connected to the dc bus via a dc–dc converter. The BESS can be realized through flow battery technology connected to the dc bus via a dc–dc converter. It is connected close to the LV–MV transformer to reduce losses and voltage drop and it is connected to main grid.

Advantage of Wind and Solar–Hybrid System

The major advantage of the system is that it meets the basic power requirements of non-electrified remote areas, where grid power has not yet reached. The power generated from both wind and solar components is stored in a battery bank for use whenever required. A hybrid renewable energy system utilizes two or more energy production methods, usually solar and wind power. The major advantage of solar / wind hybrid system is that when solar and wind power productions are used together, there liability of the system is enhanced. Additionally, the size of battery storage can be reduced slightly as there is less reliance on one method of power production. Wind speeds are often low in periods (summer, eventually) when the sun resources are at their best. On the other hand, the wind is often stronger in seasons when there are less sun resources. Even during the same day, in many regions worldwide or in some periods of the year, there are different and opposite patterns in terms of wind and solar resources. And those different patterns can make the hybrid systems the best option.

Grid Congestion

Power grid congestion is a situation where in the existing transmission and/or distribution lines are unable to accommodate all required load during periods of high demand or during emergency load conditions, such as when an adjacent line is taken out of service or damaged by a storm, it also reflects a decrease in efficiency. Under high load conditions, line losses escalate exponentially. If lines are congested and operating at or near their thermal limits, they would also be exhibiting significant line losses during high load conditions.

There have been cases when wind farms are forced to shut down even when the wind is blowing because there is no capacity available in the lines for the electricity they create. Without adequate transmission to transport power from "renewable" rich areas (like Arizona) to densely populated areas, it is only cost effective to use renewable sources in certain areas of the country. While building new infrastructure would certainly help, smart grid technologies can also help utilities all evirate grid congestion and maximize the potential of our current infrastructure. As smart grid technologies become more widespread, the electrical grid [5] will be made more efficient, helping reduce issues of congestion. Sensors and controls will help intelligently reroute power to other lines when necessary, accommodating energy from renewable sources, so that power can be transported greater distances, exactly where it's needed. Relieving grid congestion can be achieved in several ways:

By adding new transmission lines

By building new electric generating capacity near load centres

By reducing the demand for electricity in congested areas through greater use of energy efficiency and conservation.

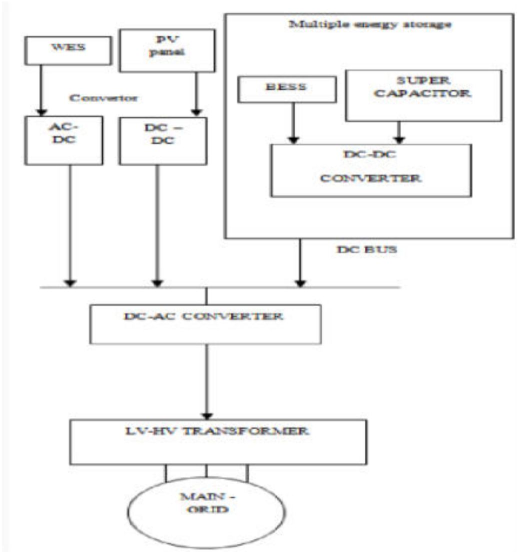


Fig.3.WindandSolarIntegration

REFERENCES

[1] S. Galli and O. Logvinov, “Recent developments in the standardization of power line communications within the IEEE,” IEEE Communications Magazine, vol. 46, no. 7, pp. 64-71, July 2008.

[2] F. Giraud and Z. M. Salameh, “Steady-state performance of a grid connected rooftop hybrid wind-photovoltaic power system with battery storage,” IEEE Trans. Energy Convers., vol. 16, no. 1, pp. 1–7, Mar. 2001.

[3] H.Yang,W.Zhou,L.Lu,andZ.Fang,“Optimalsizingmethodforstand-alonehybridsolar-windsystemwithlpsptechnologybyusinggeneticalgorithm,”Solar Energy, vol. 82, no. 4, pp. 354–367,2008.

[4] M.A.Mahmud,H.R.Pota,andM.J.Hossain, “Dynamic stability of three-phasegrid-connectedphotovoltaicsystemusingzerodynamicdesignapproach,”IEEEJ.Photovoltaics,vol.2,no.4,pp. 564–571,Oct.2012.

[5] C.-H. Lin, W.-L. Hsieh, C.-S. Chen, C.-T.Hsu, T.-T. Ku, andC.-T. Tsai, “Financialanalysis of a large-scale photovoltaic systemand its impact on distribution feeders,” IEEETrans.Ind.Applicat.,vol.47,no.4,pp.1884–1891,Jul./Aug. 2011.

Control and Improvement of Power Grids Using Data from Smart Metres): A Review

Rajendra Kumar Prajapati

Assistant Professor,

Department of Electrical Engineering

JB Institute of Technology, Dehradun

ABSTRACT

This paper provides a comprehensive review of the applications of smart meters in the control and optimisation of power grids to support a smooth energy transition towards the renewable energy future. The smart grids become more complicated due to the presence of small-scale low inertia generators and the implementation of electric vehicles (EVs), which are mainly based on intermittent and variable renewable energy resources. Optimal and reliable operation of this environment using conventional model-based approaches is very difficult. Advancements in measurement and communication technologies have brought the opportunity of collecting temporal or real-time data from prosumers through Advanced Metering Infrastructure (AMI). Smart metering brings the potential of applying data-driven algorithms for different power system operations and planning services, such as infrastructure sizing and upgrade and generation forecasting. It can also be applied to demand-side management, particularly in the context of cutting-edge innovations like electric vehicles, 5G and 6G networks, and cloud computing. These algorithms must effectively handle difficulties related to cybersecurity and privacy preservation. The most recent research on each of these subjects is examined in this article, along with applications, difficulties, and potential for employing smart metres to solve them. Additionally, it outlines the difficulties that smart grids face when working with smart metres as well as the advantages that smart metres might offer. The study also includes some anticipated future directions and possible research problems for smart grids, smart metres, and their interactions.

Keywords: smart meters; smart grids; control; optimisation

1. Introduction

Power systems are among the most important pieces of infrastructure because they allow for the transfer of power from huge central power facilities to users. Network operators have started utilising services from generation units, such as frequency and voltage management and black start, to deliver excellent power quality [1]. The optimisation of the power grid is currently a hot topic in both academia and business due to the rise in electricity demand as well as social and political movements in favour of adopting renewable energy sources to minimise greenhouse gas emissions [2]. Increased infrastructure expenses and capital expenditures are necessary to accommodate the demand growth using the conventional paradigm, which will result in higher power prices for consumers [3]. However, unlike conventional generation units, renewable resources are unpredictable and intermittent in nature, making them less dependable to support the grid with functions like frequency and voltage management. Due to the increased integration of renewable-based generation units into electricity distribution systems during the past ten years, the difficulties have gotten more serious. Every home may now have solar rooftop panels installed, transforming traditional customers into prosumers—entities that can both produce and consume electricity. These distributed generators (DGs) may be able to provide the entire local demand at certain periods of the day if their penetration level is high, which would result in negative local demand. Traditional electricity grids have never encountered this situation. The electricity system is made more sensitive to frequent disturbances, which frequently result in cascade failures or even blackouts [4] due to these difficulties as well as the lack of sight and situational awareness brought on by outdated infrastructures.

Technology advancements in sensing and communication have made it easier for network operators to address these problems [5]. system operators have always had a limited amount of real-time information on the distribution system. Additionally, compared to their renewable-based counterparts, fossil fuel-based generation units have been easier to operate and predict [6]. In order to increase the current renewable-based power grid's resilience and reliability in such a complex environment, the idea of a "smart grid" has been developed [7]. This concept involves adding communication and control facilities to the system. It makes it possible for power systems and information and communication technology (ICT) to work closely together, which ensures a wise and effective balance between production and consumption [8]. This idea incorporates generation, transmission, and distribution networks, allowing for real-time monitoring, forecasting, and control of supply and demand at all levels.

Real-time data from smart metres is necessary for the best possible design and operation of smart grids. These new power system players have the measurement and communication tools necessary to track crucial variables like power import and export from and to the grid and transmit that information to the right data centres [9]. The data centre can run decision-making algorithms and manage the grid using this data and cutting-edge data-driven algorithms. In the case of the demand response (DR), smart metre capability is used to combine prosumers with intelligent gadgets. To increase versatility, smart metres may include additional features including automation, phase measurements, and protection. [**10**].

More than 50 nations have started the process of installing smart grids. The Australian government is advocating more incentives to increase investments in smart grids. It also creates time-of-use tariffs and demand-side control and asserts that demand-side management, energy security, and energy efficiency are the top goals [11]. A national strategy for the development of smart grids has been laid forth in the US Department of Energy's "GRID 2030" document [12]. An electricity grid project created by the European Commission creates a nine-year plan for studying and creating smart grid technology and market developments [13]. At the same time, the installation of smart meters is also rapidly growing worldwide. For instance, the European Union countries are required to adopt 71% smart meters by 2023 [**14**]. The smart meters in the United Kingdom are designed to measure the system parameters every 30 min [**15**], whereas the rate is doubled in Texas at every 15 min [**16**]. The measuring rate of smart meters is expected to rise dramatically in the near future to prepare for higher requirements of operating efficiency under the growth of renewable energy integration and a more complex energy market [17].

In recent years, there has been a lot of interest in the study on smart grids and smart metres [18]. Future energy systems will mostly be built using the communication architecture and standards for smart grids and the analysis of data from smart metres [19,20,21,22]. Applications using data from smart metres have been created to accommodate various stakeholder interests [23]. A study on the cybersecurity of smart grids can be found in [24], which notes that communication gaps may expose system data to security risks. Although there are other review publications on the topic of controlling and optimising smart grids using data from smart metres [22,23,24,25], they are not as thorough as this paper Additionally, the present publications do not explicitly address the connection between smart grids, smart metres, and their role in facilitating high renewable energy adoption. Additionally, due to a lack of incentive in light of the low revenue and privacy concerns, the introduction of smart grids and the installation of smart metres are frequently constrained. The development is having trouble coming up with the right uses to get around these problems. Finding viable applications that encourage the power grid to embrace changes in the penetration of renewable energy and motivate the utility to improve operation efficiency is crucial.

With a focus on recent research, this paper aims to provide a thorough overview of the control and optimisation of smart grids utilising data from smart metres. There are also some earlier classical compositions included. The references are evaluated using a variety of criteria, such as papers that focus on current and future smart grid and smart metre applications, cutting-edge communication and computation technologies, ongoing smart grid developments, and studies of customer awareness of smart metre deployments. Smart grids and smart metres can be provided with information on future advances and research directions. With a focus on recent research, this paper aims to provide a thorough overview of the control and optimisation of smart grids utilising data from smart metres. There are also some earlier classical compositions included. The references are evaluated using a variety of criteria, such as papers that focus on current and future smart grid and smart metre applications, cutting-edge communication and computation technologies, ongoing smart grid developments, and studies of customer awareness of smart metre deployments. Smart grids and smart metres can be provided with information on future advances and research directions.

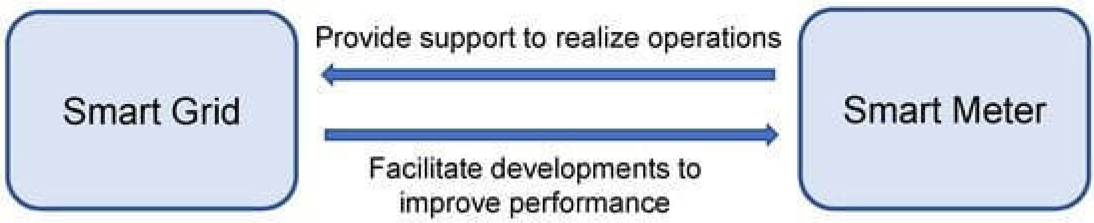


Figure 1. The relationship between smart grid and smart meter.

1. It lists the difficulties that smart grid development faces at each level of the domain. The applications that are meant to address the problems are then introduced following a review. The main source of challenges and smart grid applications comes from the standpoint of the grid operator, who seeks to maximise the profitability of smart grid operations. As the smart meter is essential to support smart grid operations, the challenges of smart grid development are reflected in the smart meter perspective. The review identifies the challenges and provides the applications for solutions. The challenges and

applications from smart meter perspective are mainly developed from the customer side, which focuses on improving user satisfaction and smart grid performance.

2. Future advancements of smart metres are brought about by the prospective applications and research initiatives for smart grids. The advancement of smart metering technologies is facilitated by the growth of smart grids, and the performance of smart grids is improved by smart metre advancements. Additionally, the customer's acceptance of the adoption of smart metres is examined. This is important for the smooth growth of smart grids. The principles of smart grids and smart metres are illustrated in Section 2, where the characteristics and capabilities are also discussed. The extensive control and optimisation applications in smart grids using data from smart metres are shown in Section 3 and are illustrated from both the smart grid and smart metre viewpoints. It shows how smart grids and smart metres interact in more detail. The key issues with smart metres are discussed in Section 4 along with the developments of smart grids in the future. It also offers potential answers. The conclusion of the essay is found in Section 5.

2. Smart Grids and Smart Meters

The ideas of smart grids and smart metres are introduced in this section. In Section 2.1, it first illustrates the definition of the smart grid, along with its functionalities and domains. The applications mentioned in Section 3.1 are based on the features, which generally cover the capabilities of the smart grid. The domains represent the core elements of the smart grid, and the interactions between them provide various smart grid processes. Additionally, the domain-level impact of the energy transition to renewable energy on the smart grid is discussed, which also presents the problems that the apps are created to address. Later, in Section 2.2, the smart metre and the metering functionalities are introduced. The difficulties that the smart grid faces are also mirrored from the standpoint of smart metres, which are necessary for many smart grid applications. These difficulties offer a framework for creating smart metre applications, which will be illustrated in Section 3.3.

2.1. Smart Grids

The commonly accepted definition of a smart grid is an intelligent electrical network that integrates information, two-way cyber-secure communication technologies and computational intelligence throughout the energy system from power generation to consumption endpoints [12]. Several state-of-the-art communication technologies, multi-tariff meters and power distribution devices have been applied to guarantee the efficiency and reliability of the operations through energy generation, transmission, distribution and consumption. A network model of a smart grid is shown in **Figure 2**.

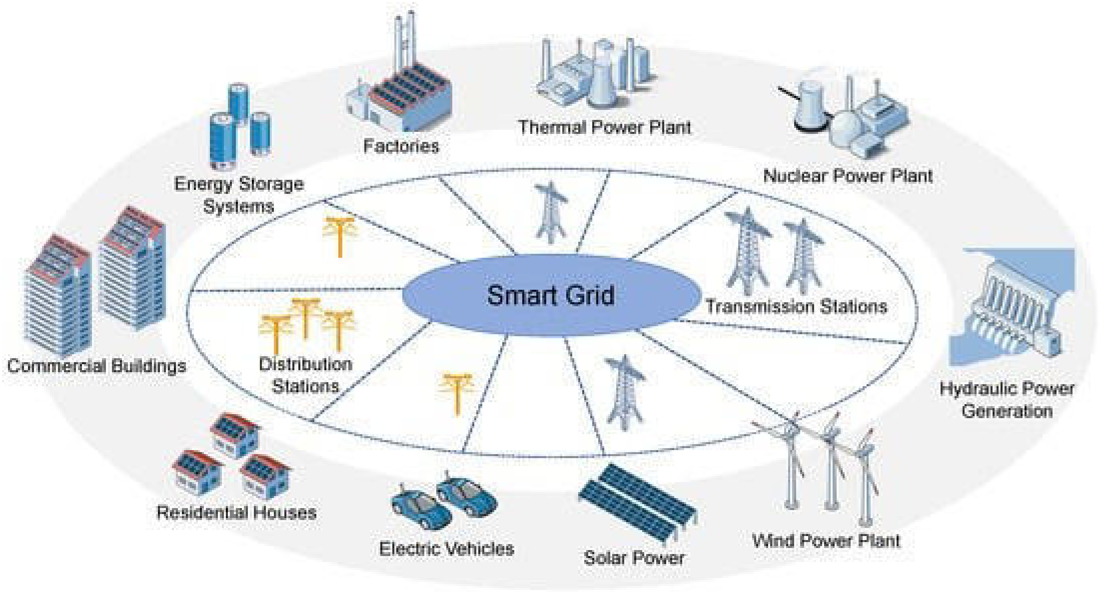


Figure 2. The smart grid framework [26,27].

Generally, the smart grid has multiple sensors to support remote testing and coordinative control, which enable self-monitoring and self-healing capabilities. It also features with auxiliary functions including the integration of renewable and distributed energy sources and the data exchange among renewable energy sources (RES) and electric vehicles (EV) [7]. Each function of smart grid contains a number of specific technologies that cover the whole grid, from generation through transmission and distribution, to a variety of consumers. The key functions are demonstrated in Table 1.

Table 1. The functionalities of smart grid.

According to the national institute of standards and technology (NIST), smart grid can be separated into several domains, each of which consists of many components and applications [28]. The domains are shown in Figure 3.

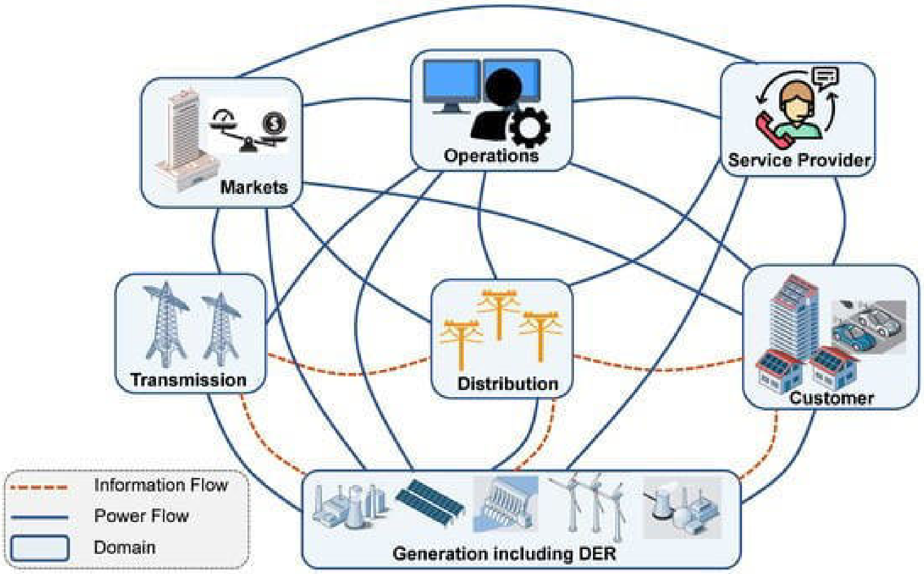


Figure 3. The conceptual model of the smart grid [28].

2.1.1. Energy Generation

This domain focuses on power generation to supply the consumers' demands. It connects to the power transmission and distribution domains through electrical and communication networks. The communication network exchanges information on generator performance, as well as quality-of-service issues such as scarcity and generator failure [29]. It also enables the routing of electricity from multiple power sources due to lack of sufficient supply [30]. With the development of power girds, the power generation domain faces new challenges such as reducing carbon emissions and increasing the use of RES [8]. In addition, the distributed energy resources (DER)s significantly contribute to the power generation in smart grids, improving the capacity and flexibility of smart grids, yet, leading to higher operation complexity.

2.1.2. Power Transmission

The domain focuses on high voltage power delivery over long distances. As power transmission is the boundary of generation and utilization, it usually operates in substations. The substations are responsible for levelling-up or levelling-down the voltages for connecting the generation and distribution, which contain control and protection devices. A supervisory control and data acquisition (SCADA) system is used for monitoring and controlling the transmission network via communication networks and regulation devices [31].

2.1.3. Power Distribution

The domain is responsible for providing electrical interactions among distributed generation (DG), distributed energy storage system and consumer consumption. The reliability of the distribution system depends on the types of devices and their communication structures. The operators need to balance the initial investment and reliability when choosing the network structure among various categories, such as looped, radial or meshed [32]. In addition, the devices closely communicate with the operating system in real-time to regulate power flows. The regulation regards the dynamics of power demand, considering factors like market value, environmental impacts and security [33,34]. The interaction with the market will affect localized consumption and generation, which would further influence the development of distribution system, or the even larger utility grid, from both the structural and electrical perspectives.

2.1.4. Operation

The operation domain is responsible for managing the electricity delivery with reliability and efficiency under different situations. The operating systems are essential through power generation, transmission and distribution to the consumers. Many applications are developed in this domain in terms of monitoring, control, demand side management, fault management, operation planning, maintenance and consumer support [35]. The main challenge for the operation domain is to improve the overall performance of such applications and provide innovative ones for adopting the future renewable energy transition.

2.1.5. Utility

The utility domain is responsible for supporting the business process among power generators, distributors and consumers. The utility ranges from conventional applications, like billing and consumer account administration, to advanced applications, like energy management and home power generation [36]. It is connected with the operation, consumer and market domains. The communication with the operation domain is essential for situational awareness and system regulation. The connections with consumer and market domains are necessary to encourage economic growth with a variety of applications in smart grids [37,38,39]. The utilities produce novel applications to match different requirements and opportunities introduced by the development of smart grid. The main challenge for the utility domain is to provide a core interface and standards to support the active power trading market, while maintaining operation stability of crucial power infrastructures. The interfaces are required to support different types of communication technologies, while maintaining high quality connections.

2.1.6. Electricity Market

The market domain balances the electricity supply and demand with respect to the market price. The participation of DERs in the power market makes the smart grid more interactive, which in turn, brings about more data exchange among different domains [40]. Therefore, their communication is required to be reliable, efficient and traceable. The communication latency should be reduced as the operation rate rises [9]. The challenges in the market domain are the expansion of DER information to each community subdomain, expanding the interactions of utilities and consumers, simplifying the market rules and developing interaction frameworks for regulating the rising retail and wholesale energy trading markets.

2.1.7. Consumer

The consumers are the end-users of the electricity, who are the stakeholders that the utility domain is developed to support. The consumers manage their energy consumption and generation, which electrically connect to the distribution and generation domains through smart meters. The consumer domain communicates with market, operations, distribution and utility domains, where the smart meters provide a bridge to operating systems, like building automation systems or energy management systems [41]. Generally, the consumer domain is separated into subsystems with respective to home, building, commercial and industrial. Each subsystem has several applications, including the display of customer power usage, remote monitoring and regulation of DGs and loads [42,43,44,45]. The main challenge in the consumer domain is to improve customer awareness and acceptance of smart meter implementation.

The smart grid promotes higher automation and control capabilities to the transmission and distribution grids; it also adds more complexity to the power system, which challenges the reliability and safety of operations [17]. More requirements of energy measuring units are proposed to realize the smart grid operations, which shape the development of smart meters.

2.2. Smart Meters

Smart meters are energy measuring units that locally record a number of electricity parameters of each prosumer, such as power consumption and power export, and sends the data to a central server through communication networks for operation purposes. A common smart metering system employs metering and communication infrastructures, which is shown in **Figure 4**. The metering infrastructure allows the smart meter to have functions such as voltage and current waveforms recording and data storage. The communication infrastructure enables the bidirectional communication between consumer and utility through the power line connection or wireless connection. It allows the smart meters connect to the remote centres for control and management purposes, which forms an advanced metering infrastructure (AMI) [41]. The evolvement of smart metering systems is correlated to the development of smart grids, which is reflected in several features.

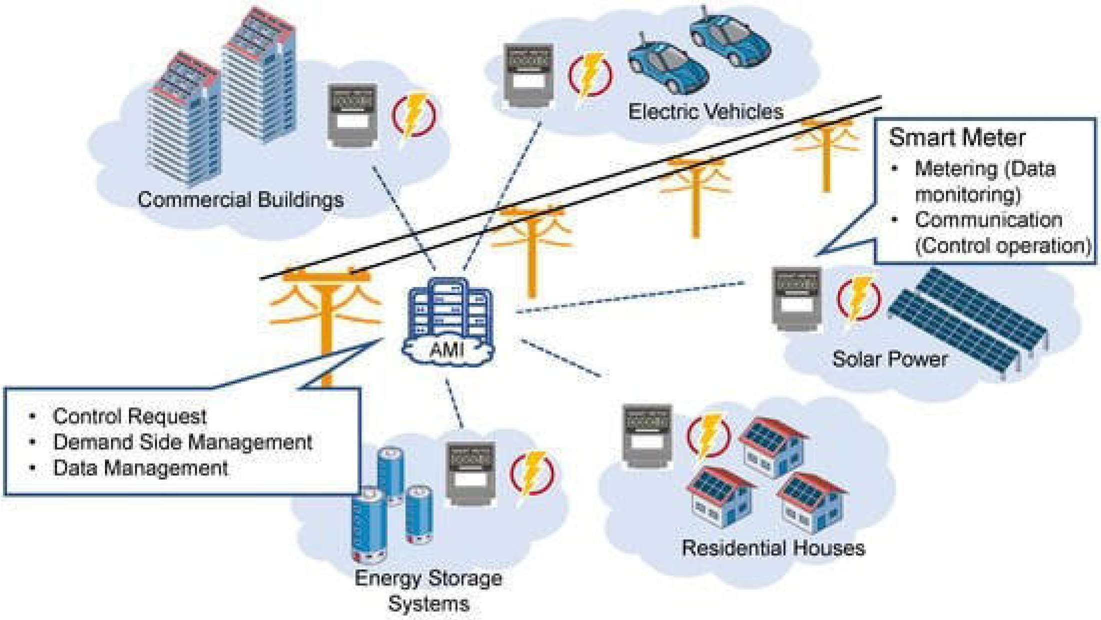


Figure 4. Smart metering configuration and functionalities.

2.2.1. Periodic and Precise Metering

The basic function of a smart meter is to perform regular and accurate measurements of electrical parameters such as voltage, current, power, frequency and power factor [46]. These parameters are essential factors for load management, load profiling, load monitoring and fault analysis. The monitoring and recording activities are activated at particular time intervals, where the frequency varies from a few minutes to a few hours [9]. Due to the high level of intermittence and uncertainty in both generation and demand sections, especially in the presence of RES-based generation units, reliable operation of smart grids requires more real-time actions compared to conventional power systems; thus, the frequency of data collection in a smart grid is high. This high periodic measurement provides a more detailed understanding of system operating patterns, which benefits applications like load forecasting and demand response. In contrast, it also adds challenges to smart meters, such as the deployment of the smart meter in a way that can achieve the most efficient measurement, and how to collect data in an efficient way.

2.2.2. Data Collection, Storage and Alarming

In smart grids, the increased data measuring frequency greatly increases the amount of measured data. Since the current computational capacities are often not enough to process the whole dataset, efficient data extraction is required to support effective decision-making processes [47]. In addition, smart meters can store the measured data to prevent data loss when the communication to the central server fails. The data can be locally collected from meters, which adds to the reliability of the system. The stored data can benefit the energy suppliers and consumers to track the history of energy consumption. Billing and cost data can also be stored for further reference and support decision making. Furthermore, the smart meter can make alerts and notifications based on a variety of alarm conditions on different monitored parameters. These alarms are beneficial for fault-preventing applications such as fault detection, energy theft prevention and system security [48,49]. The challenges for this feature are effective data extraction and accurate fault detection using measured data.

2.2.3. Communication Interfaces

There exists a bi-directional communication between smart meters and the grid operator, that allows operators to provide reliable operation, better maintenance, optimal demand management and to efficiently plan for the infrastructure upgrade and expansion [50]. It also allows consumers to track their energy usage, take part in the demand management programs that the operators run, and have revenue from selling electricity to the grid [20]. The communication is achieved by using either wired or wireless technologies [19]. The practical connection often adopts hybrid communication, where the advantages of different technologies are exerted under various situations to meet the communication requirements. The challenges for this feature are avoiding communication traffic and keeping efficient communication, while achieving optimal levels of reliability and security.

2.2.4. Demand Side Management

As the two-way directional communication allows the smart meter to receive remote control instructions, it has the ability for consumers and energy suppliers to regulate the power consumption, yielding more efficient use of resources in power systems. For instance, the consumer could turn off the thermostatic home appliances such as air conditioners at peak demand intervals, when the bill is the highest, and turn them on for the rest of the intervals. The energy suppliers could have more opportunities to reduce the total power usage in peak periods by sending instructions to smart meters. These concepts are regarded as demand side management [51], which has the fundamental rule to redistribute the power consumption. Consumers are motivated to switch their power usage from peak periods to valley periods, according to dynamic pricing [52]. The challenge for this feature is increasing the reliability and accuracy of demand side control, while keeping the consumers' satisfaction within a tolerable level.

2.2.5. Data Management Systems

Smart meter data management allows the smart grid to apply analytical tools for processing data to achieve objectives such as improving and optimizing utility grid operation and management [22]. It also provides references to decision making for the development of smart grids [53]. The challenges for this feature are improving more accurate data analysis results in shorter time periods and developing proper algorithms to support the implementation of novel smart grid applications.

3. How Smart Meters Support Smart Grids

The interrelated roles of smart meters and smart grids can be shown in **Figure 5**. From the smart grid perspective, the applications are mainly focused on how smart meters can support the coordination of different electric devices to realize a reliable power system. On the other hand, these applications aim to improve the performance and efficiency of smart metering. Such aims reflect the features of smart grids, which promote the development direction of smart meters.

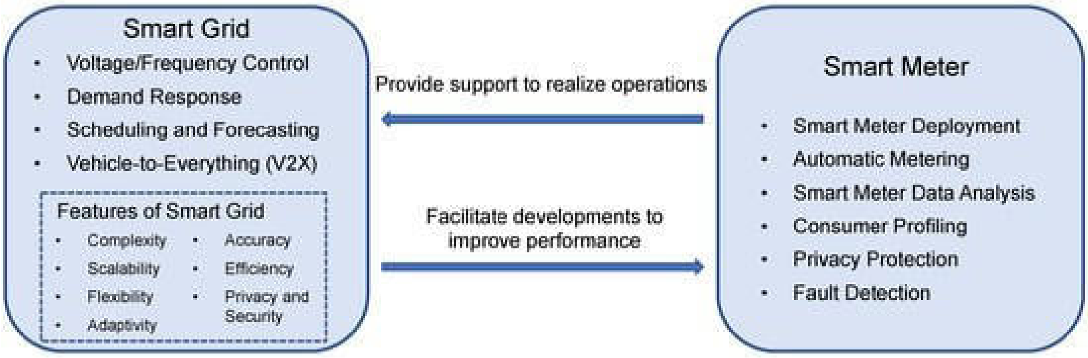


Figure 5. Applications from smart grid and smart meter perspectives.

3.1. Applications from Smart Grid Perspective

The development of smart grids had let to a large number of coordinated control and optimization algorithms covering a variety of domains with multiple aims. The traditional approach of power systems has to be improved, while taking into account challenges such as system complexity and flexibility. This subsection introduces how the smart meter can help to realize devices coordination in smart grids aiming for different objectives [54].

3.1.1. Frequency and Voltage Control

Frequency and voltage regulation are the two most common operations in power system stability and control [55]. The frequency must be maintained to close to the nominal value for the integrity of infrastructure and system protection [56]. The voltage magnitude must remain close to its rated value to guarantee the effective behaviour of end-users' equipment's and to prevent system collapse that may lead to blackouts [57]. Both control objectives are required to be achieved efficiently while considering their specific features. In particular, the voltage and frequency control are achieved by considering the power management that can enhance the system stability, while curtailing power losses. The voltage and frequency drop can be mitigated by minimizing the active and reactive power flows, respectively.

In smart grids, voltage and frequency control are performed much more flexibly, due to the deployment of DG units. With the implementation of smart meters, the smart grid has the capability to realize real-time voltage and frequency measurement, and bidirectional communication between consumers and network controllers. It further integrates the conventional large-scale power plants into grid systems, which contain thousands of distributed generators such as PV systems and wind turbines [13]. The grid systems can either operate in grid-connected mode or islanded mode, where bidirectional power flows are enabled among prosumers under various power conversion technologies [58]. The installation of smart meters allows power conversion operating in distributed control schemes, where centralized control is avoided to prevent problems like single point of failure or high control cost under a large number of DGs [59]. Moreover, the power network data collected from smart meters improve the operating performance of smart grids. As the distribution system of smart grids is becoming more complex, the system operators often lack exact knowledge of network parameters. To maintain performance, the operators apply data-driven approaches to accurately find system behaviours based on smart meter data [60]. For instance, the network status measured by smart metering technologies is analysed and used to generate decision making for various control devices like on-load tap-changer (OLTC) to solve problems like overvoltage and undervoltage across the whole network [61]. In addition, the installation of smart meters provides consumers with more suitable individual energy services with the aid of model predictive control (MPC). It uses measured information such as individual energy consumption behaviours to predict future control decisions [62].

3.1.2. Demand Response

The evolution of smart grids inevitably brings about the increasing penetration of renewable energies and installation of energy storage systems. The demand side management strategies are hence introduced to solve problems such as high generation cost, high demand peak-to-average ratio and transmission congestion, while avoiding reduced service experiences of consumers [33]. A basic configuration of demand response is demonstrated in **Figure 6**. The peak demand impacts the grid flexibility and may break the balance between energy supply and demand [63]. Therefore, the basic idea to achieve demand side management is to change the energy consumption behaviours of users from their normal consumption patterns, by using either price based or incentive based stimulations to maintain the system reliability [64]. The incentive-based demand response aims to reduce the consumers' energy usage at peak hours and provides considerable incentives in return [65]. The price-based demand response offers different electricity prices at different times, where the energy consumption behaviours of users are changed accordingly [66]. Applications of demand side management are mainly developed on home energy management and community energy management, where the smart meters are the core components to integrate a large variety of electrical devices for coordination through online functionalities such as energy usage data measuring, analysing and reporting. The integration increases the capacity of demand response under large power fluctuations. With the installation of smart meters, consumers are more aware of their energy usage from time to time, which further promote the realization of demand side management. For instance, the increasing number of electrical vehicles adds more pressure to peak demands, particularly in residential areas, where electrical vehicles cause high demand loads. However, consumers are likely to shift their charging and discharging behaviours for lower prices, and smart meters are the key component to facilitate such load shifting [67].

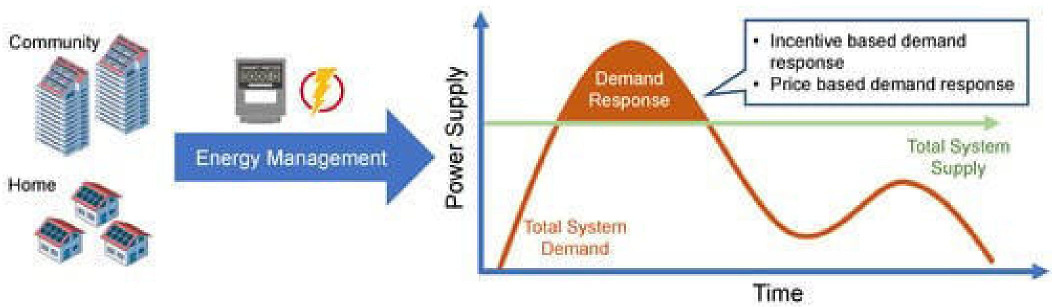


Figure 6. Demand response configuration.

Energy storage systems are often applied to accommodate fluctuations caused by renewable energies and control the power peaks in residential areas. Sufficient energy storage capacity is the prerequisite that allows smart grid operators to provide demand response, while the capacity is also positively correlated to its cost. In addition, the placement of energy storage systems is essential for optimizing the energy efficiency, as well as minimizing the fundamental investment. The properly placed and sized energy storage systems benefit many grid operations such as peak demand shifting, integration of renewable energy sources, power quality enhancement and transmission cost reduction [68]. To facilitate the optimal placement and sizing of energy storage systems, various types of power network data are essential to be collected prior to analysis and modelling, through a variety of optimization algorithms [69].

3.1.3. Scheduling and Forecasting

During the operation of smart grids, various flexible power generations, energy storage systems and load demands are involved. The utility operators require scheduling and forecasting to provide constant, sustainable and rapid reserve supply in the power grid. In addition, the increasing penetration of renewable generations brings about additional uncertainties. Operators require more information for decision making for more frequent changes between supply and demand. Generally, the scheduling and forecasting techniques are applied on both the generation and consumption sides to guarantee the reliability of smart grid while maintaining its flexibility. An infographic is shown in **Figure 7**. From the generation side, the generation scheduling applies fast reserve supply, which requires the resources generated by the reserve with higher resolution to provide reservation and balance uncertainties of wind and solar power plants through demand response [34]. In addition, renewable energy forecasting drew much attention as it improves the certainty of the power generations [70]. However, the forecasting is based on data driven techniques, which require accurate and sufficient system information and efficient algorithms to ensure the performance [71]. From the consumption side, load scheduling and forecasting are often applied, where the smart meter is used to identify shiftable and non-shiftable loads to facilitate the demand response. It also records relevant information in detail and helps to generate precise scheduling model of the smart grid. With the aid of novel learning techniques, accurate load forecasting, considering technical and economical constraints, is achieved [72]. In addition, the uncertainty of weather also increases the complexity of electrical load forecasting. For instance, the value of thermal loads is highly related to the local temperature. Smart metering technologies can collect and process the nonlinear data and obtain accurate load forecasting [73]. As the smart grid is becoming more complex and more prosumers are involved in the distribution side, power trading markets are becoming more active. The electricity price forecasting has drawn more attention due to its fundamental influence on the decision-making process of utility operators [74]. The price forecasting also faces challenges, as the integration of renewable generations and energy storage systems often increases its uncertainties. Such uncertainty could be solved with the support of high resolution smart meter data, where precise price forecasting is made from the short-term to the long-term [75].

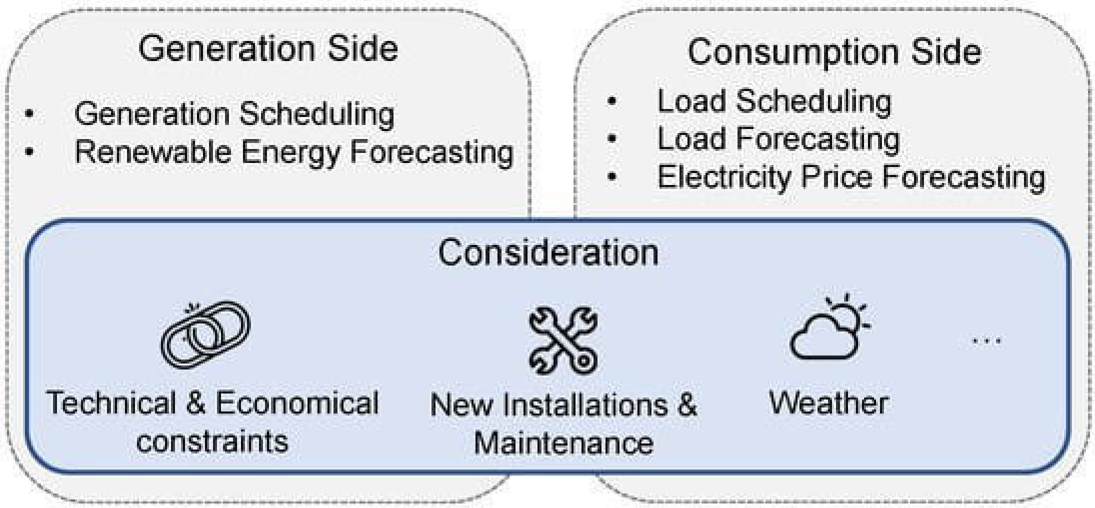


Figure 7. Scheduling and forecasting.

3.1.4. Vehicle-to-Everything (V2X)

The term "V2X" indicates the applications that focus on vehicle-to-everything, which allows electric vehicles to connect with other objects such as other vehicles, infrastructures and customers. Nowadays, electric vehicles are becoming more popular due to the increasing gas price and more consideration of carbon emissions. Reports indicate that the number of electric vehicles has reached 13 million in 2021 and is expected to exceed 73 million by 2025 [76]. With the increasing use of electric vehicles, their energy capacity has grown to a considerable number that is required to be integrated in the demand response. The installation of smart meters realizes such integration, where the electric vehicle users in their smart homes become prosumers. They can make choices to reduce their electricity cost according to the optimal scheduling algorithms. Smart meters provide incentives, like current electricity prices, to help prosumers decide the change or discharge of their electric vehicles from time to time [77]. Electric vehicles are hence switching between home-to-vehicle mode (charging) and vehicle-to-home mode (discharging), to interact with the smart grid. The integration of electric vehicles is operating along with stationary energy storage systems to compensate for the fluctuations caused by renewable energy generations and loads in the grid [78]. On one hand, the smart meter data reflect the charging and discharging behaviours of electric vehicles, which support the scheduling and decision making for utility operators through data driven approaches [79]. On the other hand, the smart meter data also provide detailed information of the vehicle's battery, which is closely related to the battery's state of health. In particular, effects such as ageing and degradation impact the battery capacity and performance, which further influence the service experience of prosumers [80]. To effectively maintain the battery lifetime, prosumers make predictive maintenance services through prognostic methods [81].

3.2. Features of Smart Grid

The smart grid is developed toward a more complex power grid to meet an increasing number of stakeholders. Its evolution reveals several features, shown in **Figure 8**. These features become the design requirements to facilitate the evolvement of smart meter applications.

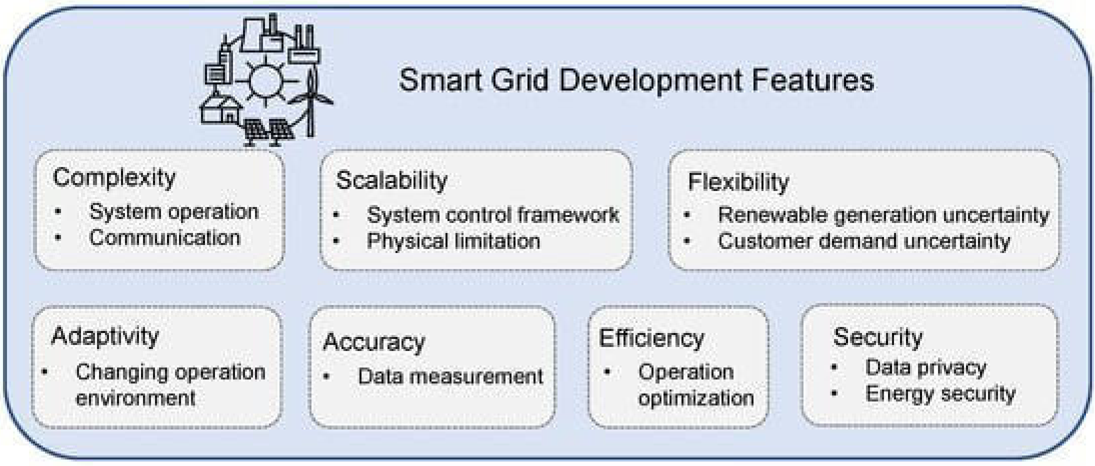


Figure 8. Features of the smart grid.

3.2.1. Complexity

Complexity is one of the most essential features of smart grid, as it involves numerous electric devices and systems mutually coordinated at multiple voltage levels under various time scales. The growing penetration of renewable energy and increasing load demand led to more complexity in dealing with the increasing uncertainties [50]. The complexity of smart grid reflects the complexity of smart meter communication, which in turn, also challenges the configuration of communication networks among smart meters.

3.2.2. Scalability

The development of the smart grid brings about high penetration of DG units, which are distributed throughout the power systems, particularly at the distribution domain. The control of such units requires a large number of controllers, which challenges the current scheme of power system regulation. Recently, distributed and hierarchical control approaches have been implemented to solve such issues [82]. The units achieve the control and optimization objectives by communicating with their neighbours or higher-level units, where the connections are usually realized by their locally equipped smart meters. The improper communication among smart meters may deteriorate the operating performance of smart grids. The coordinating strategy is required to be optimized, considering the physical limitation of communication and system constraints [83].

3.2.3. Flexibility

Flexibility of the smart grid indicates that it is able to adapt variability and uncertainty using available resources during a certain time period in an economic approach [84]. It allows the power system to efficiently accommodate the uncertainties from wind/solar generation and end-users' demands with various distributed energy resources and flexible loads. The coordination among various devices are often flexible changes in different time and regions, where the smart meters are required to provide sufficient and timely network data for support [85].

3.2.4. Adaptivity

The adaptivity indicates that the controller could update its parameters according to the changes in the controller units [86]. In smart grids, the dynamics of the electricity market are becoming more active due to the significant increment of various market players, different types of DG units and their interactions. The changeable behaviour requires controllers to adaptively adjust the control inputs, so that the system can remain stable [87]. In addition, the topologies of power networks also require such features considering cyberattacks. The connection may not be available facing an attack or a failure, while the system stability should be maintained. The uncertainties are often dealt with through proactive and online strategies [88].

3.2.5. Accuracy

Smart grids require high accuracy to reach complex coordination among multiple energy resources and loads. The accuracy stands for both the time instant perspective and the system parameter perspective. In particular, smart meters are required to provide real time system measurement and more frequent communications to allow complex system coordination in smart grids [89]. However, such requirements challenge the data storage capacity and communication constraints of smart meters [9]. The optimal strategies for smart meter deployment and measurement, as well as data analysis, are necessary to solve such issues.

3.2.6. Efficiency

Considering the limitation of the resources and physical constraints, the smart grid is required to operate with high efficiency. This indicates that optimization techniques are involved to minimize the operating cost [71]. As the complexity of the smart grid is growing, the system is required to transmit an enormous amount of data to achieve accurate and timely operation, increasing the pressure on the communication network. Therefore, approaches are required to extract fundamental information from the measured data before transmitting it through communication networks. Such approaches often taken place at the smart meter, by using certain algorithms such as a singular value decomposition-based method [90].

3.2.7. Security

The measured power system data are closely related to the energy consumption behaviours of users. Their privacy concern has drawn more attention and has become a substantial obstacle in the development of the smart grid. Therefore, privacy preservation has become one of the crucial features of smart grids to prevent information leakage such as address and identification [91]. Energy safety is another perspective of security, where energy theft and operation fault are crucial factors that influence smart grid performance [92].

3.3. Applications from Smart Meter Perspective

3.3.1. Smart Meter Deployment

As the smart grid becomes more complex, it requires massive smart meters for data collection monitoring and regulating utility energy consumption. Conventional approaches require a large scale of energy meter networks, which often suffer from high deployment, maintenance and data collection costs [32]. Thus, the deployment optimization of smart meters has drawn great attention. In particular, the deployment is required to use minimal number of smart meters to track massive utility states on time [93,94,95]. Research works often apply optimization techniques to the communication networks of smart meters, while considering practical constraints. For instance, one approach is to decompose the power distribution network into a forest of several trees, where the deployment locations, as well as the required number of smart meters, are optimized accordingly [32]. In addition, as the operation of smart meters requires energy, the energy consumption of large-scale smart meters is significant. It brings about problems to find optimal deployment and data transmission rate for smart meters to minimize the overall energy consumption [93]. Furthermore, the physical limitations of the communication networks could impact the overall performance of smart metering [94]. Limitations such as communication bandwidth and data transmission rate often result in communication delay and further jeopardize power system stability [95]. Such constraints should be considered during the optimization of smart meters deployment to obtain feasible results.

3.3.2. Automatic Metering

Since the smart meter is the key element in the control and optimization of smart grids, the approach for smart meters to collect and transmit data with accuracy and efficiency is vital to achieve stable and efficient operations in smart grids. The essential factors for automatic metering are illustrated in **Figure 9**. The smart meters can be deployed in various situations to measure different parameters. For instance, as smart meters are implemented in the customer domain, load monitoring is one of the important applications to track power usage for energy management. Traditionally, load monitoring is achieved through a power meter at a building level, which is classified as non-intrusive load monitoring (NILM) approach [42]. As the approach provides aggregated data, it is hard to differentiate power consumption patterns for different loads. Therefore, the intrusive load monitoring (ILM) approach is introduced, which provides precise power consumption of individual loads by installing smart power plugs at each electrical socket [43]. The ILM approach can further support applications such as activity recognition [44] and user–appliance interaction [45].

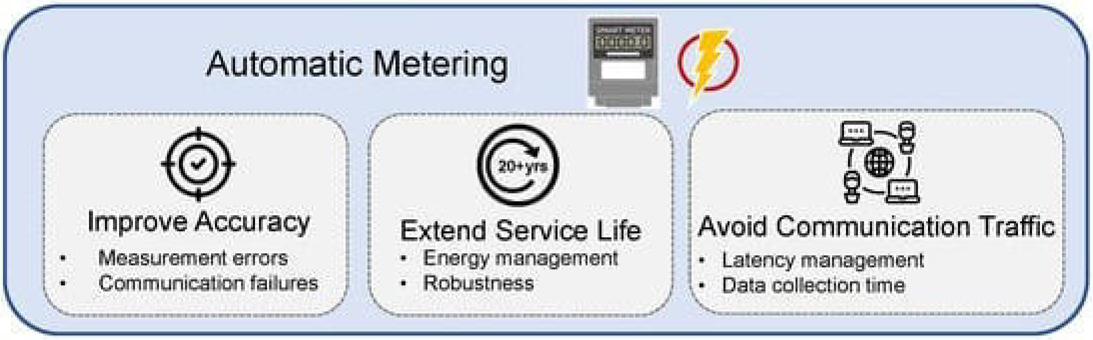


Figure 9. Essential factors for automatic metering.

As some parameters in the smart grid are not available for direct measurement, state estimation techniques are implemented to solve such issues [96]. In addition, smart meters require accurate consumption metering, even under extreme operating conditions, which is also a crucial factor to influence consumers' confidence in using smart meters [97]. The customers require precise energy readings to optimize their energy cost. Therefore, many techniques have been proposed to improve the observability and robustness of smart metering by enhancing the performance of state estimation algorithms against various uncertainties such as measurement errors or communication failures [96,97,98,99]. In particular, state estimation algorithms could apply uncertainty propagation theory to optimize the accuracy performance with the integration of smart meter data at multiple voltage levels [96]. The robustness against uncertainties can also be improved by data driven approaches, where the historical measured data are used for supervised learning to provide accurate system operating patterns [98]. As the smart meter can offer more precise energy measurements for individual loads, more detailed parameters in the power system can be obtained, which in turn, improves the state estimation accuracy [99].

For constantly providing quality services in smart grids, the smart meters are expected to last for several decades. Hence, it is crucial for them to manage their available energy resources. In other words, smart meters need to balance their operational performance and system lifetime according to energy management policies [100]. One feasible approach is to harvest energy from environmental resources such as solar and wind when they are available; otherwise, harvest electricity from smart grids [101,102]. The approach maintains the reliability of smart meters, while solving the uncertainty of environmental resources. In addition, energy harvesting management techniques are designed to consider the performance of monitoring and communication with high efficiency [55].

With the development of smart grids, smart meters interact during multiple operations, and the interaction becomes more frequent, especially in peak hours. This may create a lot of traffic and interference. Such issues lead to data transmission delay, where the latency management of the communication networks can be made [40]. The smart meters can also be separated into clusters with respect to their locations, and a data collection time is assigned based on the communication network [55].

3.3.3. Smart Meter Data Analysis

One of the advantages of the smart meter implementation is that it could provide more detailed measurement data in power networks with near-real-time resolution. By analysing the data through cloud computing or machine learning techniques, many applications are proposed to improve the performance of smart grids in various aspects, which is shown in **Figure 10**.

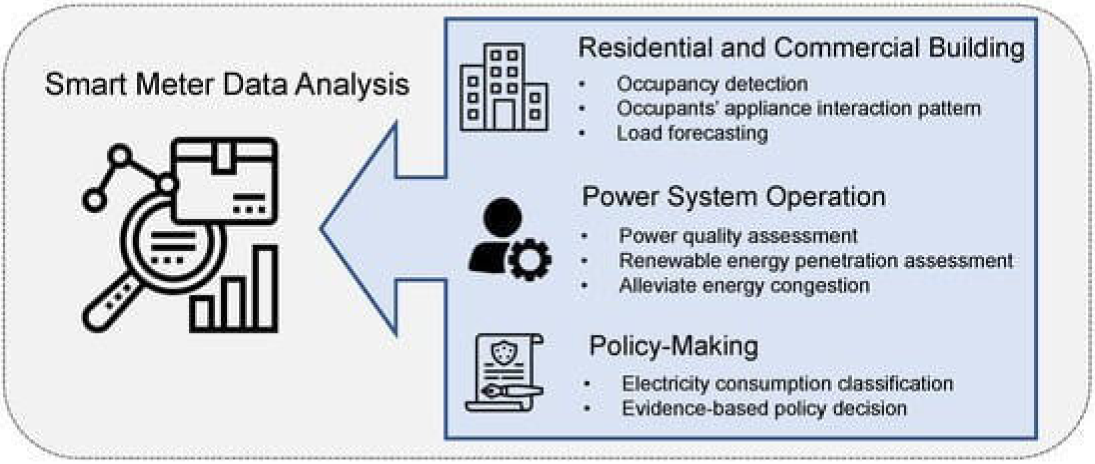


Figure 10. Aspects that smart meter data analysis is dedicated to improve.

In the residential and commercial buildings aspect, the smart meter data can be applied to analyse the occupancy status of households. With the aid of machine learning techniques, occupancy detection can find not only the current status, but also predict it in the future [36]. In addition, the occupants' appliance interaction patterns can be identified by analysing both the power consumption and occupants' presence data. The patterns reveal different profiles of interactions between occupants and appliances, which further improve energy performance [45]. For instance, an IoT-based plug load management system is proposed based on occupancy information. The system reduces the power consumption of plug loads (such as laptops and monitors) for individual users through their personalized control preferences, which greatly improves their satisfaction [103]. Furthermore, the smart meter data can feed data-driven models for building-level short-term load forecasting, which benefit demand response applications [104].

For the power system operation aspect, the smart meter data improve power quality assessment and renewable energy penetration assessment [25]. For instance, the growing penetration of renewable generations leads to overvoltage and overcurrent during their operations [105,106]. Analysing the data measured by the smart meters allow operators to design effective control strategies, as well as protective devices to mitigate voltage and current violations [107]. On the other hand, the data allow operators to alleviate energy congestion during peak hours, considering the physical limitations of power transmission networks [108,109]. Using the data collected among smart meters, the congestion issue can be modelled as a knapsack problem, where the utility control centre can disconnect certain DGs accordingly to maintain the system stability [108]. In addition, as the customers' behaviours are unknown, the model can be generated based on the Poisson point process to avoid the traffic of power transmission networks and maximize the transmission throughput [109].

On the policy-making aspect, the smart meter data help to facilitate making evidence-based policy decisions. In particular, the smart meter data are closely related to the power consumption patterns of users, which can be used for electricity consumption classification [110]. It reveals demographic and locality information of customers that provide the grid operator with better knowledge of their occupancy behaviourss [111]. Such information can benefit demand response operations and potentially support evidence-based policy decisions [112]. A case study to optimize energy management and the required energy capacity for a large group of households in the Netherlands is conducted over one year [113]. The study shows that consumers contribute to the demand response by changing their consumption behaviourss according to the dynamic electricity tariff. The data describe the detailed energy consumption behaviours with and without energy storage systems, which could further promote the development of novel energy technologies, as well as proper demand response policies.

3.3.4. Consumer Profiling

The smart meter data often reflect the energy consumption behaviours of customers, which can be used for analytical studies to identify profiles such as network topologies, loads and prosumers. An infographic is shown in **Figure 11**. The identification could provide more information to the grid operator, so that the operations could be more precise and, hence, more efficient. In particular, the topology information of a power distribution network is crucial for its efficient operation. However, the network connectivity is often not available in low voltage distribution networks due to its flexibility and complexity. The number of prosumers who consume and produce energy through PV power generation is also increasing. Such prosumers in the networks change their energy production and consumption behaviours from time to time. To identify the distribution network topologies in a cost-effective way, the data driven approach can be used based on smart meter data [37]. The measurement of smart meters provides the network connectivity in time series, where the graph's theoretic interpretation is applied to infer the steady-state network topology. For prosumer identification, the electricity utilities have lack of knowledge of the location and size of all solar prosumers due to unauthorized or unreported installations. However, the installation of smart meters increases the visibility of energy flow among end-users, which provides granular information that improves the accuracy of prosumer identification and load profiling [38]. Such knowledge can support better circuit protection and voltage regulations and improve the situational awareness of smart grid operators, such that a more efficient demand side management strategy can be applied [39]. The load profiling indicates the categorization of load according to energy utilization behaviours. The utility operators would improve the scheduling and forecasting processes and arrange proper demand side management if accurate load profiling is provided. For instance, knowledge of flexible loads like air conditioners and washing machines could support the operator making accurate optimization models for economic dispatch [22]. However, as accuracy of the profiles improves, the data complexity and variability are also increased. It would bring about more pressure on both the communication and computation capacity. To reduce the data size while maintaining their accuracy, approaches such as clustering algorithms are hence studied [114].

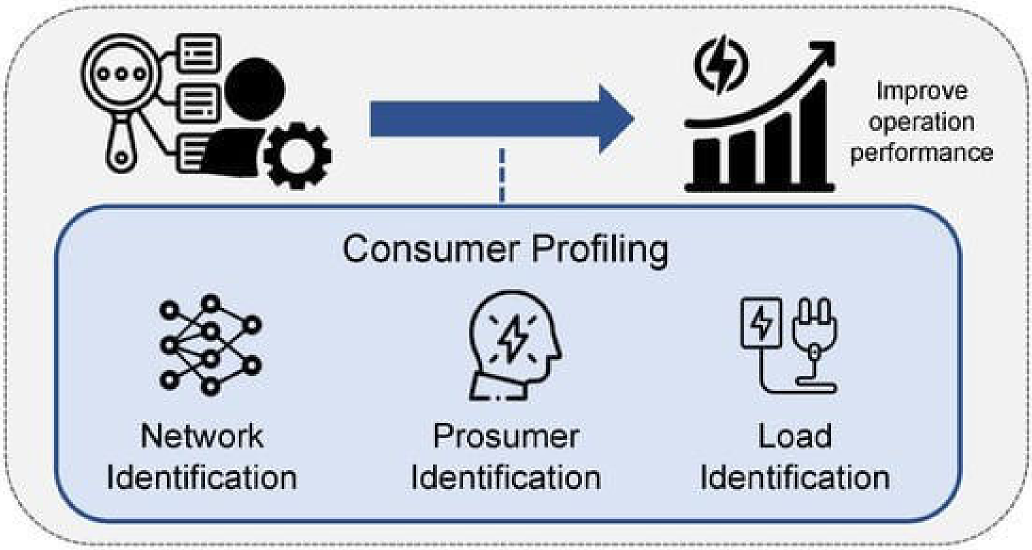


Figure 11. Consumer profiling.

3.3.5. Privacy Protection

As the smart meter data reflect detailed energy consumption behaviours of consumers, it leads to serious concerns about privacy protection [24]. There are two main approaches to privacy protection. The first approach modifies the smart meter data before sending it to the utility provider. The fundamental concept of this approach is to distort the data to protect the privacy of individuals, which includes methods such as data obfuscation [115], data aggregation [116] and data anonymization [117]. However, distorting the data also prevents the distribution system operator from precisely monitoring the grid parameters and making rapid reactions. The second approach is to directly modify the actual energy consumption profile by introducing energy storage systems. The actual energy consumption behaviours of users are hidden as the charge and discharge of the energy storage systems are added to the total energy consumption [118]. However, it also impacts the accuracy of data analysis, which further deteriorates the operating performance such as load forecasting and energy storage sizing. The privacy protection is expected to be one of the essential topics of smart grid developing towards cyber-physical systems, where more online interactions are involved among multiple domains in various applications.

3.3.6. Fault Detection

During the operation of smart grids, there are various types of electrical incidences occurs where reactions are required to take place rapidly and effectively. The operators could only achieve this with the support of advanced monitoring and decision assistant tools for collecting and analysing real-time data from the whole power system [119]. The fault detection is the essential factor to the reliability of the smart grid, which also provides the smart grid with the ability to self-heal and isolate to avoid or limit negative consequences [120]. The faults are often associated with abnormal voltages, currents and phases, which can be detected by analysing their shapes [121]. Smart meters are key components that measure system parameters such as the temperature of transmission lines, power outages and power usage. They could detect the faults and alert the operators through communication networks. Furthermore, smart meters can be applied to transmission and distribution networks to reduce energy losses, both technically and commercially [122]. The technical energy losses are related to the miss operation of the power system, where the smart meters will alert the operator by applying algorithmic procedures [123]. The commercial loss is often caused by energy theft, where the implementation of smart meters can detect remote exploits and local physical tampering of energy theft. In particular, the smart meters form an intrusion detection system, which combines the energy consumption data with audit logs of physical and cyber events to generate a more accurate model for detecting theft-related behaviour's [124].

4. Further Developments of Smart Grids, and Challenges of Smart Meters

Future smart grids are expected to operate in more efficient, flexible, reliable, sustainable, decentralized, secure and economic manners [5]. In particular, the smart grid is expected to implement more distributed generators to solve large transmission loss due to long transmission distances. They will be downscaled into microgrids and nano grids, which have more connections with multiple voltage levels [125]. More electrical devices will participate in energy management through the energy market. More secure data encryption and transmission protocols will be involved in various communications. Such changes will result in more complex and frequent operations in the smart grid. To ensure operational stability, the smart grid essentially requires higher computation and communication capabilities, which in turn, promote the future development of smart meters.

4.1. Communication Capacity

A reliable communication network is one of the essential prerequisites to stable operations in the smart grid. In particular, many applications in the smart grids are achieved through distributed approaches, where smart meters are involved to provide a reliable communication network for support. Data collected and transmitted through smart meters realize the coordination of multiple electric devices such as EVs and energy storage systems. An unreliable communication network will impact the coordination and further deteriorate the operation performance of the smart grid. Some studies assume that smart meter data can be transmitted on time [126]. However, in practical smart grid operations, communication delays and transmission errors are often inevitable, which can result in negative impacts on the stability of power systems [127]. To overcome such challenges, the smart grid could apply 5G technologies to speed up the data transfer rate. The 5G technology stands for the fifth-generation cellular network technology, which has been developed and applied in many countries due to its advantages of data transfer speed, reliability and security [128]. In addition, due to the mobility feature of 5G communication, it could further allow consumers to better track their energy usage and participate in the demand response through remote control applications. For instance, the communication between EVs and smart meters allows customers to remotely track and control the charging and discharging of their EVs according to the incentives. The communication also enables the grid operator to obtain the latest information of the overall EV energy consumption and to provide suitable demand response strategies [129]. However, there are also challenges to the implementation of 5G technology due to its low transmission distance. The electromagnetic wave frequency spectrum of 5G is much larger than the frequency of 1G–4G, which brings about a large communication bandwidth, but a lower transmission distance [130]. The ability to transfer data through obstacles is much lower than 1G–4G, which leads to less communication reliability. It brings about challenges to the development of smart grids. To solve such issues, one approach is to increase the density of 5G cellular network. However, this also results in higher deployment cost [131]. The other feasible approach is to apply hybrid communication technologies [132]. The data can transmit among multiple communication protocols in different circumstances. In addition, the energy transfer capacity of 5G is much higher than the 4G, which indicates that more data can be transmitted simultaneously. However, it also has higher energy consumption, which in turn, challenges the energy management strategy on how to optimize data transmission [133]. Furthermore, research on 6G technologies, considering future communication traffic, is proposed, due to the explosive growth of communication demands [134]. Compared to 5G, 6G technologies are superior in multiple perspectives such as data transmission rate, efficiency, reliability and security.

4.2. Computation Constraints

With the constant development of smart grids and deployment of smart meters, the related operation data also significantly increase in terms of volume, velocity, variability and complexity. It leads to a series of challenging problems considering the limited data storage and computing power. To solve such issues, one approach is to apply cloud computing technologies [135]. With the improvement of communication technologies, sophisticated data processing and storage procedures could be realized through cloud services. The cloud-based smart metering model is formed to optimize energy utilization through cloud platforms such as IBM Core metrics and Google Big Query [23]. Alternatively, edge computing technologies would also enhance the computing power in a distributed manner [136]. It mitigates the burdens of the centre cloud computing terminals. However, as smart meters often monitor different types of data, it brings about variability and complexity to process them. The smart grid faces the challenge to process mixed data types in different time scales, formats and forms. Particularly for applications related to forecasting and optimization, the smart grid needs to process data from different aspects such as the power networks and climate. Therefore, data standardization and data fusion are required to establish smart grids. In addition, as the operation data are uploaded for cloud computing, it also raises privacy and security issues as the data may be vulnerable to unauthorized usage.

4.3. Cooperation with "Smarter" AI

The term AI is represented by intelligent computer programs. With rapid evolution of machine learning technologies and acceleration of hardware improvements, AI-based computer programs can behave more intelligently according to different situations [137]. On the other hand, the interconnected smart meters create the environment of the Internet of Things (IoT) as it facilitates energy interaction among prosumers and significantly increases the capacity of devices number connected to the smart grid [138]. The devices are monitored and managed by the mutually connected smart meters, and they coordinate according to the optimal control signal to realize system-wise corporations. The optimization is provided by the IoT-based smart grids, which is expected to become "smarter" as it opens up possibilities to integrate AI into power systems [139]. The decision making, self-organizing and cognitive functionalities enable the smart grid to obtain comprehensive awareness of system status and act more like a grid operator [140]. Using the measured data from smart meters, the AI algorithms can be trained to be more suitable for handling operations in smart grids. However, there are also challenges considering the limitation of the existing AI algorithms and how humans can better corporate with AI in smart grid operations.

4.4. Consumers' Engagement and Awareness

The engagement of consumers is crucial as they are the end-users of smart meters. Their acceptance of smart meter fundamentally affects the data quality of the smart grid, which further influence its performance. Although smart meters bring about great benefits to the operations of smart grids, consumers may still hesitate to install them due to multiple concerns [141]. Such negative concerns slow down the installation process and hinder the development of smart grids. It is reported that the global implementations of smart meters have been interrupted by obstacles multiple times [142]. To improve the engagement and awareness of consumers, there is a challenge to highlight the importance of smart meters and to make suitable policies to facilitate their implementations. Specifically, the prior question is to understand the user perception of adopting smart meters. Studies find that barriers can be categorized into several factors [143].

1. External and internal influence: The external influence indicates the impact of user's decisions externally such as policies or other users. In contrast, the internal influence indicates the intrinsic determinant that impacts the user's decisions, such as awareness and self-motivation. To overcome such barriers, some approaches can be applied, including incentives and publicity.
2. User appeal and ability: User appeal and ability refer to the smart metering technologies that can constantly attract users' interest and provide suitable control ability for users to manage their power consumption. To overcome such barriers, personalized services can be applied to satisfy individual requirements.
3. Reliability: The reliability of the smart meter is essential to guarantee reliable operations and low maintenance costs. It requires the smart meter to operate under extreme conditions like low temperatures, high voltages and disclosure to electromagnetic waves, while maintaining high performance. High reliability can also improve the customers' confidence and satisfaction.
4. Ease of use: Ease of use stands for the difficulty of users interacting with smart meters. As most of the smart meters are installed on the consumer side, they are the interface for consumers to interact with smart grids. Therefore, a user-friendly UI of smart meters is important for consumers to better track their energy usage and understand consumption policies to rapidly respond to the variations in smart grids.
5. Privacy: Smart meter data are regarded as users' privacy, where the level of data security impacts their acceptance of smart meters. Therefore, advanced privacy protection technologies are required.

The factors can be used to guide future energy management system design and policy-making. The proper design would improve the consumers' knowledge of the energy transition towards renewable energies. It also facilitates the consumers to install suitable peripherals for smart meters to enhance their performance and provide more benefits to consumers. In addition, consumers are less motivated, concerning the expensive initial installation cost of smart meters with limited benefits in return [144]. Improving the performance of operations in smart grids, as well as expanding smart meter implementations with novel applications, would potentially promote their installation benefits. For instance, smart metering technologies can support the fourth industrial revolution, which can be expanded to multiple industry fields [145]. A case study is conducted in Singapore, which investigates the challenges and strategies for adopting smart technologies in the construction industry. The study seeks to enhance industrial performance by improving workflows and work conditions [146].

5. CONCLUSIONS

In this paper, a comprehensive review of the control and optimization of smart grids using smart meters is presented. Challenges for the energy transition towards renewable energies future are identified in both the smart grid and smart meter perspectives. It is shown that energy providers and consumers in smart grids coordinate with each other through various applications, which are supported by multiple control and optimization technologies. The applications from smart grid and smart meter perspectives are mutually supported and facilitated, which can be summarized in the following ideas.

1. From the smart grid perspective, many applications are developed to facilitate the penetration of renewable energies and to increase the benefit for grid operators and consumers with the support of smart meters. The evolution of communication and computation technologies further pushes the development of the smart grid towards the IoT in the future, where more electric devices are expected to be involved in more intelligent cooperative operations.
2. From the smart meter perspective, the development of smart grids reflects several essential features, which promote the evolution of smart meter applications. The applications are not only dedicated to improving the operation performance, but also enhance the relationship between customers. Customer awareness significantly influences the implementation of smart meters. Requirements such as personalized services and privacy protection stimulate the advancement of smart metering technologies, which are expected to have more interactions with consumers.

REFERENCES

1. Diahovchenko, I.; Kolcun, M.; Čonka, Z.; Savkiv, V.; Mykhailyshyn, R. Progress and challenges in smart grids: Distributed generation, smart metering, energy storage and smart loads. Iran. J. Sci. Technol. Trans. Electr. Eng. **2020**, 44, 1319–1333.
2. Dileep, G. A survey on smart grid technologies and applications. Renew. Energy **2020**, 146, 2589–2625. [
3. Hossain, M.; Madlool, N.; Rahim, N.; Selvaraj, J.; Pandey, A.; Khan, A.F. Role of smart grid in renewable energy: An overview. Renew. Sustain. Energy Rev. **2016**, 60, 1168–1184. [
4. Bajaj, M.; Singh, A.K. Grid integrated renewable DG systems: A review of power quality challenges and state-of-the-art mitigation techniques. Int. J. Energy Res. **2020**, 44, 26–69. [
5. Faheem, M.; Shah, S.B.H.; Butt, R.A.; Raza, B.; Anwar, M.; Ashraf, M.W.; Ngadi, M.A.; Gungor, V.C. Smart grid communication and information technologies in the perspective of Industry 4.0: Opportunities and challenges. Comput. Sci. Rev. **2018**, 30, 1–30. Lu, X.; Wang, W.; Ma, J. An empirical study of communication infrastructures towards the smart grid: Design, implementation, and evaluation. IEEE Trans. Smart Grid **2013**, 4, 170–183.
6. Ourahou, M.; Ayrir, W.; Hassouni, B.E.; Haddi, A. Review on smart grid control and reliability in presence of renewable energies: Challenges and prospects. Math. Comput. Simul. **2020**, 167, 19–31.
7. Rehmani, M.H.; Reisslein, M.; Rachedi, A.; Erol-Kantarci, M.; Radenkovic, M. Integrating renewable energy resources into the smart grid: Recent developments in information and communication technologies. IEEE Trans. Ind. Inform. **2018**, 14, 2814–2825.

8. Avancini, D.B.; Rodrigues, J.J.; Martins, S.G.; Rabêlo, R.A.; Al-Muhtadi, J.; Solic, P. Energy meters evolution in smart grids: A review. J. Clean. Prod. **2019**, 217, 702–715.
9. Martins, J.F.; Pronto, A.G.; Delgado-Gomes, V.; Sanduleac, M. Smart meters and advanced metering infrastructure. In Pathways to a Smarter Power System; Elsevier: Amsterdam, The Netherlands, 2019; pp. 89–114. [
10. Lovell, H. The promise of smart grids. Local Environ. **2019**, 24, 580–594. [
11. Rihan, M. Applications and requirements of smart grid. In Smart Grids and Their Communication Systems; Springer: Singapore, 2019; pp. 47–79. [
12. Tuballa, M.L.; Abundo, M.L. A review of the development of Smart Grid technologies. Renew. Sustain. Energy Rev. **2016**, 59, 710–725. [
13.], M.; Korczak, K.; Skoczkowski, T. Technology innovation system analysis of electricity smart metering in the European Union. Energies **2020**, 13, 916. [
14. . Smart metering trends, implications and necessities: A policy review. Renew. Sustain. Energy Rev. **2016**, 55, 227–233. [
15. Cooper, A.; Shuster, M. Electric Company Smart Meter Deployments: Foundation for a Smart Grid; The Institute for Electric Innovation (IEI): Washington, DC, USA, 2016. [
16. Rivas, A.E.L.; Abrao, T. Faults in smart grid systems: Monitoring, detection and classification. Electr. Power Syst. Res. **2020**, 189, 106602. [
17. Kabalci, E.; Kabalci, Y. Smart Grids and Their Communication Systems; Number 1; Springer: Singapore, 2019.
18. Raza, N.; Akbar, M.Q.; Soofi, A.A.; Akbar, S. Study of smart grid communication network architectures and technologies. J. Comput. Commun. **2019**, 7, 19–29.
19. Ghorbanian, M.; Dolatabadi, S.H.; Masjedi, M.; Siano, P. Communication in smart grids: A comprehensive review on the existing and future communication and information infrastructures. IEEE Syst. J. **2019**, 13, 4001–4014.
20. Abrahamsen, F.E.; Ai, Y.; Cheffena, M. Communication technologies for smart grid: A comprehensive survey. Sensors 2021, 21, 8087.
21. Wang, Y.; Chen, Q.; Hong, T.; Kang, C. Review of smart meter data analytics: Applications, methodologies, and challenges. IEEE Trans. Smart Grid 2018, 10, 3125–3148. [
22. Alahakoon, D.; Yu, X. Smart electricity meter data intelligence for future energy systems: A survey. IEEE Trans. Ind. Inform. 2015, 12, 425–436. [
23. El Mrabet, Z.; Kaabouch, N.; El Ghazi, H.; El Ghazi, H. Cyber-security in smart grid: Survey and challenges. Comput. Electr. Eng. 2018, 67, 469–482. [
24. Chaudhari, A.; Mulay, P. A bibliometric survey on incremental clustering algorithm for electricity smart meter data analysis. Iran J. Comput. Sci. 2019, 2, 197–206. [
25. IEEE Innovation. The Smart Grid Could Hold the Keys to Electric Vehicles. 2018. Available online: https://innovationatwork.ieee.org/the-smart-grid-could-hold-the-keys-to-electric-vehicles/ (accessed on 17 December 2022).
26. Keeping, S. Power Modules Underpin Smart Grid Adoption; Digi-Key Electronics: Thief River Falls, MN, USA, 2015. [
27. Gopstein, A.; Nguyen, C.; O'Fallon, C.; Hastings, N.; Wollman, D. NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 4.0; Department of Commerce, National Institute of Standards and Technology: Gaithersburg, MD, USA, 2021.
28. Tur, M.R.; Bayindir, R. A review of active power and frequency control in smart grid. In Proceedings of the 2019 1st Global Power, Energy and Communication Conference (GPECOM), Nevsehir, Turkey, 12–15 June 2019; pp. 483–488. [
29. Jordehi, A.R. Optimisation of demand response in electric power systems, a review. Renew. Sustain. Energy Rev. 2019, 103, 308–319.
30. Darmis, O.; Korres, G. A Survey on Hybrid SCADA/WAMS State Estimation Methodologies in Electric Power Transmission Systems. Energies 2023, 16, 618. [

31. Hao, X.; Wang, Y.; Wu, C.; Wang, A.Y.; Song, L.; Hu, C.; Yu, L. Smart meter deployment optimization for efficient electrical appliance state monitoring. In Proceedings of the 2012 IEEE Third International Conference on Smart Grid Communications (SmartGridComm), Tainan, Taiwan, 5–8 November 2012; pp. 25–30. [
32. Wen, G.; Yu, X.; Liu, Z. Recent progress on the study of distributed economic dispatch in smart grid: An overview. Front. Inf. Technol. Electron. Eng. **2021**, 22, 25–39. [
33. Alirezazadeh, A.; Rashidinejad, M.; Abdollahi, A.; Afzali, P.; Bakhshai, A. A new flexible model for generation scheduling in a smart grid. Energy **2020**, 191, 116438. [
34. Alotaibi, I.; Abido, M.A.; Khalid, M.; Savkin, A.V. A comprehensive review of recent advances in smart grids: A sustainable future with renewable energy resources. Energies **2020**, 13, 6269. [
35. Razavi, R.; Gharipour, A.; Fleury, M.; Akpan, I.J. Occupancy detection of residential buildings using smart meter data: A large-scale study. Energy Build. **2019**, 183, 195–208. [
36. Pappu, S.J.; Bhatt, N.; Pasumarthy, R.; Rajeswaran, A. Identifying topology of low voltage distribution networks based on smart meter data. IEEE Trans. Smart Grid **2017**, 9, 5113–5122. [Khan, Z.A.; Jayaweera, D. Smart meter data based load forecasting and demand side management in distribution networks with embedded PV systems. IEEE Access **2019**, 8, 2631–2644. [
37. Donaldson, D.L.; Jayaweera, D. Effective solar prosumer identification using net smart meter data. Int. J. Electr. Power Energy Syst. **2020**, 118, 105823. [
38. Al-Khatib, O.; Hardjawana, W.; Vucetic, B. Traffic modeling and optimization in public and private wireless access networks for smart grids. IEEE Trans. Smart Grid **2014**, 5, 1949–1960. [
39. Shaukat, N.; Ali, S.; Mehmood, C.; Khan, B.; Jawad, M.; Farid, U.; Ullah, Z.; Anwar, S.; Majid, M. A survey on consumers empowerment, communication technologies, and renewable generation penetration within Smart Grid. Renew. Sustain. Energy Rev. **2018**, 81, 1453–1475. [**Google Scholar**] [**CrossRef**]
40. Aladesanmi, E.; Folly, K. Overview of non-intrusive load monitoring and identification techniques. IFAC-PapersOnLine **2015**, 48, 415–420. [**Google Scholar**] [**CrossRef**]
41. Tekler, Z.D.; Low, R.; Zhou, Y.; Yuen, C.; Blessing, L.; Spanos, C. Near-real-time plug load identification using low-frequency power data in office spaces: Experiments and applications. Appl. Energy **2020**, 275, 115391. [
42. Franco, P.; Martinez, J.M.; Kim, Y.C.; Ahmed, M.A. IoT based approach for load monitoring and activity recognition in smart homes. IEEE Access **2021**, 9, 45325–45339.
43. Tekler, Z.; Low, R.; Blessing, L. Using smart technologies to identify occupancy and plug-in appliance interaction patterns in an office environment. IOP Conf. Ser. Mater. Sci. Eng. **2019**, 609, 062010.

DEDUCING ERRORS IN TRILATERATION LOCALIZATION TECHNIQUE USING AN ACOUSTIC SOURCE

Manish Kumar

Associate Professor

Department of Computer Science & Engineering

JB Institute of Technology, Dehradun

ABSTRACT

The continuously augmenting range of Wireless Sensor Systems (WSNs) applications requires accurate node location which needs efficient and error free localization techniques. Localization techniques created in the past totally took into account fine numerical calculation of different network parameters, for example, transmission range, propagation shape, transmitted or received power, sending or arrival time, connectivity information etc.
As of late, research is confined to minimization of localization error in the available techniques. Here we classical techniques employed for localization that are trilateration and TDOA for an acoustic source and deduce error parameters like mean absolute error and root mean square error
Keywords-*Wireless Sensor Systems, localization, , transmission range, , propagation shape, acoustic source, mean absolute error, root mean square error*

INTRODUCTION

Localization can be defined as the technique of defining exact position of sensor nodes. To be exact it can be depicted as a system of discovering spatial relationships among objects. There are various existing localization techniques for solving the localization problem. While dealing with localization we have to keep in mind the assumptions about the device hardware, signal propagating models, timing and energy needs, network composition, costs incurred in communication, error requirements, node activity and mobility.

Two classical techniques are presented below:

(a) Trilateration

Trilateration is a mechanism to know the absolute or relative coordinates of an object according to continuous measurement ranges taken from various stations located at aware locations. As its implementation is quite easy, it is used quite often in applications like surveillance in aerospace, radar, robotics and applications which are automated to give location known facilities. It has some anomalies and errors are present in all the range-based techniques.

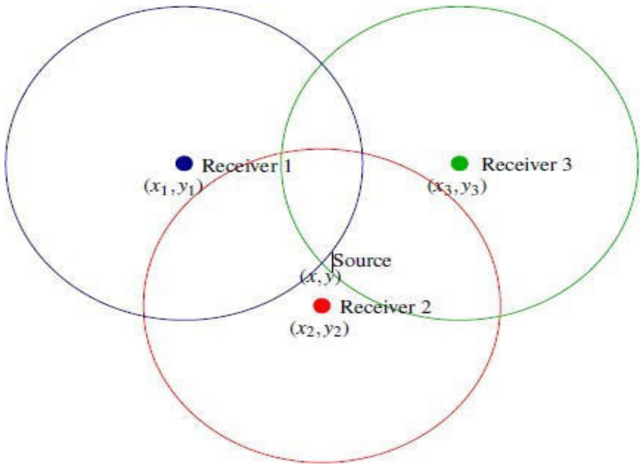


Figure 1- Trilateration Mechanism

METHODOLOGY

Implementation of Trilateration

A Sound file is taken as input to get a matrix which has 606171 double values in 2 columns and a variable containing the frequency of the input wave file i.e. 44100.

(i) The matrix and variable are named rows and freq respectively.

(ii) The values contained in rows are segregated into 10 equal sets each set containing 2000 values, starting from 1 and ending in 2000 values. So there are 10 sets of values and each set is stored in the variables d1, d2, ….,d10 respectively.

(iii) 3 initial parameters namely Sigd1, Sigd2, Sigd3 are taken to be 0.5, 0.2 and 0.1 respectively. Another parameter Sig0 is 0.5

An Eigen (eye matrix) W is created which contains 200x200 double values.

(iv) (a) A variable m is taken, initially it is assigned to 1.

(b) An iteration is carried out from 1 to 200 and values are assigned from W(1,1) to W(200,200) by using the term

$$Sig0^2 / Sigd1^2$$

(c) 3 coordinate positions are initially chosen to be

$(x_a, y_b) = (30,150)$ $(x_b, y_b) = (10, 120)$ $(x_c, y_c) = (50, 50)$

and the reference node (or anchor node) is

$$(x_f, y_f) = (140, 90)$$

(d) 3 matrices namely V, B and f are created containing (600x600) values, (200x200) values and (200x1) values all initialized to zeros, variables max_iter is initialized to 200, iter to 1 and continue_moving to 1.

(e) Another 3 parameters pi = 10, last pi = 20 and threspoint =1.0e-06 are taken according to the network scenario.

(v)Now the following calculations are performed till continue_moving is equal to 1.

$$dax = \sqrt{(x_a - x_f)^2 + (y_a - y_f)^2}$$

$$dbx = \sqrt{(x_b - x_f)^2 + (y_b - y_f)^2}$$

$$dcx = \sqrt{(x_c - x_f)^2 + (y_c - y_f)^2}$$

B's 1st row

$$b(1,:) = [\ (x_a - x_f)/dax \quad (y_a - y_f)/dax\ ]$$

B's 2nd row

$$b(2,:) = [\ (x_b - x_f)/dbx \quad (y_b - y_f)/dbx\ ]$$

B's 3rd row

$$b(3,:) = [\ (x_c - x_f)/dcx \quad (y_c - y_f)/dcx\ ]$$

Now f is a 200x1 double matrix and it's first value is calculated as

$$fo(1) = -(d1(1) - \sqrt{(x_a - x_f)^2 + (y_a - y_f)^2})$$

and similarly fb(2) and fb(3) are calculated as follows:

$$fo(2) = -\left(d2(1) - \sqrt{(x_b - x_f)^2 + (y_b - y_f)^2}\right)$$

$$fo(3) = -\left(d3(1) - \sqrt{(x_c - x_f)^2 + (y_c - y_f)^2}\right)$$

(vi) Now solving and updating, and checking convergence na = b' * W * b

t = b' * W * fo del = inv (na) * t

x_f and y_f comes from

$x_f = x_f$ + del (1)

$y_f = y_f$ + del (2) v = f – B * del phi = v' * w * v

Procedure for Convergence check

if (abs (pi –last_pi) / last_pi < threshpoint)
continue_moving = display the message (" We have converged"); last_pi = pi
if iter > 10
continue_moving= 0
display the message ("Too many iterations");
increment iter by 1
Display the final coordinates as [, y_f]

Results:

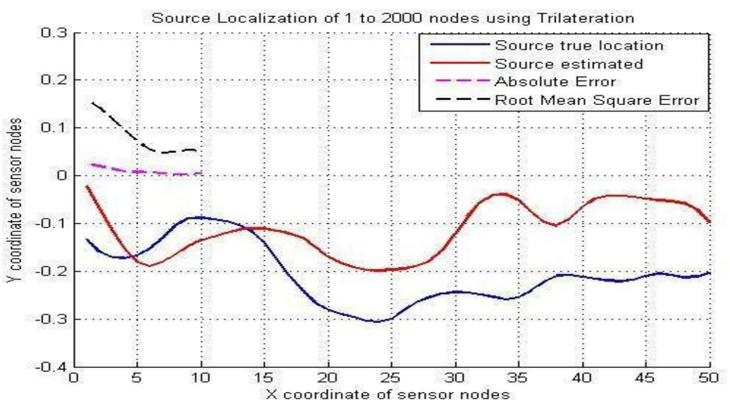


Figure 2- Localization of 1-2000 nodes using Trilateration

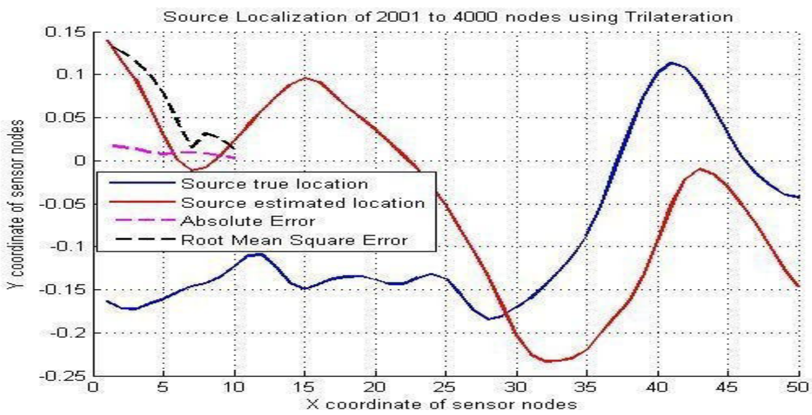


Figure 3- Localization of 2001-4000 nodes using Trilateration

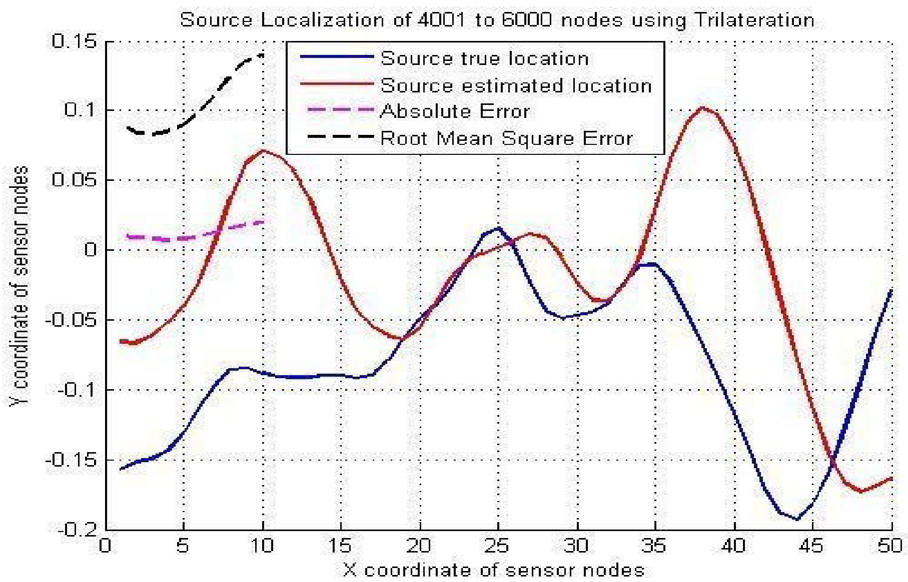


Figure 4- Localization of 4001-6000 nodes using Trilateration

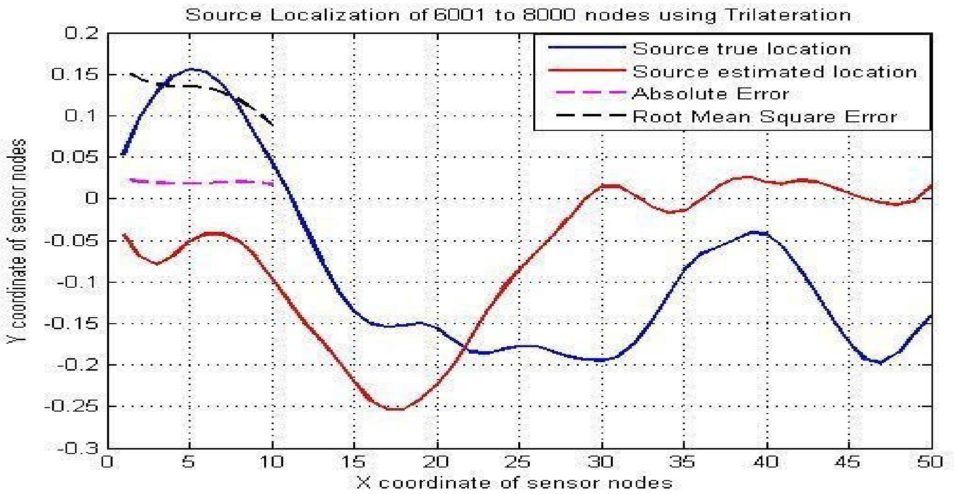


Figure 5- Localization of 6001-8000 nodes using Trilateration

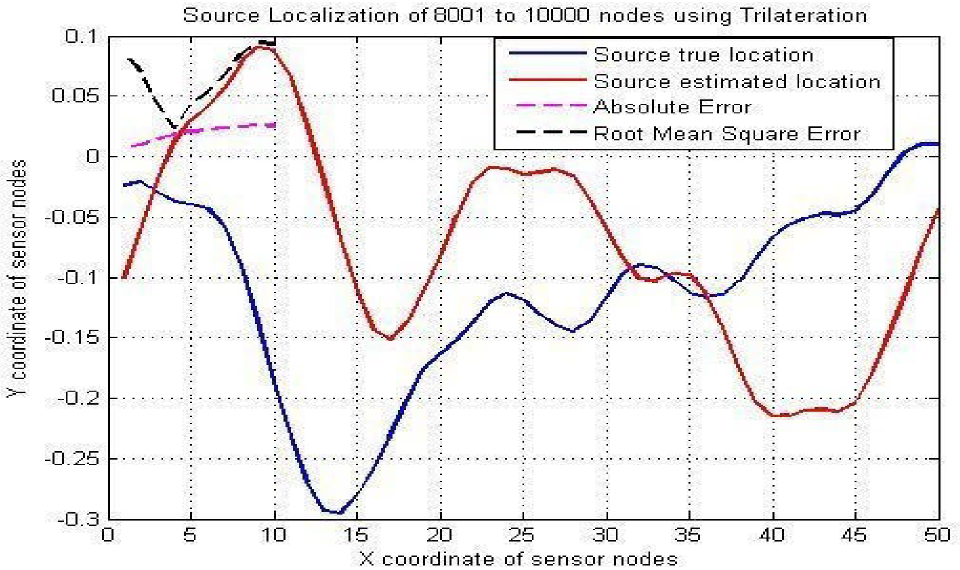


Figure 6- Localization of 8001-10000 nodes using Trilateration

Error Deduction

Table 1- Localization Errors for source values through Trilateration

Trilateration Localization	Mean Absolute Error	Root Mean Square Error
1-2000	0.2446	0.4788
2001-4000	0.4796	0.6637
40001-6000	0.7026	0.8000
6001-8000	0.9122	0.9108
8001-10000	1.1127	1.0068
10001-12000	1.3044	1.0904

12001-14000	**1.4972**	**1.1661**
14001-16000	**1.7002**	**1.2357**
16001-18000	**1.9158**	**1.3012**
18001-20000	**2.1419**	**1.3642**

CONCLUSION AND FUTURE SCOPE

The Trilateration technique for localization has been applied to an acoustic source and the results have been deduced for an acoustic source.
It is evident that the technique produces some errors as numerous parameters of network, information that is connecting etc. are likely to get affected by environmental situation and obstacles that are present in the environment.
We have taken two parameters for error calculation that are Mean Absolute Error and Root Mean Square Error respectively. It has been found that for Trilateration technique the numerical values for the two error parameters are less than that of the Time Difference of Arrival technique (TDOA). For the sake of convenience, we have taken 2000 source values at a time.
It is found that the performance of Trilateration is satisfactory.

(i) Comparison of other localization techniques like RSSI and AOA can be done so as to assist in devising a new technique which gives better result.
(ii) Trilateration and TDOA techniques can be merged to give a better localization technique.

REFERENCES

[1] C. Wang and L. Xiao, "Sensor localization in concave environments," ACM Transactions on Sensor Networks, vol. 4, no. 1, article 3, 2008.

[2] Jungang, Chengdong, Hao and Yang" An improved RSSI Measurement in Wireless Sensor Networks." Procedia Engineering, Elsevier, vol. 15. pp. 876–880, 2011.

[3] N. Patwari, J. N. Ash, S. Kyperountas, A. O. Hero III, R. L. Moses, and N. S. Correal, "Locating the Nodes: Cooperative Localization in Wireless Sensor Networks," IEEE Signal Processing Magazine, vol. 22 no. 4, pp. 54–69, 2005.

[4] A. Srinivasan and Jie wu "A Survey on Secure Localization in Wireless Sensor Networks", Florida Atlanatic University, USA.

[5] C. Miao, G. Dai, K. Mao, Y. Li and Q. Chen. "RI-MDS: Multidimensional Scaling Iterative Localization Algorithm using RSSI in Wireless Sensor Networks". Computer and information Science, Springer, vol. 501. pp. 164–175, 2015.

[6] H. C. So and L. Lin, "Linear Least Squares Approach for Accurate Received Signal Strength Based Source Localization," IEEE Transactions on Signal Processing, vol. 59, no. 8, pp. 4305-4040, 2011.

[7]] P. Pivato, L. Palopoli, and D. Petri, "Accuracy of RSS-Based Centroid Localization Algorithms in an Indoor Environment," IEEE Transactions on Instrumentation and Measurement, vol. 60, no. 10, pp. 3451-3460, 2011.

Machine Learning in Cricket: A Review

Santosh Kumar Mishra

Assistant Professor ,Department of CSE

JB Institute of Technology, Dehradun ,

ABSTRACT

Cricket is now a well-known team sport played all over the world and is regarded as the second most popular sport overall. There is a huge need for cricket data analytics due to the abundance of available data and the advancement of Machine Learning (ML) technology. In the recent two decades, there has been a sharp growth in the number of ML applications in the field of cricket. This paper undertakes a thorough analysis of the published research from the years 2001 to 2021 on ML applications in cricket.

Keywords: Machine Learning applications, Cricket, Cricket outcome prediction

INTRODUCTION

Any successful cricket team now relies heavily on data analysis. The results of cricket analytics offer a deeper understanding of the players and the game, which is highly beneficial to those who are involved in it, including current players, technical staff, managers, and the next generation of players. Administrators constantly look for novel solutions to improve cricket players' performances and provide them a competitive edge because of how quickly the sport has evolved. The competitive sports environment is characterized by intense and demanding events.
Sport athletes have a responsibility to manage pressure and psychological reactions in order to reach their full potential. The goal of player-performance management is to maximize player performance while lowering the risk of injury that comes with participating in different sports. The examination of cricket data is critical to this procedure. The player-performance management is related to enhancing player performance while lowering the risk of injury hazards present in a variety of sports. Cricket data analysis has a significant role to play in this process.
Machine Learning (ML), a subfield of artificial intelligence, is a group of computer algorithms that enable computers to automatically learn from and improve upon experience. The primary goal of ML approaches is to replace time-consuming human operations with a greater level of automation in the knowledge engineering process. The popularity of ML approaches used in sports data analytics has skyrocketed because to the quantity of computing power and data.Over the past two decades, the development of the ML method and its applications has demonstrated incredible maturity. Furthermore, thanks to the abundance of sport-related data and the advancement of machine learning algorithms, sports data analytics have achieved a greater level.By enabling these systems to learn from data without imposing rules or being explicitly programmed, ML approaches distinguish them from ordinary computer systems.
Systematic reviews assist in gathering empirical data on the ML-based research's ongoing expansion in the cricket sector. Additionally, the author is aware of no such comprehensive evaluation of the results of two decades of research integrating cricket and ML. As a result, this study aims to fill the aforementioned gap in the literature, and its findings will be useful for athletes, coaches, and sports administrators. Finally, this endeavor will assist academics in developing a brief summary of the current cricket study domains and in identifying research needs for their future research work.

METHODOLOGY

In cricket in modern literature, this paper extensively examined how machine learning techniques have been used. Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) standardized standards for systematic reviews were used as a guidance. Three steps make up the complete review protocol: identification, screening, and final selection.
Using four main databases, namely Google Scholar, Science Direct, Scopus, and Web of Science, we first identified every published material. In February 2022, same search employing expanded study fields was carried out. The term "Applications of Machine Learning in Cricket" was used in the electronic search. All research that has been published and satisfies the following search criteria has already been identified. Second, we chose the publications that were the most pertinent based on the following standards.

- Studies that are directly relevant to the game of cricket were taken into consideration, including but not limited to player performance, game outcome, team performance, score prediction, pitch-related studies, cricket commentary, and videotaping of cricket matches.
- Robotic or electronic versions of the game of cricket are not taken into consideration; only the human game is.
- At least one ML approach was used in the studies that were chosen.
- From 2001 to 2021, peer-reviewed journal studies were taken into account.
- Publications included conference and journal versions.

For the final selection, duplicates were lastly eliminated. Only 59 publications were left after deleting the duplicates from each database for the final selection.

RESULTS

The findings of this systematic review are intended to be presented and discussed in this section. First, a debate is held to determine the key research fields where ML applications may be noticed. The reviewed papers are then provided some descriptive statistics.
To determine which studies have addressed the research questions relating to whatever sort of feature extractions, ML technique, and accuracy estimation approach were employed, all the selected publications are evaluated in the research question section. The data sets and the number of characteristics utilized in each research are reviewed in the next sections. The results of the feature extraction and data reduction strategies are then reported. A survey of the most popular ML approaches is then given. The accuracy of the employed ML approaches will be evaluated in the final part.

Study areas in cricket

(a) Game outcome prediction
Predicting the outcome of a cricket match has become crucial because to the game's rising popularity and commercialization. In this area, researchers apply a variety of ML algorithms to predict the outcome of the game together with numerous performance metrics that reflect different game elements. The most often utilized performance measures to employ in the forecast are batsman, bowler, and fielder qualities. In addition, the projection has taken into account additional factors including home field advantage, the result of the toss, and the pitch's behaviours.

(b)Player's performance classification
Although batting, bowling, and fielding are regarded as the game's three primary departments, batting and bowling statistics are the most often utilized to measure performance of the players. Although batting, bowling, and fielding are regarded as the game's three core departments, batting

and bowling statistics are the most frequently utilized to evaluate individual accomplishments. The abilities of individual players significantly affect how the game turns out. As a result, determining each player's skill level is crucial to the game in many ways; to do so, ML approaches and player-level factors can be employed.

(c) Batting style and bowling action classification
Cricket is regarded as a batsman's game that requires the capacity to choose and execute shots. To detect and evaluate the batsmen's shot-making abilities, ML approaches and body-worn internal measuring units (IMUs) have been applied. Additionally, wearable tech and machine learning can be used to study bowler traits like bowling action, bowling volume, ball releasing speed, and identifying the intensity zones. Additionally, proper workload evaluation of the blower may be tracked and forecasted using ML, which will reduce the likelihood of player injuries in the future.

(d) Other areas
In addition to the aforementioned applications, ML has also been employed in pitch behaviours prediction, score prediction, umpire-related activity prediction, and media coverage of cricket.
The majority of professional cricketers interact often with their followers on social media. This analysis demonstrates how ML and various media outlets, including social media, are used to anticipate news about cricket. With the advancement of ML technology, video analytics in cricket has developed into a fascinating field. There are examples of ML approaches being used in cricket video research.
As the level of competition in the game has increased, umpires may feel under pressure since their choice can have a significant influence on the game's outcome. Systems that reduce umpire human error can be constructed using technology and ML approaches. These efforts are evident.
he evaluated publications state that score prediction is another field of research that makes use of ML approaches. Additionally, a sizable amount of research has been done on various aspects of the game, including Duckworth-Lewis, injuries, and cricket data analytics.

Cricket data and the features used
Using a representative sample is essential for the study's accuracy and quality. A bigger sample can also be used to reduce bias in the inference. The quality of the results of the ML-based data analysis is also strongly impacted by choosing a proper representation of features. So choosing a decent data collection is of utmost importance. In this part, the sizes of the data sets utilized in the chosen research are summarized. The average amount of data points utilized in research for the T20 format of cricket is 537,502, which is the greatest number among the papers we analysed.
An average of 27,240 data have been used in ODI-related research, on average. These are around 1666 and 862 for Test and First-Class cricket, respectively. Compared to other gaming forms, is the highest. Second, research employing Test cricket have employed an average of 115 characteristics, whereas ODI and T-20 have an average of 40 and 12, respectively.

Used data reduction and feature extraction techniques
A crucial ML phase is feature selection. According to Guyon and Elise (2003), the goal of the feature selection strategy is to pick a subset of variables from the input data that will accurately characterize the input data while minimizing the impacts of noise or irrelevant variables and yet producing good prediction results. The following strategies were able to be identified as the main feature selection techniques based on the examined studies.
Principal Component Analysis, Chi-Square, Graphics-Based Feature Selection, Correlation-Based Feature Selection, Regression, Recursive Feature Elimination
The most often employed strategies from the list above were the Chi-Square, Recursive Elimination,

and Correlation-based feature selection techniques.

Frequently used ML techniques

This section examines the common ML strategies used in cricket.

The following ML approaches have reportedly been utilized as the most common ML techniques to analyses cricket data, per the research that were examined.

Regression, K-Means; Naive Bayes (NB), Artificial Neural Networks (ANN), Decision Trees (DT), Random Forest (RF), kth Nearest Neighbor (kNN), Support Vector Machine (SVM), and XGBoost

estimating a game's time limit analyzing player performance

SVM (45%) is the most often used ML approach among those listed above in the publications that have been reviewed. The second most used machine learning (ML) approach was RF (42%) and the third most utilized machine learning (ML) technique was NB (36%). The results show that SVM was utilized in 45% of the examined research, 26% of which were published in 2019 and 24% in 2021. RF is the second most common ML method. RF has been utilized in published research in 42% of cases, and in 2020 and 2021, it was used in 29% of cases. NB was the third widely utilized ML approach from 2010 to 2021 in the papers that were published. The results show an increase in the number of research utilizing ML methods with cricket data over the past two decades.

Quantifying the accuracy of ML technique

Since all ML models are data-driven, it is crucial to assess the model's correctness. This is arguably the most crucial component of ML models. Confusion matrix-based accuracy metrics are the most common (approximately 58%) way to assess the accuracy of the ML model, according to the research that have been analysed. F-Score, the Receiver Operating Characteristic (ROC) curve (about 9%), and Root Mean Square Error (RMSE) (about 6%) round out the common methodologies. The confusion matrix-based methodology is the primary accuracy testing method, as previously mentioned. Some confusion matrix-based strategies that have been employed by researchers include accuracy, balance accuracy, custom accuracy, precision, recall, sensitivity, and specificity.

Some of the addressed problems

The purpose of this section is to briefly review some of the research done to use ML approaches to address current problems in cricket.

The selection process for teams is laborious, and selecting the best eleven players for an upcoming game necessitates several brainstorming sessions. This issue was solved by a research using the player strength-weakness rating system. They created two innovative performance indicators for batsman and bowler as the basis for categorizing players after gathering batter and bowler characteristics. SVM outperformed the other ML models that they had trained, including NB and RF.

Due to the complex bio-mechanical motions of the bowler's arm, it is difficult to determine if a bowling action is lawful, and the on-field umpire cannot correctly monitor the bowler's action. Research classified the bowler's bowling action regarding the legality of the delivery using inertial measurement units (IMU) and ML approaches. The writers began by gathering information on various bowling techniques. They discovered crucial moments in the lawful bowling action during the profiling step. The traits were then derived from data collected by inertial sensors mounted on the bowler's arm. Finally, in order to categories the bowling motion with a greater degree of classification accuracy, a number of ML approaches, including SVM, KNN, NB, RF, and ANN, were trained.

Due to the many aspects that must be taken into account, declaring at the end of the third innings can be difficult. A test cricket match's third innings declaration was the subject of inquiry. In order to determine whether to declare an inning, they created a decision support system to forecast the outcome of a test match at various points in the game. They created three models to forecast the result of the game before it began, after the second innings, and after the third innings after compiling a sizable collection of factors related to the game's characteristics. They employed a number of ML approaches, including ANN, Regression, RF, SVM, and XGboost, but the SVM seems to be the most successful.

The publications under evaluation demonstrated the use of several ML approaches in various cricket research fields. certain that the effectiveness of the ML approach depends on a number of factors, it is challenging to suggest a specific ML technique for a certain application in cricket. According to these papers, kNN, Regression, and RF have been used more frequently during the past 20 years compared to other ML approaches.

SVM continues to be popular in applications related to cricket, unlike other ML approaches like neural networks and Naive Bayes. One of the key findings was the absence of various well-known ML methods, including deep learning, reinforcement learning, and natural language processing. Future research on more complex difficulties in cricket is anticipated to include cutting-edge ML approaches including automated machine learning, multi-modal learning, multi-objective models, and small ML.

DISCUSSION AND CONCLUSION

It is clear from the performed systematic review that since 2001, there has been an increase in the amount of research in cricket employing ML technology. This pattern is encouraging for the game because the conclusions of these study findings will eventually aid in the game's growth.

The analysis of numerous cricket features that was before impossible to do with the current approaches is now possible thanks to improved ML techniques. Additionally, the combination of ML methods with electronic wearable devices in cricket study has several advantages. By reducing their chance of injury, cricketers can now offer faster performances.

REFERENCES

1. Ahmad, H., Ahmad, S., Asif, M., Rehman, M., Alharbi, A., & Ullah, Z. (2021). Evolution-based performance prediction of star cricketers. CMC-Computers Materials& Continua, 69(1), 1215–1232.

2. Basit, A., Alvi, M. B., Jaskani, F. H., Alvi, M., Memon, K. H., & Shah, R. A. (2020). ICC T20 cricket world cup 2020 winner prediction using machine learning techniques. In 2020 IEEE 23rd international multitopic conference (pp. 1–6). IEEE.

3.Dubey, P. K., Suri, H., & Gupta, S. (2021). Naïve Bayes algorithm based match winner prediction model for T20 cricket. In Intelligent computing and applications (pp. 435–446). Singapore: Springer.

4. Guyon, I., &Elisseeff, A. (2003). An introduction to variable and feature selection. Journal of Machine Learning Research, 3, 1157–1182.

5.Kumar, R., Santhadevi, D., & Barnabas, J. (2019). Outcome classification in cricket using deep learning. In 2019 IEEE international conference on cloud computing in emerging markets (pp. 55–58). IEEE.

6. Mody, K., Malathi, D., &Jayaseeli, J. D. (2021). An artificial neural network approach for classifying cricket batsman’s performance by adam optimizer and prediction by derived attributes. In 2021 smart technologies, communication and robotics (pp. 1–7). IEEE.

7.Wickramasinghe, I. P. (2014a). Predicting the performance of batsmen in test cricket. Journal of Human Sport &Excercise, 9(4), 744–751.

8. Wickramasinghe, A. N., &Yapa, R. D. (2018). Cricket match outcome prediction using tweets and prediction of the man of the match using social network analysis: Case study using IPL data. In 2018 18th international conference on advances in ICT for emerging regions (p. 1). IEEE,

9.Salman, M., Qaisar, S., & Qamar, A. M. (2017). Classification and legality analysis of bowling action in the game of cricket. Data Mining and Knowledge Discovery, 31(6), 1706–1734.

10.Pathak, N., & Wadhwa, H. (2016). Applications of modern classification techniques to predict the outcome of ODI cricket. Procedia Computer Science, 87, 55–60.

11. Salman, M., Qaisar, S., & Qamar, A. M. (2017). Classification and legality analysis of bowling action in the game of cricket. Data Mining and Knowledge Discovery, 31(6),1706–1734.

12. Tyagi, S., Kumari, R., Makkena, S. C., Mishra, S. S., &Pendyala, V. S. (2020). Enhanced predictive modeling of cricket game duration using multiple machine learning algorithms. In 2020 international conference on data science and engineering (pp. 1–9).IEEE.

.

COMPARATIVE STUDY OF DEADLOCK RESOLUTION TECHNIQUES

Dr. Vishant Kumar

Professor, Department of CSE
JB Institute of Technology, Dehradun

ABSTRACT

A deadlock occurs when there is a set of processes waiting for resource held by other processes in the same set. The processes in deadlock wait indefinitely for the resources and never terminate their executions and the resources they hold are not available to any other process. The occurrence of deadlocks should be controlled effectively by their detection and resolution, but may sometimes lead to a serious system failure. After implying a detection algorithm, the deadlock is resolved by a deadlock resolution algorithm whose primary step is to either select the victim then to abort the victim. This step resolves deadlock easily. This paper describes deadlock detection using wait for graph and some deadlock resolution algorithms which resolves the deadlock by selecting victims using different criteria.

. **Keywords**: Deadlock, Resources, Processes, Release.

INTRODUCTION

Deadlock is a situation where a set of processes are blocked because each process is holding a resource and waiting for another resource acquired by some other process. Consider an example when two trains are coming toward each other on same track and there is only one track, none of the trains can move once they are in front of each other. Similar situation occurs in operating systems when there are two or more processes hold some resources and wait for resources held by other(s). There is a variant of deadlock called lovelock. This is a situation in which two or more processes continuously change their state in response to changes in the other processes without doing any useful work. This is similar to deadlock in that no progress is made but differs in that neither process is blocked or waiting for anything. A human example of lovelock would be two people who meet face-to-face in a corridor and each move aside to let the other pass, but they end up swaying from side to side without making any progress because they always move the same way at the same time. Deadlocks can be avoided by avoiding at least one of the four conditions, because all these four conditions are required simultaneously to cause deadlock.

Mutual Exclusion Resources shared such as read-only files do not lead to deadlocks but resources, such as printers and tape drives, requires exclusive access by a single process.

Hold and Wait In this condition processes must be prevented from holding one or more resources while simultaneously waiting for one or more others.

No Pre-emption - of process resource allocations can avoid the condition of deadlocks, where ever possible.

Circular Wait Circular wait can be avoided if we number all resources, and require that processes request resources only in strictly increasing (or decreasing) order.

The above points focus on preventing deadlocks. But what to do once a deadlock has occurred. Following three strategies can be used to remove deadlock after its occurrence.

Pre-emption We can take a resource from one process and give it to other. This will resolve the deadlock situation, but sometimes it does causes problems.

Rollback In situations where deadlock is a real possibility, the system can periodically make a record of the state of each process and when deadlock occurs, roll everything back to the last checkpoint, and restart, but allocating resources differently so that deadlock does not occur.

Kill one or more processes this is the simplest but it works.

A process in operating systems uses different resources and uses resources in following way.

(1) Request a Resource
(2) Use a resource
(3) Release a resource

Generally speaking, there are three ways of handling deadlocks:

(1) Deadlock prevention or avoidance - Do not allow the system to get into a deadlocked state.
(2) Deadlock detection and recovery - Abort a process or pre-empt some resources when deadlocks are detected.
(3) Ignore the problem all together - If deadlocks only occur once a year or so, it may be better to simply let them happen and reboot as necessary than to incur the constant overhead and system performance penalties associated with deadlock prevention or detection. This is the approach that both Windows and UNIX take.

In order to avoid deadlocks, the system must have additional information about all processes. In particular, the system must know what resources a process will or may request in the future. (Ranging from a simple worst-case maximum to a complete resource request and release plan for each process, depending on the particular algorithm.) Deadlock detection is fairly straightforward, but deadlock recovery requires either aborting processes or pre-empting resources, neither of which is an attractive alternative. If deadlocks are neither prevented nor detected, then when a deadlock occurs the system will gradually slow down, as more and more processes become stuck waiting for resources currently held by the deadlock and by other waiting processes. Unfortunately, this slowdown can be indistinguishable from a general system slowdown when a real-time process has heavy computing needs.

Mono-processing systems do not have to worry about deadlock. The reason is that deadlock involves resource allocation, and if there is only one process, it has uncontested access to all resources. Only certain types of resources are associated with deadlock, and they are of the exclusive-use, non-preemptible type. That is to say, only one process can use the resource at any given time, and once allocated the resource cannot be unallocated by the operating system, but rather the process has control over the resource until it completes its task. Excellent examples of such resources are printers, plotters, tape drives, etc. Resources that do not fit the criteria are memory and the CPU. While it is convenient to discuss deadlock in terms of hardware resources, there are software resources that are equally good candidates for deadlock, such as records in a data base system, slots in a process table, or spooling space. Hardware or software, all that matters is that the resources are non-preemptible and serially reusable. The four conditions that must exist for deadlock are as follows: The first two are described above - mutually exclusive use of resources by the processes and non-pre-emption (resources cannot be removed from the processes). The third condition is called the 'hold and wait' or 'wait for' condition.

DEADLOCK

In concurrent computing, a deadlock is a state in which each member of a group is waiting for another member, including itself, to take action, such as sending a message or more commonly releasing a lock.[1]

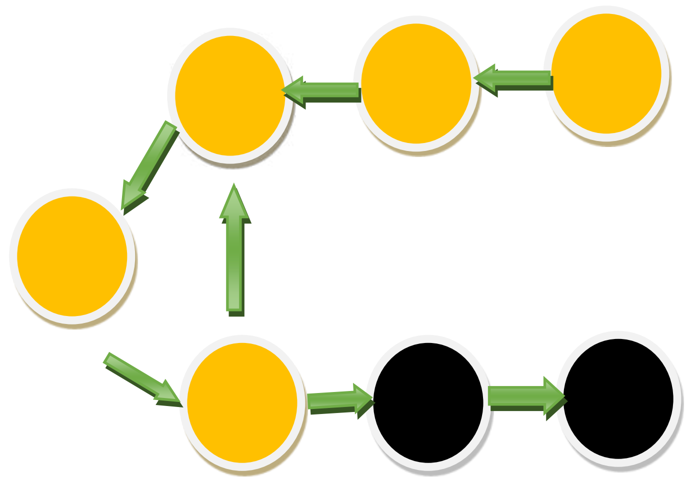


Fig. A Few Processes in Deadlock

Deadlock is a common problem in multiprocessing systems, parallel computing, and distributed systems, where software and hardware locks are used to arbitrate shared resources and implement process synchronization.[2]

In an operating system, a deadlock occurs when a process or thread enters a waiting state because a requested system resource is held by another waiting process, which in turn is waiting for another resource held by another waiting process. If a process is unable to change its state indefinitely because the resources requested by it are being used by another waiting process, then the system is said to be in a deadlock.[3]

In a communications system, deadlocks occur mainly due to lost or corrupt signals rather than resource contention

BACKGROUND

Deadlock can occur when the permanent blocking of a set of processes competes for the same system resources. A set of processes is deadlocked when each process in the set is blocked awaiting an event that can only be triggered by another blocked process in the set. Deadlock is permanent because none of the events are ever triggered. Three conditions must take place for a deadlock to take place. The first one is Mutual exclusion, which is a single process that uses one resource at a time. No process may access a resource unit that is being utilized by another process. Hold and wait is the second condition, it can be described as one process that holds assigned resources while waiting for another assignment. Finally, no pre-emption occurs when no resource can be forced or removed from a process holding it. These three conditions are necessary for a deadlock to exist. However, a fourth condition is required for an actual deadlock to take place. Circular wait occurs when a closed chain of processes exists, and each process holds one or more resources needed by the next process in the chain. This condition is an immediate result of the first three. Below is a self-explanatory illustration of Deadlock. Deadlock blocks a set of processes that competes for system resources. This can be permanent unless the OS takes action, such as forcing one or more processes to backtrack. Deadlock may involve consumable or reusable resources. A reusable resource is one that is not depleted by use. A consumable resource is one that is destroyed when it is obtained by a process. There are three approaches to dealing with deadlock: prevention, detection, and avoidance. Prevention guarantees that deadlocks will not happen. Detection is required if the OS is willing to grant resource requests; the OS checks for deadlocks and takes action to break the deadlock. Avoidance involves the analysis of each new resource request to determine if it could lead to deadlock, and granting it only if deadlock is not an option. For Windows you can run driver verifier to scan for any corrupted drivers, which may be causing problems, this program works by running various stress tests on drivers, in order to produce a BSOD, which will locate the driver. To the best of my knowledge deadlocks are ignored by Linux operating systems.

Under the deadlock detection, deadlocks are allowed to occur. Then the state of the system is examined to detect that a deadlock has occurred and subsequently it is corrected. An algorithm is employed that tracks resource allocation and process states, it rolls back and restarts one or more of the processes in order to remove the detected deadlock. Detecting a deadlock that has already occurred is easily possible since the resources that each process has locked and/or currently requested are known to the resource scheduler of the operating system.

DEADLOCK PREVENTION

Deadlock prevention works by preventing one of the four conditions from occurring.

1. By Removing the mutual exclusion condition means that no process will have exclusive access to a resource. This proves impossible for resources that cannot be spooled. But even with spooled resources, deadlock could still occur. Algorithms that avoid mutual exclusion are called non-blocking synchronization algorithms.

2. The hold and wait or resource holding conditions may be removed by requiring processes to request all the resources they will need before starting up (or before embarking upon a particular set of operations). This advance knowledge is frequently difficult to satisfy and, in any case, is an inefficient use of resources. Another way is to require processes to request resources only when it has none. Thus, first they must release all their currently held resources before requesting all the resources they will need from scratch. This too is often impractical. It is so because resources may be allocated and remain unused for long periods. Also, a process requiring a popular resource may have to wait indefinitely, as such a resource may always be allocated to some process, resulting in resource starvation.(These algorithms, such as serializing tokens, are known as the all-or-none algorithms.)

3. The no pre-emption condition may also be difficult or impossible to avoid as a process has to be able to have a resource for a certain amount of time, or the processing outcome may be inconsistent or thrashing may occur. However, inability to enforce pre-emption may interfere with a priority algorithm. Pre-emption of a "locked out" resource generally implies a rollback, and is to be avoided, since it is very costly in overhead. Algorithms that allow pre-emption include lock-free and wait-free algorithms and optimistic concurrency control. If a process holding some resources and requests for some other resource(s) that cannot be immediately allocated to it, the condition may be removed by releasing all the currently being held resources of that process.

4. The final condition is the circular wait condition. Approaches that avoid circular waits include disabling interrupts during critical sections and using a hierarchy to determine a partial ordering of resources. If no obvious hierarchy exists, even the memory address of resources has been used to determine ordering and resources are requested in the increasing order of the enumeration.[3] Dijkstra's solution can also be used.

5. FUTURE WORK

In the future any other new prevention techniques can be originated .so that it can give more efficient result.

REFERENCES

[1] Terekhov, T. Camp, “Time efficient deadlock resolution algorithms”, June 1998

[2]D. Manivannan and Mukesh Singhal, “An Efficient Distributed Algorithm for Detection of Knots and Cycles in a Distributed Graph”, IEEE Transactions on Parallel And Distributed Systems, Vol. 14, No. 10, October 2003.

[3] Lee, S., “Fast, Centralized Detection and Resolution of Distributed Deadlocks in the Generalized Model”, IEEE Trans. On Software Engineering, Vol. 30, NO. 9, 561-573, 2004

[4]. Yibei Ling, Shigang Chen and Cho-Yu Jason Chiang, “On Optimal Deadlock Detection Scheduling”, IEEE TransactionsOn Computers, Vol. 55, No. 9, September 2006.

[5]. Pallavi Joshi, Mayur Naik, “A randomized Dynamic Program Analysis Technique for Detecting Read Deadlocks”, 2009 ACM, June 2009.

[6]. Prodromos Gerakios, Nikolaso Papaspyrou, Konstantinos, Vekris,”Dynamic Deadlock Avoidance in System Code Using Statically Inferred Effects”, 2011 ACM, October 2011

[7]. Iryna Felko, TU Dortmund, “Simulation based Deadlock Avoidance and Optimization in Bidirectional AGVS”, 2011 ACM, march 2011.

[8]. Selvaraj Srinivasan, R. Rajaram, “A decenreralized deadlock detection and resolution algorithm for generalized model in distributed systems”, January 2011.

[9]. Kunwar Singh Vaisla, Menka Goswami, Ajit Singh, “VGS Algorithm -an Efficient Deadlock Resolution Method”, International Journal ofComputerApplications (0975 –8887),Vol.44-No. 1April 2012.

[10] Jeremy D.Buhler, Kunal Agrawal, Peng Li, Roger D. Chamberlain, “Efficient Deadlock Avoidance For Streaming Computation With Filtering”, 2012 ACM, February 2012.

PERFORMANCE ANALYSIS OF ROUTING PROTOCOLS IN MOBILE AD HOC NETWORKS

Dr. Vishant Kumar

Professor, Department of CSE
JB Institute of Technology, Dehradun

ABSTRACT

Mobile Ad Hoc networks are gaining popularity to its peak today, as the users want wireless connectivity irrespective of their geographic position. In Mobile ad hoc networks mobile devices are in movable form so that there can be chances of congestion can be occurred. Therefore, congestion is likely to an issue in mobile Ad Hoc network routing. Routing protocols can improve the speed of a network and also improve the performance of network. In this research paper we analyse that which protocol gives the best performance by increasing the queue length. So that if the performance of a network will be good then the congestion chances will be decreases, hence the congestion problem is mostly removed and the performance of network will be good. And the aim of this research paper is to improve the performance of a network, network speed and preventing the network from congestion as well. In this process we will use Network simulator (NS-2) to analyse the simulation results from different perspectives.

Index Terms -MANETs, Mobile Ad Hoc networks, Queue size, Routing Protocols, Network simulator (NS-2)

1. INTRODUCTION

Mobile Ad Hoc Networks are autonomous and decentralized wireless systems. MANETs consist of mobile nodes that are free in moving in and out in the network. Nodes are the systems or devices i.e. mobile phone, laptop, personal digital assistance, MP3 player and personal computer that are participating in the network and are mobile. These nodes can act as host/router or both at same time. They can form arbitrary topologies depending on their connectivity with each other in the network. These nodes have the ability to configure themselves and because of their self-configuration ability, they can be deployed urgently without the need of any infrastructure. Internet Engineering Task Force (IETF) has MANET working group (WG) that is devoted for developing IP routing protocols. Routing protocols is one of the challenging and interesting research areas for researchers. Many routing protocols have been developed for MANETS.

Security in Mobile Ad Hoc Network is the most important concern for the basic functionality of network. Availability of network services, confidentiality and integrity of the data can be achieved by assuring that security issues have been met. MANET often suffer from security attacks because of the its features like open medium, changing its topology dynamically, lack of central monitoring and management, cooperative algorithms and no clear defines mechanism. These factors have changed the battle field situation for the MANET against the security threats.

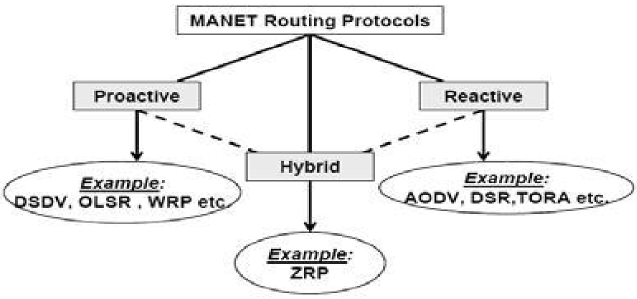


Fig 1. MANET Routing Protocols

There is a new aspect to categorize routing protocols into two divisions (i) congestion-control routing and (ii) congestion non control routing.

When we consider the congestion non control routing protocol, during the packet transfer between the source and destination, congestion may occur; this is not managed by the existing routing protocol.

The above problems turn into the harmful in a network in terms of packet loss, increasing delay and reduced throughput. The existing congestion control techniques cannot directly use in an ad hoc network because in an ad hoc network, it is more expensive, in terms of time and overhead and removes congestion after it happened.

2. PROPOSED WORK

2.1 Simulation Environment

The basic parameters of the proposed work are presented respective to the simulation environment. The system is implemented on Ubuntu Environment with NS2 simulator and XGraph is used as the tool for graph analysis.

Parameter	**Value**
Number of Nodes	30
Topography Dimension	800 m x 800 m
Traffic Type	CBR
MAC Type	802.11.Mac Layer
Packet Size	512 bytes
Pause time	5sec
Antenna Type	Omni directional

Table 1.

On the basis of the graphs of simulation we analyse the performance of AOMDV and DSR routing protocols which are shown in 1 and in fig 2the performance analyse in terms of packet drop ratio and end to end delay. After analysing we are getting these results which are described below:

Performance is analysed in the terms of End to End delay.

<u>End To End delay</u>

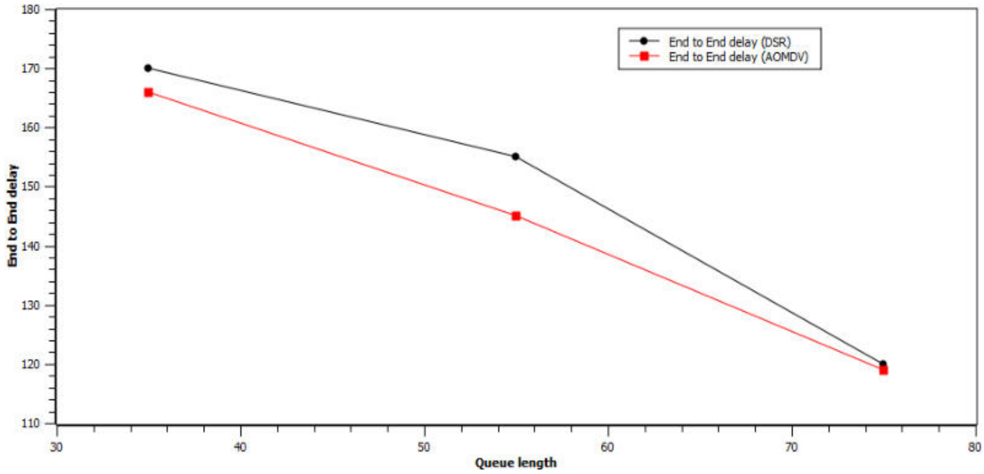


Fig. 2End To End delay with different -2 protcols with different-2 sizes

Here in the Fig. 2 shows that the End to End delay delay with AOMDV and DSR protocols and here the Queue size are taken 45,55,75. After the simulation result these values are founded which are mention in graph and and on the basis of these values the graph has been drawn. These values are taken after the simulation

2.2 Observations

The analysis results which are getting after simulation are described below:

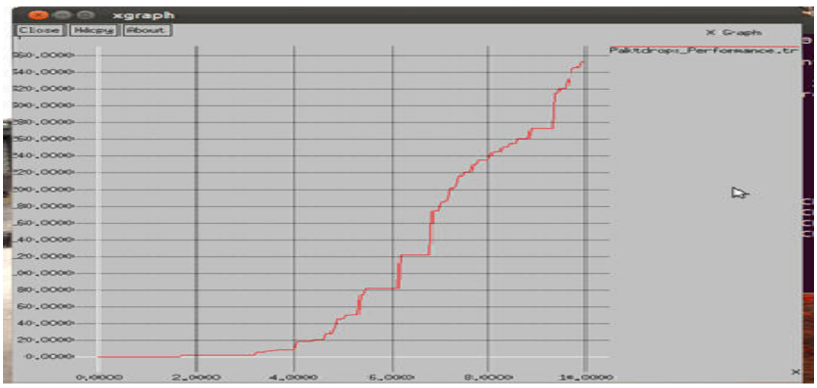


Fig 3. Packet drop (AOMDV with 45 queue length) i.g. 350

Here in Fig 3 shows that the packet drop which is calculated with the AOMDV routing protocol where the queue size is taken 45 and after simulation the results are getting which is the packet drop are 350.when we setup the queue size 45 then the packet drop are 350.

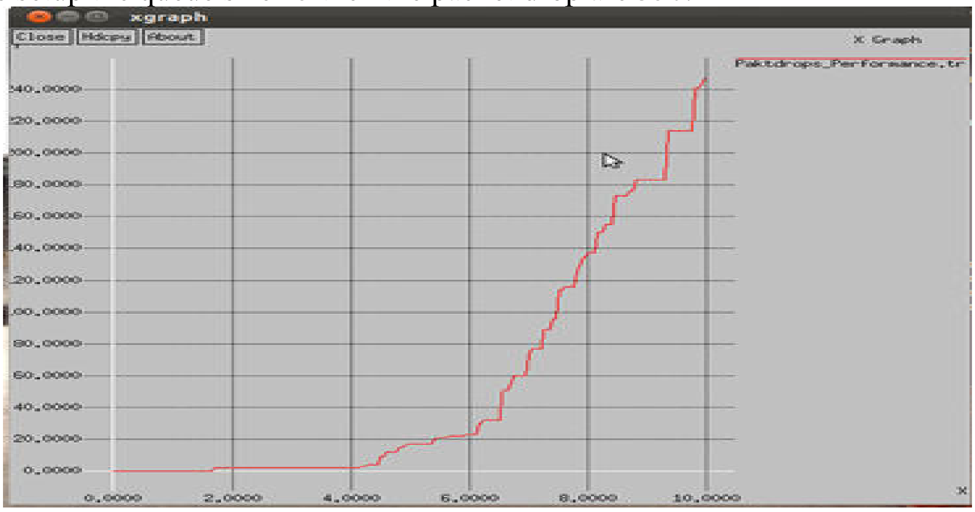


Fig 4 Packet drop (AOMDV with queue length 55) i.g. 250

Here in figure 4 shows that the packet drop which is calculated with the protocol AOMDV routing protocol where the queue size is taken 55 and after the simulation the results are getting in terms of the packet drop are 250. In this simulation we take the queue length 55 and after simulation we getting our results in terms of packet drop that the packet drop are 250 which are less than the previous where we setup the queue length 35.

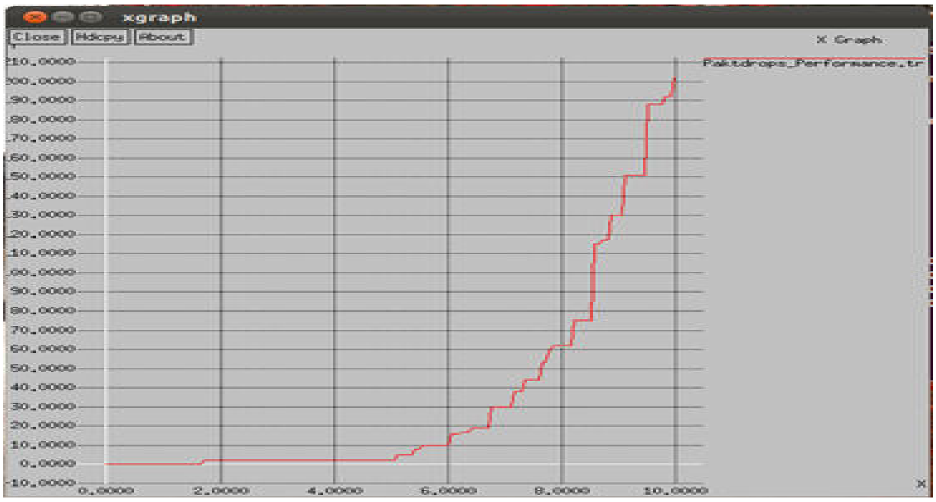


Fig 5. Packet drop (of AOMDV with queue length75) i.g. 205

Here in Figure 5 shows that the packet drop which is calculated with the protocol AOMDV routing protocol where the queue size is taken 35 and after simulation the results shows that the packet drop are 205. In this simulation we taken the queue length 75 and after simulation our result is getting that is the packet drop is 205 which is less than the previous where we setup the queue length are 55.

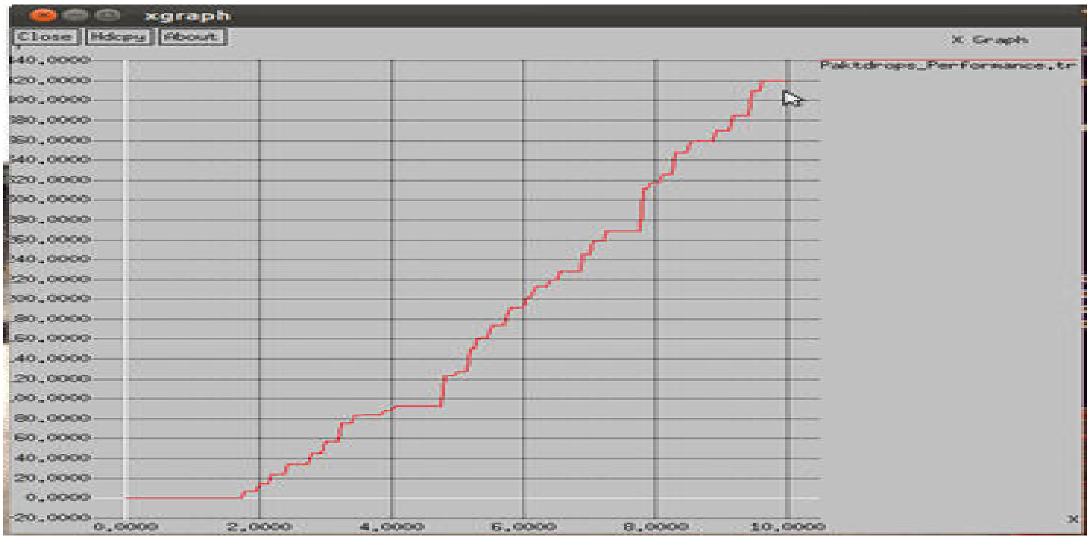


Fig 6. Packet drop (DSR with queue length 45) i.g.420

Here in Figure 6 shows that the packet drop which is calculated with the protocol DSR routing protocol where the queue size is taken 35 and after simulation the results shows that the packet drop are 420. In this simulation we have taken the queue length 35 and after simulation result we getting the results that is the packet drop ratio is 420.

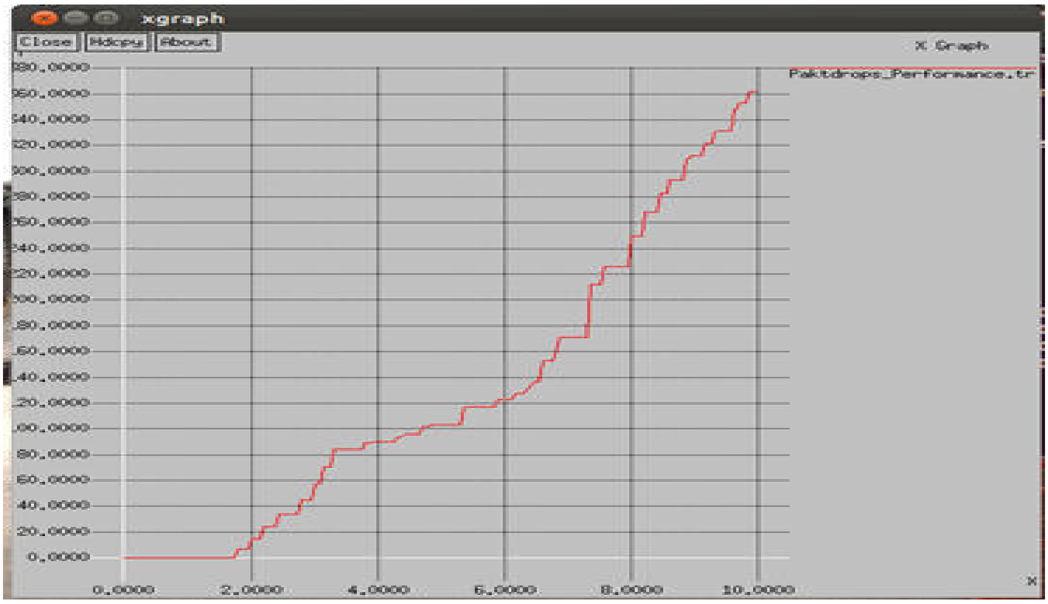


Fig 7 Packet drop (DSR with queue length 55) i.g.365

Here in Figure 7 shows that the packet drop which is calculated with the protocol DSR routing protocol where the queue size is taken 55 and after simulation the results shows that the packet drop are 365. In this simulation we take the queue length 55 and the result which is getting in terms of the packet drop is 365 and is comparatively less than the previous simulation.

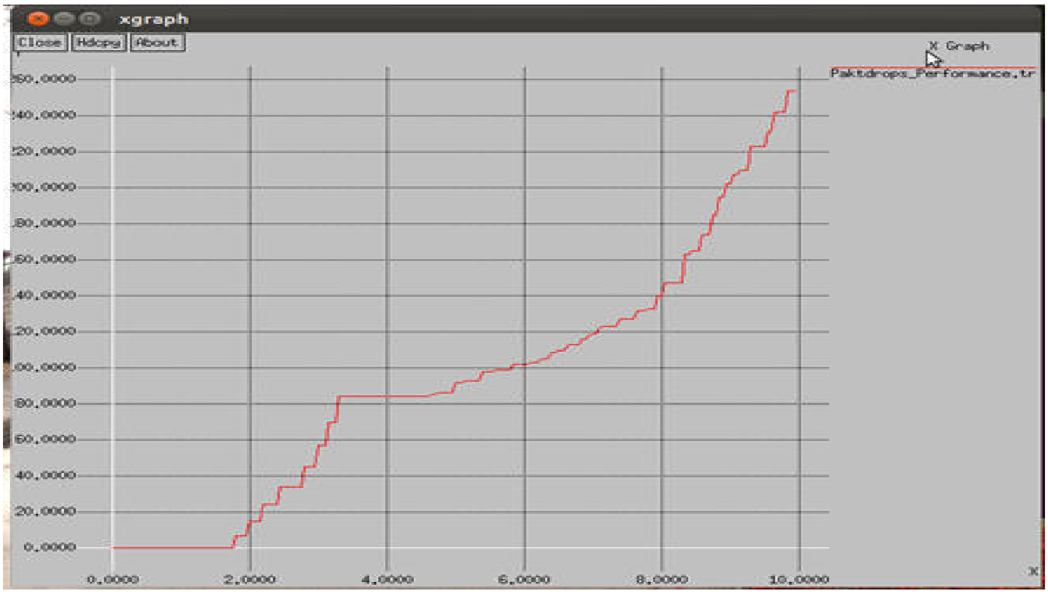


Fig 8. Packet drop (DSR with queue length 75) i.g.245

Here in Figure 8 shows that the packet drops which is calculated with the protocol DSR protocol where the queue size is taken 75. after simulating the simulation results shows that the packet drop is 245. In this simulation we taken the queue length 75 and after the simulation result the packet drop are 245 which is less than to the previous one.

\

4. CONCLUSION

In this research paper we analyse that by increasing the queue length of nodes in a network, the packet delivery ratio increases. It is not only reducing the end-to-end delay due to little chances of transmission of packet but also increases the throughput of connection because of wrongly interpretation of congestion. Simulation shows that the positive effect of queue by increasing the queue size/length at every node. This analysis is more beneficial in preventing congestion because of wrongly interpretation of congestion. it improves the network performance if because of avoiding the slow start problem and also if there are packet drops in the network are very less. then the slow start problem has been occurred but if there are less packet drop then this problem will not occur so that the performance is improve. We work only with AOMDV and DSR protocol. The work can be implemented and analysed along with other protocols. We work only with CBR traffic source. the work can be implemented with any other traffic source. Our work has done with 20 nodes in future we can take more than 20 nodes for simulation.

5. FUTURE SCOPE

Congestion loss in bust networks depends on the number of active flows and the total storage in the network. Total storage included both router buffer memory and packets in flight on long links. In this thesis a simple flow counting algorithm is presented. The algorithm takes a few instructions per sender and uses one bit of state per flow. The algorithm provides congestion feedback by varying the number of packets per sender in proportion to the queue length. This approach has the desirable effect of reducing queuing delay, however it produces high loss rate as the number of flows increases, causing long and unfair timeout delays.

REFERENCES

[1]Amirhossein M., Hero M., Rosli S. and Ehsan M. 2013.Performance Analysis of AODV, AOMDV, DSR, DSDV Routing Protocolsin Vehicular Ad Hoc Network. Research Journal of Recent Sciences, 2(7): 2277-2502.

[2]Chadha M.S.,Joon R., Sandeep. 2012.Simulation and Comparison of AODV, DSR and AOMDV Routing Protocols in MANETs. International Journal of Soft Computing and Engineering, 2(3) 2231-2307.

[3]Vanaja K., Dr. Umarani R. 2012.An Analysis of Single Path AODV Vs Multipath AOMDV on Link Break Using ns-2.International Journal of Electronics and Computer Science Engineering. 1(3) 1080-1086

[4]Pirzada AA. 2006.Performance Comparison of Multi-Path AODV and DSR Protocols in Hybrid Mesh Networks.IEEE Conference, Queensland Research Laboratory, National ICT Australia Limited, Brisbane, QLD 4000, Australia.

[5]RamadhanMstafa. 2013.Analysis of Routing Protocols overVANET. American society for engineering studied.

[6]Aujla G.S.,Kang S.S. 2013,Comprehensive Evaluation of AODV, DSR, GRP, OLSR and TORA Routing Protocols with varying number of nodes and traffic applications over MANETs, IOSR Journal of Computer Engineering.9(3) 54 -61.

[7]Annapurna D, K B Raja, Venugopal K R, Patnaik L.M. 2012.Analysis of On Demand and Table Driven Routing Protocol for Fire Fighter Application.International Journal of Innovative Technology and Exploring Engineering.1(2) 55-59.

[8] Mahesh K. Marina Samir R. Das. 2001. On-demand Multipath Distance Vector Routing in Ad Hoc Networks. IEEE Conference.Dept. of ECECS University of Cincinnati Cincinnati, OH 45221.

[9] Chaudhary D.D., Pawar P., Waghmare L.M. 2011.Comparison and Performance Evaluation of Wireless Sensor Networkwith different Routing Protocols.International Conference on Information and Electronics Engineering.6.

[10] Singh D.Wadhwa, Singh T. 2011.Performance Comparison of Single and Multipath Routing Protocols in Adhoc Networks. Int. J. Comp. Tech. Appl. 2 (5) 1486-1496.

[11] Rao A, Upadhyay N, Rai V.K. 2013. A Survey on AODV Protocol Performance with Black Hole Node in MANET, International Journal of Engineering and Advanced Technology, 2 (4) 57-62.

Adaptive Learning: An approach of personalized learning

Manoj Chaudhary

Associate Professor, Department of CSE
JB Institute of Technology, Dehradun

ABSTRACT

Adaptive learning is a transformative educational approach that tailor's instruction to suit individual learners' needs and preferences. By utilizing advanced technologies like artificial intelligence and machine learning, adaptive learning platforms gather data on learners' strengths and weaknesses, enabling the creation of personalized learning pathways. This abstract explores the principles and benefits of adaptive learning, highlighting its potential to revolutionize education by providing tailored experiences that improve engagement and learning outcomes. However, ethical considerations, including data privacy and algorithmic bias, must be carefully addressed to ensure responsible implementation. Adaptive learning holds the promise of fostering a more inclusive and effective educational landscape, bridging the gap between traditional one-size-fits-all methods and the diverse learning needs of students.

Keywords: Adaptive learning, personalized learning, individualized learning, educational technology, artificial intelligence, machine learning, data-driven education, learner-centric, engagement, learning outcomes, educational transformation

1. Introduction: -

Education is a powerful tool that has the potential to transform lives, shape societies, and drive progress. However, the one-size-fits-all approach to teaching and learning has long been recognized as a limitation, as it fails to accommodate the diverse needs, strengths, and learning styles of individual students. This realization has spurred the development of innovative educational approaches, and among them, adaptive learning has emerged as a promising solution to address these challenges.

Adaptive learning is a revolutionary pedagogical method that leverages advanced technologies, such as artificial intelligence (AI) and machine learning, to create personalized learning experiences for each student. Unlike traditional classrooms, where all learners follow the same curriculum and pace, adaptive learning systems analyses data on students' performance, behaviourss, and preferences to tailor the educational content and delivery to match their unique needs and abilities.

The core idea behind adaptive learning is to optimize the learning process by providing students with precisely what they need at the right time and in the most suitable format. By continuously adapting the learning experience based on real-time data, adaptive learning platforms can offer individualized challenges to more advanced learners, while providing additional support and guidance to those who might be struggling with certain concepts.

Adaptive learning empowers learners to take ownership of their educational journey. It nurtures a learner-centric environment, where students can explore topics of interest, progress at their own pace, and receive immediate feedback on their performance. This personalized approach fosters greater engagement, motivation, and a deeper sense of accomplishment, as students experience learning that is relevant and tailored to their unique aspirations and goals.

Moreover, adaptive learning is not limited to formal academic settings. It has found applications in corporate training, professional development, and even informal online learning platforms. In all these contexts, adaptive learning's ability to cater to individual learning styles and preferences has proven to be a game-changer, significantly improving learning outcomes and overall satisfaction.

However, as with any transformative technology, there are challenges to be navigated. Ethical considerations, such as data privacy and algorithmic bias, must be carefully addressed to ensure that the benefits of adaptive learning are harnessed responsibly and equitably.

In this ever-changing landscape of education, adaptive learning stands as a beacon of promise, offering a path towards a more inclusive and effective learning environment. This introduction sets the stage for a deeper exploration of adaptive learning, delving into its principles, underlying technology.

2. History of Adaptive Learning

The history of adaptive learning dates back several decades, with roots in early computer-based learning systems. Over time, it has evolved and grown in complexity, integrating advancements in technology and educational research. Here is a brief overview of the key milestones in the history of adaptive learning:

- 1960s - Early Beginnings:
  The concept of adaptive learning can be traced back to the 1960s when researchers began exploring the potential of computers in education. Early computer-assisted instruction (CAI) systems delivered personalized content and exercises based on students' responses, providing a rudimentary form of adaptivity.
- 1970s - Intelligent Tutoring Systems (ITS):
  In the 1970s, intelligent tutoring systems (ITS) emerged as a significant development in adaptive learning. ITS aimed to simulate the role of a human tutor, providing individualized instruction and feedback to students based on their interactions with the system. One of the pioneering ITS was "SHERLOCK," developed by Richard E. Mayer at Stanford University.
- 1980s - Knowledge Tracing:
  The 1980s saw the development of knowledge tracing algorithms, which became a crucial component of adaptive learning systems. These algorithms tracked individual students' knowledge and learning progress, allowing the system to adjust the difficulty of questions and content accordingly.
- 1990s - Web-Based Adaptive Learning:
  With the rise of the internet, adaptive learning systems transitioned to web-based platforms. This allowed for more extensive data collection and analysis, enabling a more sophisticated personalization of learning experiences.
- 2000s - Learning Management Systems (LMS):
  The 2000s witnessed the integration of adaptive learning features into learning management systems (LMS). Educational institutions and online platforms started using adaptive algorithms to recommend specific learning resources and adapt the curriculum based on students' performance.
- 2010s - Big Data and Artificial Intelligence:
  The 2010s marked a significant shift in adaptive learning with the rise of big data analytics and artificial intelligence (AI). These advancements allowed for more robust data processing, enabling adaptive systems to analyse vast amounts of student data and provide more accurate and personalized recommendations.
- Today - Data-Driven Personalization:
  In the present day, adaptive learning has become a mainstream educational approach, with a focus on data-driven personalization. Modern adaptive learning platforms employ sophisticated AI algorithms and machine learning models to create highly tailored learning pathways for individual students. These systems continuously adjust and optimize the content, pace, and difficulty of instruction based on real-time data and learner interactions.

The future of adaptive learning holds the promise of even more advanced technologies, seamless integration with virtual reality, augmented reality, and other emerging technologies, as well as ongoing efforts to address ethical considerations related to data privacy and algorithmic fairness. As adaptive learning continues to evolve, it is poised to reshape education, making personalized and effective learning experiences accessible to learners of all backgrounds and abilities.

3. Benefits of adaptive learning

Adaptive learning offers a wide range of benefits that have the potential to significantly enhance the educational experience for both learners and educators. Some of the key advantages of adaptive learning include:

- Personalized Learning: Adaptive learning platforms tailor the learning experience to the unique needs and preferences of individual learners. By analyzing data on each student's performance and learning patterns, adaptive systems deliver customized content and adapt the level of difficulty in real-time, ensuring that students receive the most appropriate and engaging learning materials.
- Improved Learning Outcomes: The personalized nature of adaptive learning fosters increased student engagement and motivation. By addressing each student's strengths and weaknesses, adaptive learning can lead to improved learning outcomes, higher retention rates, and better academic achievements.
- Self-Paced Learning: Adaptive learning allows students to progress at their own pace. Advanced learners can move ahead to more challenging material, while those who need additional support can spend more time on specific topics until they grasp the concepts fully.
- Targeted Remediation: Adaptive learning systems identify areas of difficulty for each student and provide targeted remediation. This approach helps students overcome learning gaps and build a stronger foundation in challenging subjects.
- Real-Time Feedback: Adaptive learning platforms offer instant feedback to students as they progress through lessons and exercises. Immediate feedback allows learners to correct mistakes and reinforce their understanding of concepts, promoting a deeper understanding of the material.
- Data-Driven Decision Making: Educators gain access to comprehensive data on student performance and progress through adaptive learning systems. This data-driven approach empowers teachers to make informed decisions regarding instructional strategies, content selection, and individualized support.
- Enhanced Student Engagement: The personalized and interactive nature of adaptive learning captures students' attention and maintains their interest in the learning process. Adaptive learning often incorporates gamification elements, which can make learning more enjoyable and engaging.
- Flexibility and Accessibility: Adaptive learning can be delivered through various platforms, including online courses, mobile apps, and learning management systems. This flexibility enables learners to access educational content anytime and anywhere, making education more accessible to a broader audience.
- Cost-Effectiveness: While implementing adaptive learning systems may involve an initial investment, the potential for long-term cost savings is significant. Adaptive learning can reduce the need for extensive printed materials and optimize the use of educational resources, leading to cost-effective education delivery.

- Inclusive Education: Adaptive learning caters to individual learning differences, making it an inclusive approach that accommodates students with diverse abilities, learning styles, and backgrounds.
- Continuous Improvement: Adaptive learning platforms collect vast amounts of data on student interactions, enabling continuous improvement of the system over time. These data-driven insights allow for ongoing enhancements and refinements, optimizing the learning experience.

Overall, adaptive learning has the potential to transform traditional educational models by providing a learner-centric and personalized approach that maximizes student potential, fosters engagement, and promotes lifelong learning.

4. <u>Challenges of adaptive learning</u>

The adaptive learning offers numerous benefits, it also faces several challenges that need to be addressed for its successful implementation and widespread adoption. Some of the key challenges of adaptive learning include:

- Technology Integration: Implementing adaptive learning systems requires integrating advanced technology into educational settings. This process can be complex and may require significant investments in hardware, software, and infrastructure, making it challenging for some institutions to adopt adaptive learning on a large scale.
- Data Privacy and Security: Adaptive learning relies heavily on collecting and analyzing student data to personalize learning experiences. Ensuring the privacy and security of this data is of utmost importance, as any breach or mishandling of data could lead to serious consequences and undermine learner trust.
- Algorithmic Bias: Adaptive learning algorithms must be carefully designed to avoid bias and discrimination. If the algorithms are built using biased data or assumptions, it could lead to unequal treatment or reinforcement of stereotypes among learners.
- Teacher Training and Support: Educators play a crucial role in guiding students' learning journeys through adaptive learning platforms. Proper training and ongoing support are essential to help teachers effectively utilize the technology and interpret data to make informed instructional decisions.
- Content Adaptation Challenges: Creating adaptive learning content that caters to individual learning needs while maintaining educational standards can be demanding. Developing high-quality, adaptive content requires substantial effort and expertise from subject matter experts, instructional designers, and content developers.
- User Engagement and Motivation: While adaptive learning aims to improve engagement, some students may still struggle with self-directed learning and require additional motivation to stay committed to the learning process.
- Limited Domain Coverage: Some adaptive learning systems may be more effective in certain subject areas or skill domains compared to others. Expanding adaptive learning to cover a wide range of disciplines and learning objectives can be a challenge that requires ongoing research and development.

- Standardization and Interoperability: The lack of standardization and interoperability between different adaptive learning platforms can create difficulties in sharing data, content, and resources across different systems, limiting scalability and collaboration.
- Ethical Considerations: Ethical concerns, such as over-reliance on algorithms for decision-making, lack of human interaction, and the potential for over-personalization, need to be

carefully navigated to strike the right balance between technology and human involvement in the learning process.

- Learning Bias and Overfitting: Adaptive learning systems may inadvertently reinforce learning bias by presenting content that aligns with students' existing beliefs and preferences. Moreover, overfitting—when the system tailors content too narrowly based on a limited dataset—can hinder learners from exploring diverse perspectives and gaining a comprehensive understanding of a subject.

Addressing these challenges requires collaboration among educators, researchers, policymakers, and technology developers. By promoting responsible implementation, data privacy, and inclusivity, adaptive learning can overcome these obstacles and continue to evolve as a valuable educational tool. As technology advances and best practices emerge, adaptive learning has the potential to offer increasingly effective and equitable personalized learning experiences for learners worldwide.

5. Theoretical foundations of adaptive learning

The theoretical foundations of adaptive learning are grounded in educational psychology, cognitive science, and learning theories. These principles provide the framework for designing and implementing adaptive learning systems that cater to individual learner needs. Some of the key theoretical foundations include:

- Cognitive Load Theory: Cognitive load theory posits that learners have limited cognitive resources, and instructional materials should be designed in a way that minimizes cognitive load. In adaptive learning, the system can adjust the complexity and difficulty of content based on the learner's cognitive abilities, ensuring an optimal learning experience.
- Zone of Proximal Development (ZPD): The concept of ZPD, proposed by Lev Vygotsky, suggests that learning is most effective when it occurs within a learner's ZPD—the gap between what a learner can do independently and what they can achieve with guidance. Adaptive learning systems can identify a learner's ZPD and provide appropriate challenges and support to facilitate learning.
- Learning Styles and Preferences: Adaptive learning considers individual learning styles and preferences, such as visual, auditory, or kinaesthetic learning. By presenting content in formats that align with the learner's preferences, adaptive systems can enhance engagement and comprehension.
- Mastery Learning: Mastery learning emphasizes that learners should achieve a certain level of mastery before progressing to more advanced topics. Adaptive learning can monitor and assess mastery levels, providing additional practice or support as needed before moving on to new concepts.
- Bloom's Taxonomy: Bloom's taxonomy categorizes cognitive skills into levels, ranging from lower-order thinking (remembering, understanding) to higher-order thinking (applying, analysing, evaluating, creating). Adaptive learning can adjust the complexity of questions and tasks based on a student's cognitive abilities and progress through Bloom's levels.
- Personalized Feedback and Assessment: Constructive feedback is essential for promoting learning and growth. Adaptive learning systems can offer personalized feedback, highlighting areas of improvement and providing specific guidance tailored to each learner's performance.
- Behaviourism and Reinforcement: Behaviourist principles, such as positive reinforcement, can be integrated into adaptive learning systems. Providing immediate positive feedback and rewards for correct answers can motivate learners and reinforce their learning efforts.

- Self-Regulated Learning: Self-regulated learning theory emphasizes learners' ability to take control of their learning process by setting goals, monitoring progress, and applying learning strategies. Adaptive learning can support self-regulated learning by encouraging learners to reflect on their learning progress and adjust their strategies accordingly.
- Zone of Feasible Innovation (ZFI): The ZFI, proposed by Roger Schank, refers to the space in which learners can explore novel concepts and ideas without fear of failure. Adaptive learning can create a safe environment for learners to experiment and learn from mistakes.

By drawing from these theoretical foundations, adaptive learning systems can create dynamic and personalized learning experiences that optimize the educational journey for each individual learner. As technology and educational research continue to advance, the theoretical underpinnings of adaptive learning will continue to evolve, shaping more effective and learner-centric approaches to education.

6. Future of adaptive learning

The future of adaptive learning holds tremendous potential for transforming education and personalized learning experiences. As technology continues to evolve and our understanding of learning processes deepens, adaptive learning is likely to experience several exciting developments:

- Enhanced AI and Machine Learning: Advancements in artificial intelligence and machine learning algorithms will enable adaptive learning systems to become more sophisticated and accurate in assessing learners' abilities, preferences, and learning patterns. This will result in even more personalized and precise content recommendations and adaptive pathways.
- Immersive Technologies: The integration of virtual reality (VR) and augmented reality (AR) into adaptive learning environments will provide learners with immersive and interactive experiences. VR and AR can simulate real-life scenarios, allowing students to engage in hands-on learning and practice skills in a safe and controlled virtual environment.
- Seamless Integration with Educational Platforms: Adaptive learning systems will become seamlessly integrated into existing educational platforms, such as learning management systems (LMS) and online course platforms. This integration will enable educators to harness the power of adaptive learning without significant disruptions to their current teaching practices.
- Continuous Learning Analytics: Adaptive learning platforms will gather more extensive and granular data on learners' interactions, allowing for continuous learning analytics. These insights will provide educators with a deeper understanding of learners' progress, challenges, and preferred learning methods, facilitating more informed decision-making.
- Personalized Learning Assistants: Adaptive learning may be complemented by personalized learning assistants, chatbots, or virtual tutors that offer real-time support and guidance to learners, answering questions and providing assistance whenever needed.
- Gamification and Gamified Learning: Gamification elements will be further integrated into adaptive learning to enhance engagement and motivation. Gamified learning experiences will use game mechanics, rewards, and challenges to create a more enjoyable and interactive educational journey.
- Lifelong Learning and Professional Development: Adaptive learning will extend beyond traditional education to support lifelong learning and professional development. Adults seeking to upskill or reskill will benefit from adaptive learning platforms tailored to their specific learning goals and career objectives.

- Addressing Global Education Inequalities: Adaptive learning has the potential to address global education inequalities by providing personalized and accessible education to learners in remote or underserved regions. The adaptability and flexibility of adaptive learning can accommodate diverse cultural and linguistic backgrounds.

- Collaboration and Social Learning: Adaptive learning systems may integrate social learning features, enabling students to collaborate, discuss, and learn from each other. Social learning interactions will complement personalized learning experiences, fostering a sense of community and collective learning.

- Ethical and Inclusive Design: The future of adaptive learning will prioritize ethical considerations, ensuring that data privacy, algorithmic fairness, and learner autonomy are upheld. Designers and educators will work collaboratively to create adaptive learning systems that are inclusive, equitable, and respectful of learners' diverse needs.

Overall, the future of adaptive learning promises a transformative and learner-centric educational landscape. By leveraging cutting-edge technologies and adhering to ethical principles, adaptive learning will empower individuals with personalized, effective, and engaging learning experiences, fostering a lifelong love for learning and supporting learners in reaching their full potential.

7. CONCLUSIONS

Adaptive learning represents a revolutionary approach to education, transforming traditional one-size-fits-all models into personalized and learner-centric experiences. By harnessing the power of advanced technologies like artificial intelligence, machine learning, and data analytics, adaptive learning platforms have the ability to tailor instruction to meet the unique needs, strengths, and preferences of each individual learner.

The theoretical foundations of adaptive learning draw from educational psychology and learning theories, providing a solid framework for designing adaptive systems that optimize the learning process. Concepts such as cognitive load theory, zone of proximal development, and personalized feedback underscore the importance of catering to individual differences and promoting effective learning.

The benefits of adaptive learning are manifold. Learners experience improved engagement, motivation, and learning outcomes, as they receive content and challenges tailored to their abilities. The self-paced nature of adaptive learning allows students to progress at their own speed, while targeted remediation ensures that no learner is left behind.

Adaptive learning not only empowers learners but also supports educators in making data-driven decisions. Teachers gain valuable insights into student progress, enabling timely interventions and personalized support. The collaboration between learners and educators fosters a dynamic and enriching learning environment.

However, adaptive learning also faces challenges that necessitate careful consideration. Ethical concerns surrounding data privacy, algorithmic bias, and human intervention in the learning process demand responsible implementation to ensure equitable and unbiased educational experiences for all.

Looking to the future, the evolution of adaptive learning holds great promise. With advancements in artificial intelligence, immersive technologies, and continuous learning analytics, adaptive learning will become even more sophisticated, personalized, and accessible. It will transcend traditional boundaries, supporting lifelong learning and addressing global education inequalities.

As we embrace the potential of adaptive learning, it is imperative to strike a balance between technological advancements and human interaction in education. The ethical and inclusive design of adaptive learning platforms will be paramount, respecting learners' autonomy and diverse needs.

In this journey towards personalized education, stakeholders across academia, technology, and policymaking must collaborate to shape a future where adaptive learning becomes an integral part of a transformative and inclusive educational landscape. By embracing this approach of personalized learning, we can unlock the full potential of every learner and pave the way for a brighter, more knowledge-driven world.

REFERENCE

1. Brusilovsky, P., &Peylo, C. (2003). Adaptive and intelligent web-based educational systems. International Journal of Artificial Intelligence in Education, 13(2-4), 159-172.
2. Chen, G., Jin, M., Xu, Z., & Sui, Y. (2018). Personalized E-Learning System Based on Adaptive Learning Path and Data Mining. IEEE Access, 6, 59243-59253.
3. He, X., & Han, J. (2013). Mining knowledge from heterogeneous data sources with multiple representation learning. In Proceedings of the 19th ACM SIGKDD international conference on Knowledge discovery and data mining (pp. 1216-1224).
4. Kardan, A. A., &Balakhontsev, S. (2017). Personalized adaptive e-learning. Proceedings of the 2017 ACM Conference on Innovation and Technology in Computer Science Education (pp. 216-221).
5. Lee, S., & Lim, H. (2016). An adaptive learning model based on learning analytics using Bayesian networks. Computers in Human Behaviours, 63, 698-707.
6. Moreno-Marcos, P. M., & Muñoz-Cristóbal, J. A. (2020). Evaluation of an Adaptive Learning Approach for Formative Assessment of 21st Century Skills in Higher Education. International Journal of Educational Technology in Higher Education, 17(1), 1-18.
7. Roll, I., & Wylie, R. (2016). Cognitive education and the learning sciences. Cambridge Handbook of the Learning Sciences, 2, 3-29.
8. Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67.
9. van Velsen, L., Drachsler, H., Hummel, H. G., & Koper, R. (2013). A conceptual framework for embedding of personalized learning in learning management systems. British Journal of Educational Technology, 44(6), 1116-1128.
10. Vygotsky, L. S. (1978). Mind in Society: The Development of Higher Psychological Processes. Harvard University Press.

Comparative Analysis of Coverage in Wireless Sensor Network Using Distributed Dynamic Node Deployment Schemes

Abhijit Kumar

Assistant Professor, Department of CSE
JB Institute of Technology, Dehradun,

ABSTRACT

Node deployment plays an important role in the wireless sensor network. The proper deployment solves the basic problem in the wireless sensor network. The efficiency and lifetime increase with the choice of the node deployment. The importance of a good deployment strategy is also needed to be considered. In this paper three contenders of Distributed Dynamic node deployment for a sensor network are examined: a regular hexagon based, an octagon-square based and a tri-beehive based pattern. Performance and comparison are evaluated for all the three sensor node deployment strategies.

Keywords: Sensor Nodes, Deployment, Coverage Analysis, K-coverage

INTRODUCTION

Recent years have witnessed a growing interest in deploying a large number of sensors that collaborate in a distributed manner on data gathering and processing [1]. Sensor nodes are expected to be inexpensive and can be deployed in a large scale in harsh environment, which implies that sensor nodes are capable of operating unattended. Each sensor node is capable of only a limited amount of processing. Butwhencoordinatedwiththeinformationfromalargenumberofothernodes, they have the quality to measure a given environment in complete detail. Thus, a sensor network can be described as a collection of sensor nodes which co-ordinate to perform some specification.

These nodes can be deployed over a network in random or deterministic fashion. While the random node deployment is preferable in many applications, if possible, other deployments should be investigated since an inappropriate node deployment can increase the complexity of other problems in Wireless Sensor Networks (WSNs). Three competitors of node deployment for a sensor network: a uniform random, a square grid, and a Tri-Beehive based pattern. Since the

Priority of performance metrics varies in application-Specific Wireless Sensor Networks (WSNs), it is worthwhile to investigate asset of them.

Thus, we have taken two major performance evaluation measures for all the three node deployment strategies, namely first one is the coverage analysis based on the K-coverage mapping and the other one is the distancedependentenergyconsumptionincaseofallthreedeploymentpatterns.

DEPLOYMENT STRATEGIES FOR WIRELESS SENSOR NETWORK

The Wireless Sensor Networks (WSN)'s applications can be generally classified into target tracking and are a monitoring. In the target tracking scenarios, we concern if we can trace the moving object accurately. It seems that a denser infrastructure cause a more effective WSNs. However, if not deployed well, a denser network willed to a larger number of packet collisions and traffic congestions. The number of sensor sand the position of sensors affects the performance of tracking. In the area monitoring scenarios, we need to have enough sensors to avoid blind angle. The cost of larger Sensors is another reason to devise good deploying strategy.

Classification of Deployment Strategies

In this section, we will first classify the deployment strategies [2]. The way with which the Wireless Sensor Network (WSN) is deployed provides a huge impact on its working and performance. A simple taxonomy is shown in figure (1).One branch of the figure (1) is deployment with all static sensor nodes and another is deployment with at least one mobile node.

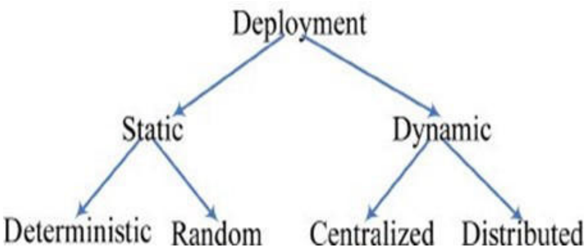


Figure1.Thetaxonomyofthedeployment

Static Deployment

In static device deployment, it can be further classified into two groups based on whether or not the placement points for all sensor nodes are planned accurately in advance. In static deployment strategy for Wireless Sensor Networks (WSN), all the sensor nodes are static in nature. All sensor nodes are applied in the field on fixed positions and they have restriction on their mobility. Following two sub-divisions of static deployment strategy are:

Deterministic Static Deployment

The deterministic static deployment is the most elaborate because this sensor topology is usually designed beforehand for best performance. However, in the situation with a lot of sensor nodes and the field unfriendly and uncontrollable, the deterministic static deployment may not work or can be difficult to deploy each sensor node as expected exactly. The sensor nodes are placed on the previously decided positions in the field. Some of deterministic protocols are grid-based deployment whose nodes are placed on the crossing points of the grids.

Random Static Deployment

Random deployment methods decide the density of a network rather than calculate each node's position like those in deterministic strategies. Using uniform distribution, we decide the interested area and the number of sensor nodes first. The random strategy is another choice. The sensor nodes are placed according to the condition of the area and thus the placement strategy of the nodes is not planned in advance.

In random strategy, sensor nodes can be deployed according to uniform, Poisson, Gaussian, or other distribution model. Then deploy them as uniformly as possible by air-drop or other methods.

Dynamic Deployment

Dynamic deployment for Wireless Sensor Network (WSN) comes with a major difference in comparison to static one. That major difference is it includes the liberty for the sensor nodes to move from their positions within the coverage area. As for the dynamic device deployment, it can be categorized into centralized and distributed methods.

Centralized Dynamic Deployment

In the centralized method, some of sensor nodes such as cluster heads or base stations decide their position themselves. After that, other nodes are deployed by those cluster heads or base stations. Thus, we can state that the locations of sensor nodes are decided by a few nodes such as base stations or cluster heads.

Distributed Dynamic Deployment

The distributed dynamic deployment strategy allows each sensor node in the Wireless Sensor Network (WSN) to choose its location of operation itself. Thus, in contrast to the centralized strategy, the location of the sensor nodes is not controlled and decided by the cluster heads or base stations. No desire deployed one at a time, with each node making use of data gathered from previously deployed nodes. The advantage of this approach is simplicity and clarity. Due to this sequential step, it usually takes more time to deploy than other concurrent methods.

Out of these various categories of the deployment strategies we have chosen three basic deployment patterns for evaluation namely Regular Hexagon pattern, Octagon-Square pattern and the Tri-Beehive pattern [4]. All of the above-mentioned node deployment patterns belong to the Deterministic Deployment classification.

REGULARHEXAGONPATTERN

A circular field with radius R is considered where the sensor nodes are positioned on the intersection vertices of the regular hexagon mesh. Each hexagonal cell inside the circular field is symmetric with each other. In the regular hexagon deployment, each of the n sensors has equal probability of being placed at the vertices points inside a given field as shown in figure (2).

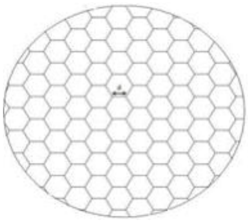


Figure2:A Regular Hexagon Deployment Pattern

OCTAGON - SQUARE PATTERN

A grid-based deployment is considered as a good deployment in WSN, especially for the coverage performance. It will be more interesting if we apply our study over a hybrid pattern i.e., a pattern made up with two different geometrical shapes. There are several grid-based designs like as unit square, equilateral triangle, regular hexagon etc. The Octagon-Square Grid deployment pattern is used for the evaluation purpose because of its natural placement strategy over a unit octagon-square pair.

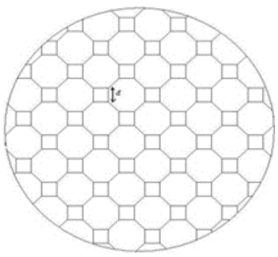


Figure3:A Octagon-Square node deployment pattern

Octagon-Square based node deployment pattern is depicted above in figure (3). Each of the sensors are deployed on the intersection points of the grid in a considered circular field with radius, say R. The Octagon-Square grid pattern within a circular field with radius R is assumed to be symmetric tessellations i.e., all the unit cells within the circular field have equal edge length d and thus equal area within each unit square cell and each unit octagon respectively.

2.1.6.3 TRI-BEEHIVEPATTERN

Tri-Beehive deployment pattern for Wireless Sensor Network (WSN) is based on tiling. A tiling can be considered as the cover in go of the entire plane with figures which neither overlap each other nor leave any gaps. Tiling's are also sometimes called as tessellations. It is also an example of hybrid pattern or tessellation with a mix of two or more shapes. In Tri-Beehive tessellations, we have every vertex employed with the same set of regular polygons. A regular polygon has the same side length sand interior angles. We consider as emit-regular tiling that uses triangle and hexagon in the two-dimensional plane, theso-called3-6-3-6Tri-HexagonTiling.

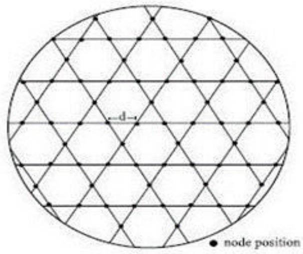


Figure4: Tri-Beehive node deployment pattern

COVERAGE

The term coverage in the sense for the network can be considered as the maximum range or area up to which the network is able to send or receive the data and also able to track the objects for monitoring them. In Wireless Sensor Network (WSN) s, the simple reason for checking coverage is to provide the high quality of information in the region of interest [5]. This is also known as the area coverage which is important for most WSN applications. A full coverage and a partial coverage are both considered for WSN applications.

K-Coverage

A network is said to have k-coverage if every point in it is covered by at least k sensors. If a particular point in the area which is being monitored by the Wireless Sensor Network (WSN) nodes is monitored by three sensor nodes, then that particular point of area is said tohave3-coverage.

3.1.1Regular Hexagon Grid Node Deployment Coverage

In the regular hexagon grid, no matter what amount of 'n' is analysed, a single cell is sufficient for the whole network coverage since it has symmetric cells. There lative frequency bar graph of the exactly k-covered points of a Regular Hexagon grid cell is shown in figure (5) between the percentage of the coverage achieved and the number value of K in K-coverage. These nos in radius, R sense used for Regular Hexagon grid cell is 13m.

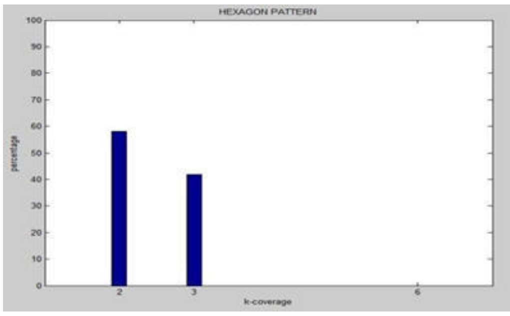


Figure5: A graph for coverage analysis of Regular Hexagon grid pattern

As we can see in figure (5), more than half of the network is covered by two sensor nodes or 2-coverage. The remaining area is covered by exact 3-coverage. The share coverage of 6-coverage is nearly equal to null. The percentage values for the 2-, 3- and 6-coverage in the figure (5) are 58.045%, 41.96% and 0%respectively. Now, for computing the average coverage and the standard deviation we have to construct table

(1) Showing the various values and the calculation.

Table1: Average coverage and standard deviation for Regular Hexagon Pattern

Thus, the regular hexagon grid has an average 2.42-coverage with a standard deviation of 0.49.

3.1.2 Octagon-Square Grid Node Deployment Coverage

Octagon-Square Sensor node deployment pattern is analysed based on the total number of cells due to the combination of a central octagon and four squares with same edge length. There lative frequency bar graph of the exactly k-covered points of an Octagon-Square grid coverage achieved and the number value of K-in K coverage. The sensing radius R_{sense} used for Octagon Square grid cell is 8m.

For computing the average coverage and the standard deviation, table(2) shows the various values and the calculation.

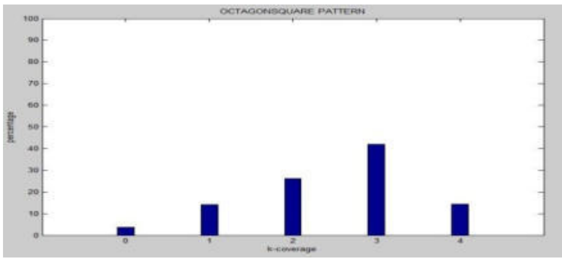


Figure 6: A graph for coverage analysis of Octagon-Square grid pattern

Table 2: Average coverage and standard deviation for Octagon – Square Pattern

K-coverage (x_i)	Exactly k-covered points (w_i %)	Weighted average (k-Coverage * exactly k-covered points/100)	Sample variance	Standard deviation
0	3.5833	0	1.03287	1.0163
1	14.0979	0.14098		
2	26.1388	0.52278		
3	41.8770	1.2563		
4	14.3030	0.57212		
		Total 2.49218		

Thus, a Octagon-Square node deployment pattern has an average 2.49-coverage with standard deviation of 1.02.

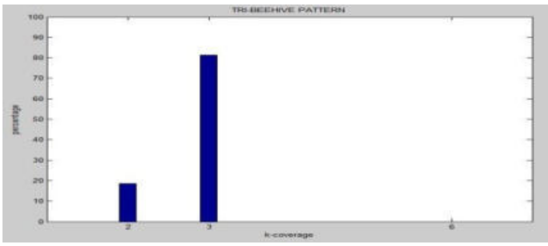
3.1.3Tri-BeehiveGridNodeDeploymentCoverage

Tri-Beehive Sensor node deployment pattern is analysed based on the total number of cells due to the combination of triangle and hexagon. The relative

K-coverage(x_i)	exactlyk-coveredpoints(w_i%)	weightedaverage(k-coverage*exactlyk-covered points/100)	samplevariance	standarddeviation
1	58.0446	1.16089		
2	41.9554	1.2587	0.2435	0.49
3	0	0		
		Total 2.41959		

Frequency bar graph of the exactly k-covered points of a Tri-Beehive grid cell is shown in figure (7) between the percentage of the coverage achieved and the number value of Kin K-coverage. The sensing radius, S_{ense} used for Tri-Beehivegridcellis10m. The average coverage and the standard deviation for the tri-beehive node deployment pattern is shown in table (3) ahead.

Figure7: A graph for coverage analysis of Tri-Beehive grid pattern



K-coverage (x_i)	Exactly k-covered points(w_i%)	Weighted average (k-coverage*exactly k-covered points/100)	Sample variance	Standard deviation
1	18.533 5	0.37067	0.1510 1	0.38
2	81.466 5	2.4439		
3	0	0		
		Total 2.8147		

6- Thus, without counting the exact coverage, a Tri-
7- Beehive node deployment pattern has an average 2.81-coveragewithstandarddeviationof0.38.

CONCLUSION

A Wireless Sensor Network (WSN) can be composed of homogeneous or heterogeneous sensors, which possess the same or different communication and computation capabilities, respectively. The conclusion of this work points towards the Tri-Beehive deployment pattern as a better option for Wireless Sensor Networks (WSN) deployment. Although, its architecture planning may create some overhead. For coverage performance evaluation, a Tri-Beehive node deployment is better than the other strategies giving the average coverage of
2.82 With least standard deviation of 0.38.Thus, ourfirst performance metrics gives Tri-Beehive Node Deployment Strategy as optimal choice for consideration. Next for the energy consumption analysis, it is shown that how the Tri-Beehive pattern is consuming the least energy of all under various sinks conditions.

REFERENCES

[1] I.F. Akyildiz, W. Su, Y. Sankara Subramaniam E. Capirci 2002, "Wireless Sensor Networks: a Survey", Computer Networks, Vol38, N.4

[2] W. Y. Poe, J. B. Schmitt 2009, ''Node deployment in large wireless sensor networks: coverage, energy consumption, and worst-case delay", Proceedings of Asian Internet Engineering Conference, pp.77-84

[3] P. Levis, S. Madden, J. Polastre, et al "Tiny OS: An Operating System for Sensor Networks,"

[4] Haita o Zhang , Cui ping Liu, "A Review on Node Deployment of Wireless Sensor Network", IJCSI International Journal of Computer Science Issues, Vol.9, Issue6, No3, November2012

[5] Mr. Rajeeb Sankar Bal , Amiya Kumar Rath "Design of node and its clustering structure in Wireless Sensor Networks" , IJCSI International Journal of Computer Science Issues, Vol.11, Issue6,No3, November2014

[6] Wint Yi Poe, and Jens B. Schmitt. Node Deployment in Large Wireless Sensor Networks: Coverage, Energy Consumption, and Worst-Case Delay. AINTEC'09, November18–20, 2009, Bangkok, (Thailand)

[7] Haita o Zhang, Cui ping Liu "A Review on Node Deployment of Wireless Sensor Network", IJCSI International Journal of Computer Science Issues, Vol.9, Issue6, No3, November2012

[8] http://webs.cs.berkeley.edu/tos

SENTIMENT ANALYSIS

Wajahat Gh Mohd.
Assistant. Professor. ,Deptt. Of CSE
JB Institute of Technology, Dehradun, Uttrakhand, India

ABSTRACT

Today, the age of the internet has changed the way to explain people's opinions. It is now primarily through blog posts, online forums, product review sites and social media. Today, millions use social networking sites such as Facebook, Twitter, Google plus etc. so that they express their feelings and opinions and give feedback about everyday life. Through the Internet community, we have an interactive way where consumers can understand and influence others. Creates very emotional rich data as social media tweets, status updates, blog posts, comments, comments and more. In addition, providing social media business opportunities through providing a platform to communicate with advertisers.

Keyword: Emotional Analysis, python, Natural Language Processing Techniques, Twitter

INTRODUCTION

They often see people's thoughts in serious study and daily decision-making. During political elections, he advised on the political debate forum, read customer reports while shopping for customers, and asked friends and suggested dinner for dinner. Today, the Internet can find millions of people from the latest gadgets to political philosophy. According to the latest Internet and Civic Joining Survey, "One in five people post content on social media with political or social themes or some civic or political participation.

1. In another study, one-third (33%) of Internet users read blogs, 11 of them every day.
2. The Internet quickly discussed and provided information to become a forum for people.

They identified objects of embedded with emotional polarity and removed them in feature set. Name is objectionable. On the other hand, they can see that many words are meaningless or meaningless. So they have to end them. They use information to get rid of these words. Another idea is that if the positive word is behind negative advances, the positive word is negative. This is an important problem with Bigram.

Classification Model

Using Twitter API, he collected tweets to analyse emotions from the Internet and created a system based on the Newbie (NB) and Support Vector Machine (SVM). After the following steps, he trained classical and rated internet tweets.

a) They made a simple bisexual classical developer to classify articles tweets and intimate tweets. A mental training set is a subject of punishment or purpose, which features based on uniforms, illusions, and training.
b) In the case of SVM classifier, they rate mental tweets positive or negatively. Emotional training set is marked as positive or negatively) Chart is also scared after analysing system emotions. Shows the analysis phase of a model's emotion based on shape 1, uniform, deformation, and object-based features.

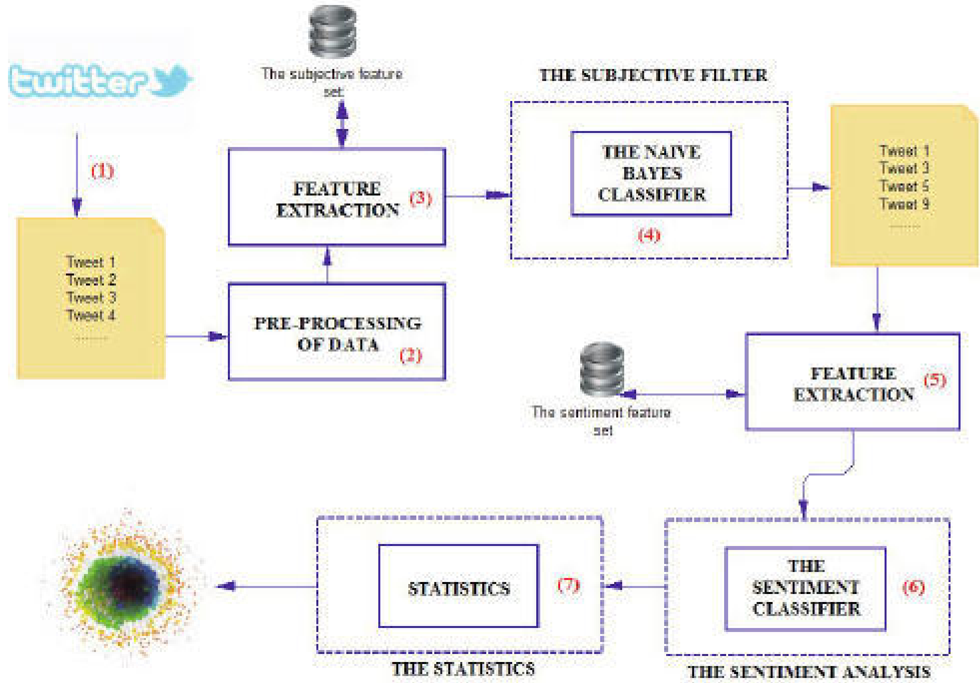


Figure 3. 1 Classification Model for twitter

Naive Bayes Classifier

Naive Bayes (NB) Base is a methodology-based method of learning machine data. The approach of this approach is a possibility of words, phrases and classes to evaluate class data. A special feature of this approach is that the appearance of words is autonomous. Naive Bayes estimates the word integration in any class. They used a multi-purpose slogan. Naive bayes to base class C the following formula is:

Theoretical Background of Naive Bayes

As mentioned previously, Naive Bayes rating providers assume that the features used for rating are free. Although this concept is generally incorrect, the analysis of the Bissan rating problem shows that there is a number of ideological reasons in the apparent unreliable effect of the knife in the Badge an classical, as presented by Zhang (2004). Though you are less likely to imagine the Naomi Beijing Chance, classification decisions can be very good (Manning & El., 2008). Thus, navy boxes generally ignore selected class possibilities, but this decision is correct and the model is correct, because the decision is made instead of predicting actual possibilities rather than using it. .

Random Forest (Proposed)

The Random Forest, which proposed in the year of 2001 by Leo Preman and Adele Cutler, is part of machine learning methods. This algorithm combines the concepts of random subfields with "stuffing". The decision tree algorithm is trained in multiple decision trees based on slightly different subsets of data.

Training Data Sets (N Number of Instance)

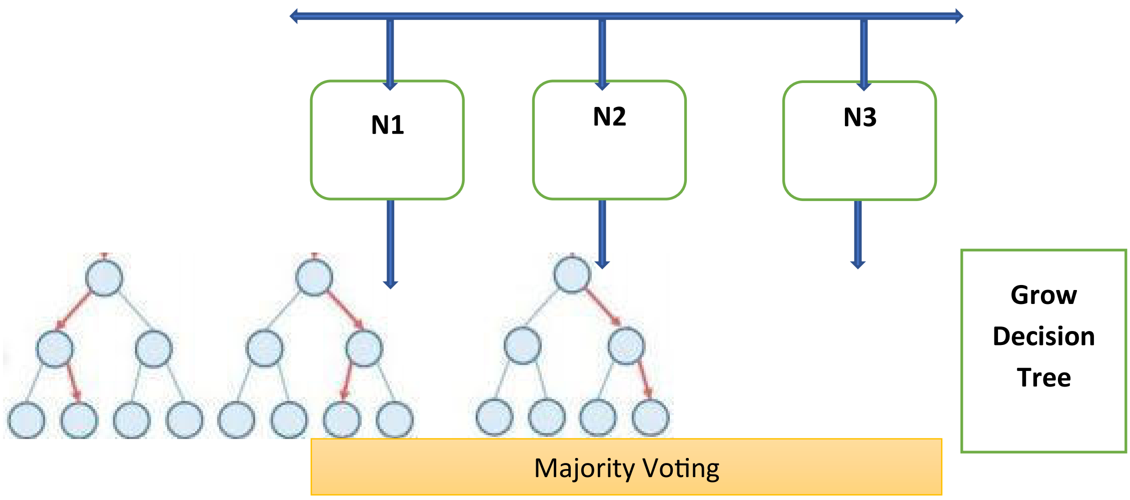


Fig 3.2 : Training Data Sets

Pictorial representation of random forest

Random is a part of the wildly defined viewpoint, which uses separate predictions of the decisions tree and based on packaging, random production, and random space. The Jungle Algorithms is one of the best rated algorithms that can accurately categorize the data. It is a learning method for a classification and regression group that builds a series of decision trees at the time of the training and provides a chapter that represents the way individual trees produce the classes.

Research Objective

This data is very important to understand this question before processing. The problem statement is as follows:

The purpose of this task is to detect hate speech in tweets. To put it simply, it says racism or hunger is swallowed up in it, so it contains a hate tweet. So the job is to rank racist or sexist pantyhose from other tweets. Typically, tweets and labels are assigned a training model where a label '1' is a tweet related to Nigeria/sexually marked and a label '0' says that the tweet is not Nigerian/sexually explicit, intended for the purpose of Labs test data per base to be predicted.

- ✓ Collect data into CSV file as trend data and test data sets
- ✓ Perform analysis on the data
- ✓ Detect negative tweets (racist/sexist/bigoted) from test datasets
- ✓ To find out the percentage accuracy of tweet outputs

The goal of this task is to detect hate speech on Twitter. Let's say geek contains hate speech if it has a racist or biased sentiment attached to it. The challenge is therefore to classify racist or sexist tweets from other tweets. If you formally provide a form of Twitter training and labels, where a label of "1" indicates that Twitter is racist/incomplete and "0" indicates that Twitter is not racist/incomplete, your goal is to predict the labels in the dataset. test.

Methodology

It explains the methodological steps in this work. In the first step, we collected data from Twitter. It then describes the process of aggregating schedules, communication between users and Twitter user profiles. A plan analysis was performed for each user to determine which policy tweets were and which were not. The details of this identification process are described. In the proposed methodology, we analyzed the sentiments of tweets that have a different approach: one for racist and non-racist tweets that addressed both candidates at the same time, and another with Twitter.

Preprocessing and Cleaning of Tweets

Look at the pictures below, to illustrate two ideas of office space, which is an extraordinary and the second is clean and organized.

A document is sought in these office premises. This scene was created with less chance of a person finding the document easily because everything is stored in its proper place. The data cleansing exercises are exactly the same. If the data is managed in a regular way, it is easy to find the right information.

The text data type is a necessary step because it creates raw text ready for mining, which makes it easier to extract information from the text and use a machine learning algorithm. If they skip this step, there's a good chance you're working with noise and conflicting data. The purpose of this stage is to remove noise that is less relevant to the search for the emotion of time, regardless of specific characters, numbers and conditions that do not prevail in terms of the text.

In one of the later steps, digital features will be removed from our Twitter text data. This feature space is created using all the unique words in the entire image. So, if they offer our data well, they will be able to achieve a better function.

Remove Twitter handles (@user)

As mentioned above, tweets contain many of the Twitter features that Twitter has come to recognize on Twitter. It removes all those Twitter handles from the data because they don't accept any additional information. For our convenience, allow Let's first finger to train and test the set. It saves the trouble and trials on the train double the test and training

Removal of punctuation, numbers and special characters

Since conversation, wings, numbers and special characters don't help much. It is better to remove them from the text when removing the Twitter handle. Here it changes everything except letters and weapons with spaces.

Short word removal

They have to be careful in choosing the length of the words they want to remove. So I decided to reduce all the words by 3 or at least. For example, the expressions "ham", "oh" are rarely used. It is better to get rid of them.

Tokenization

They will now break all the scrubbed tweets in our database. Tokens are individual terms or words, and tokenization is the process of distributing a string of text.

Story Generation and Visualization from Tweets

I n this section, they will find clean leggings. The search and insight of the data, no matter whether its text or any other data is necessary to get insight into it. Do not limit yourself in this tutorial in those ways, which feel free to find as much as possible data.

Before starting the investigation, it is necessary to ask for questions related to the data in hand. Some possible questions are as follows:

- What are the most common words in the entire dataset.

- What are the most common words in the dataset for negative and positive tweets, respectively.
- How many hashtags are there in a tweet.
- Which trends are associated with my dataset.
- Which trends are associated with either of the sentiments. Are them compatible with the sentiments.
- **Extracting Features from Cleaned Tweets**

To analyse a suggested figure, it needs to be converted into features. Depending on the application, you can use built-in techniques to create text functions - package words, TF-IDF and word embedded.

Bag-of-Words Features

This bag-of- the package is a way of representing the text through linguistic features. Consider one of the points (words of words) named CDD documents {d1, d2 ... dd} and anonymous unique tokens. N Tokens (Words) will create a list and its size bag will be given by Matrix MD X. Each row in the Matrix M doent d (i) contains the frequency of the tech.

Let us understand this using a simple example. Suppose they have only 2 document
D1: He is a lazy boy. She is also lazy.
D2: Smith is a lazy person.
The list created would consist of all the unique tokens in the corpus C.
= [‘He’,’She’,’lazy’,’boy’,’Smith’,’person’]

Model Building: Sentiment Analysis

Now they have completed the first modeling steps necessary to get the figures in the correct form and shape. Now they will build two models of set-off off-words and prediction models based on the TF-IDF database.

They will use logistic depression to make models. It predicts the possibility of an event occurring by fitting data at a logic function. The following equation is used in Logistic Regression:

Tools for implementation of sentiment Analysis

Python: Python general programming language for pastoral translators is programming language. Made by Giago Van Rasmus and was released in 1991 for the first time, Captain's design python has been emphasized on the ability to read code with remarkable use of its remarkable white space.

Experiment Analysis

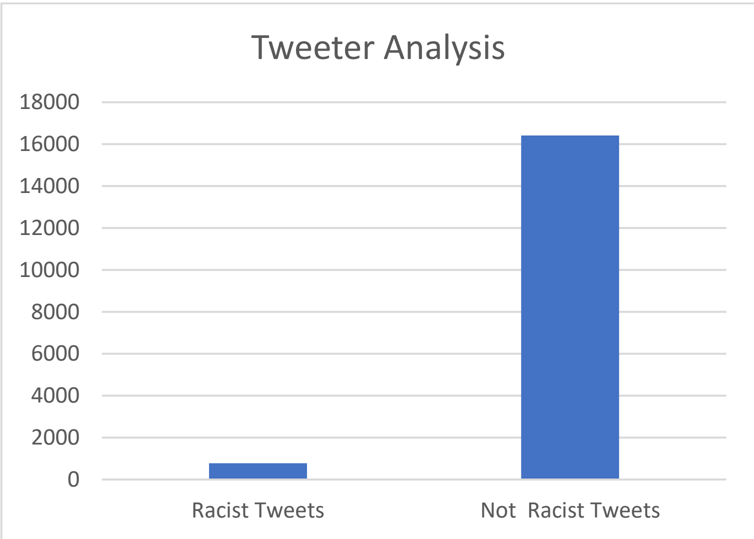


Figure 4. 1 Compare tweets of racist vs. non racist

As the above figure shows that balanced analysis has been combined with wish tweets with non-wish ing tweets. Find the nature of tweets from the database given to this article. This data has been collec ted from Twitter.

CONCLUSION AND FUTURE SCOPE

This publication focuses on examining rigorous analysis methods to find key data points. Twitter Sentiment is designed to analyses consumer opinions about the importance of a business location. The program uses machine learning techniques that allow different behaviourss to be accurately described; language processing methods will continue to be used. Emotional intelligence is a comprehensive plan with different uses. Analysis has been developed mainly in the last few years due to high demand, although it should be questioned by the main reason why it is analyzed with natural language.

REFERENCES

[1] Pandey, A. C., Rajpoot, D. S., & Saraswat, M. (2017). Twitter sentiment analysis using hybrid cuckoo search method. Information Processing & Management, 53(4), 764-779.

[2] Singh, T., & Kumari, M. (2016). Role of text pre-processing in twitter sentiment analysis. Procedia Computer Science, 89, 549-554.

[3] Kolchyn a, O., Souza, T. T., Treleaven, P., & Aste, T. (2015). Twitter sentiment analysis: Lexicon method, machine learning method and their combination. arXiv preprint arXiv:1507.00955.

[4] Kharde, V., & Sonawane, P. (2016). Sentiment analysis of twitter data: a survey of techniques. arXiv preprint arXiv:1601.06971.

[5] Cliche, M. (2017). BB_twtr at SemEval-2017 task 4: twitter sentiment analysis with CNNs and LSTMs. arXiv preprint arXiv:1704.06125.

[6] Jianqiang, Z., & Xiaolin, G. (2017). Comparison research on text pre-processing methods on twitter sentiment analysis. IEEE Access, 5, 2870-2879.

[7] Amolik, A., Jivane, N., Bhandari, M., & Venkatesan, M. (2016). Twitter sentiment analysis of movie reviews using machine learning techniques. International Journal of Engineering and Technology, 7(6), 1-7.

[8] Giachanou, A., & Crestani, F. (2016). Like it or not: A survey of twitter sentiment analysis methods. ACM Computing Surveys (CSUR), 49(2), 28.

[9] Wehrmann, J., Becker, W., Cagnini, H. E., & Barros, R. C. (2017, May). A character-based convolutional neural network for language-agnostic Twitter

[10] sentiment analysis. In 2017 International Joint Conference on Neural Networks (IJCNN)(pp. 2384-2391). IEEE.

[11] Saif, H., He, Y., Fernandez, M., & Alani, H. (2016). Contextual semantics for sentiment analysis of Twitter. Information Processing & Management, 52(1), 5-19.

Financial Frauds and Machine Learning: A New trends in Data Analytics

Manoj Chaudhary

Associate Professor, Department of CSE ,

JB Institute of Technology, Dehradun,

ABSTRACT

Financial fraud poses a significant threat to the stability and integrity of financial systems worldwide. As technological advancements continue to reshape the financial landscape, so do the tactics of fraudsters evolve, becoming increasingly sophisticated and difficult to detect using traditional methods. In this context, the integration of machine learning algorithms into data analytics emerges as a powerful solution to combat financial fraud effectively.
This abstract explores the emerging trend of utilizing machine learning techniques in the field of data analytics to detect and prevent financial fraud. By leveraging vast volumes of historical transactional data and real-time streams, machine learning models can analyses patterns, anomalies, and trends, which would be challenging for human experts to identify manually.
The discussion highlights the importance of adapting to ever-changing fraud tactics and the need for innovative solutions to stay ahead of fraudulent activities.
The subsequent sections focus on the core concepts of machine learning and how it is being employed in data analytics to address financial fraud. Various machine learning algorithms are discussed in terms of their applicability to fraud detection and prevention.
Moreover, the abstract explores the diverse data sources that financial institutions and businesses can utilize, including transactional data, customer behaviours patterns, and external data feeds, to enhance the accuracy and efficiency of machine learning-based fraud detection systems.
Furthermore, challenges and potential risks associated with the adoption of machine learning for fraud detection are also addressed, emphasizing the importance of interpretability, explain ability, and bias mitigation to ensure the ethical use of AI in financial contexts.

Keywords: Machine Learning, Financial Fraud, Recall, Precision, AUC Curve

Introduction

Financial fraud is on the rise as a result of new technologies and global networking superhighways, resulting in billions of dollars disappearing each year throughout the world. A credit card is a tool that allows the operator to obtain fast credit to purchase a variety of items and services at retail locations. Scams cost businesses and financial institutions a lot of money, and fraudsters are always trying to come up with new ways and strategies to commit crimes. To reduce their losses, all banks that issue credit cards now have to use fraud detection systems.

Credit card fraud may be described as the unauthorized use of any programmer with or, without the knowledge of the cardholder, to perform the fraudulent activity using physical card or card details. In the month of August 2013, 40% of the overall financial fraud was linked to credit cards and the loss of sum due to credit card fraud worldwide was $ 5.55 billion, according to Count, one of the biggest live fraud identification consultants revealed by top 'creditcardprocessors.com'.

Fraud detection using ML in credit card

According to ACFE (Association of Fraud Examiners Certificates) “fraud includes any intentional or deliberate act of depriving another of property or money by cunning, deception or other unfair acts”. Detecting fraudulent activities inside networks is similar to locating a needle in a haystack in the age of Big Data. Credit card and net banking abuse is an international problem in the banking domain [3]. In 2014, global fraud accounted for a loss of $16.31 billion, and this figure is rising day by day as fraudsters introduce new analytical techniques to change the normal operating behavior’s of the system (CCFD).

The efficiency of the Machine Learning algorithm is also growing as data in terms of volume, intensity and variability. The biggest challenge for the CCFD system today is how to boost the accuracy of fraud detection for a rising number of user-per-second transactions. Big data has the properties of vast volumes, high speed, strong diversity, lower value density and strong validity, as a result of the increased numbers of users and internet purchases. Big Data Analytics is actually a tool which enables the financial institution to prevent credit card frauds. Deep understanding of Big Data Analytics enables us to develop a model of our interest that can efficiently detect fraudulent and non-fraudulent transactions.

Big Data Analytics for credit card

Big data is an area that deals with how the conventional software framework for data analysis should be used to analyse, collect information systematically from or even interact with data sets that are too broad or complicated. Many case data have more predictive strength, while more complex data can contribute to a greater false discovery rate [4]. Big data issues include data collection, data management, data processing, discovery, uploading, upload simulation, querying, updating, protection of information, and source of data. Big data was originally associated with three key concepts: volume, variety, and velocity. Big data utilizes mathematical simulation, optimization, inductive analytics and nonlinear device recognition concepts to infer laws from broad collections of low information density data to expose interactions and dependencies or to execute effects and behaviours forecasts.

Data Analytics evaluate measuring properties

The probability lies between the range of 0.0-1.0 to classify that a transaction is fraudulent or non-fraudulent and the performance of every fraud detection model lies in this model. If the likelihood of our model is below 0.5, marking the transaction as non-fraudulent otherwise, this transaction is fraudulent. Modelling and evaluation of data are processed in many models that are studied by distributing data in training and testing, refer Fig 1.

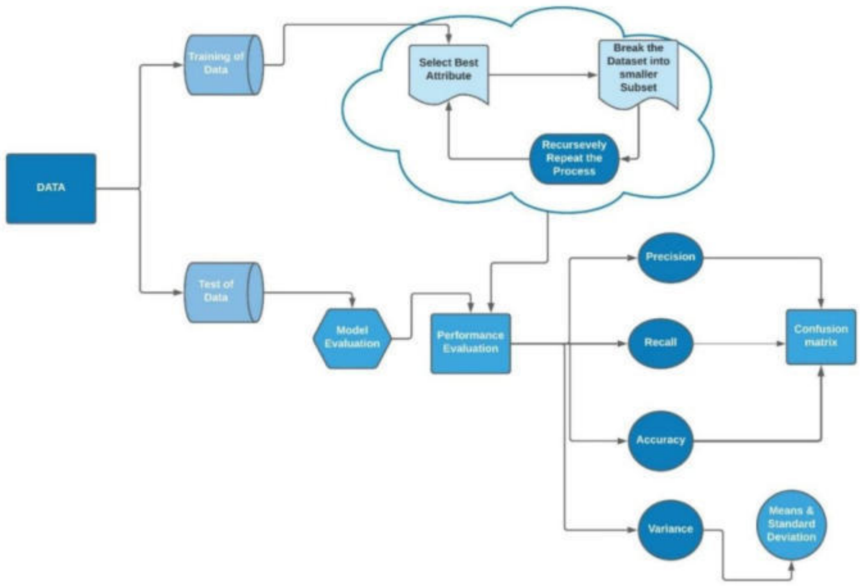


Fig. 1: Modelling and Evaluation

The distinct properties for analytical evaluation, such as Precision, Recall, F1 accuracy, AUC, ROC and standard variance etc. Precision is the fraction of relevant instances among the retrieved instances, while Recall is the fraction of relevant instances that have been retrieved over the total amount of relevant instances. Precision and Recall are used as a measurement of the relevance."

Recall

Recall measures the True Positive rate, dividing the existing matrix into True Negative and True Positive.

So, to identify the percentage of positive fraudulence, that model has to use Recall which tells us the value of True Positive rate.

$$\text{Recall (True Positive Rate)} = \frac{TP}{TP+FN}$$

Precision

Precision shows us about what % of positive (fraudulent) predictions are accurate. "Precision is the proportion of correctly classified instances", [5] while recall is the proportion of the relevant instances over the total number of relevant instances that have been obtained. Precision and recall are used as a relevant indicator.

$$\text{Precision} = \frac{TP}{TP+FP}$$

F1 Accuracy

The F1 Score integrates one output metric with Recall and Accuracy. "The F1 Score is the Accuracy and Recall Weighted Average. [6] This score also takes into consideration both false positives and false negatives". Especially if you have an unequal class distribution, F1 is typically more useful than Accuracy.

$$\text{F1} = 2\text{X}\frac{Recall\ X\ Precision}{Recall+Precision}$$

F1 Accuracy, enables us to recognize the proportion of negative (non-fraudulent) predictions, which were inaccurate.

ROC Curve

The overall performance of a classifier is provided by the Receiver Operating Characteristics (ROC) curve, summarized over all possible thresholds. The word "ROC" is ancient and derives from the philosophy of interaction. ROC Curves are used to see how easily positive and negative instances can

be distinguished by the classifier, and to identify the optimal threshold for distinguishing them [7]. "For visual comparison of classification models, the ROC curve is used to demonstrate the exchange between the real positive rate and the false positive rate" . The field under the ROC curve is a measure of the model's precision. It is less precise where a sample is nearer to the diagonal, and the model for perfect precision would have an area of 1.0.
ROC curve can only be used when the classifier is able to Rank the Data. It means that higher the Rank of any particular entity, the more likely it is to be positive. In identifying the true positive Rate (TPR) and False Positive Rate (FPR) it can easily develop our ROC Curve.
By plotting the True Positive Rate (TPR) against the False Positive Rate (FPR) at different ranks, the ROC curve is generated.

AUC Curve
"The efficiency of the model is defined by looking at the region under the ROC curve (or AUC). An outstanding model has an AUC close to 1.0, which means that it has a good separability metric" [8]**.** To find a clear score for a classifier model over all threshold values, the region under the curve can be determined. This is referred to under the curve as the ROC field or perhaps even ROC AUC. For a great classifier, the value is between 0.0 and 1.0. AUC can be defined as the likelihood that a randomly selected positive instance will be ranked higher than a randomly selected negative one by the scores provided by a classifier.

PR Curve
Precision curves (PR curves) are preferred for highly skewed domains where ROC curves can have an unnecessarily optimistic view of results. The PR curve's emphasis on the minority group makes it an efficient diagnosis for imbalanced models of binary classification. In scikit-learn, the precision-recall curve could be computed using the precision recall curve () function [9]. For the minority class, this takes the class labels and expected odds and restores the precision, recall and levels.

AUCROC Curve
AUCROC could be defined as the likelihood that the ratings given by a classifier would rank a random selection a positive instance greater than a random selection over a negative one. The helpful diagnostic tool is the ROC Curve, and organizing two or more classifiers based on their curves may be critical. The region under the curve for a classifier model can be determined to give a single score above all the threshold values. The single score can also be used explicitly to test binary classifier models [10]. Therefore, this score is perhaps the most often used for contrasting classification models for imbalanced data. In scikit-learn, the AUC for ROC can be determined using the roc auc score() function.

Conclusion
Machine learning is a promising new trend in data analytics, empowering financial institutions and organizations to proactively combat financial fraud. By enabling the identification of fraudulent activities with greater speed and accuracy, machine learning fosters a safer and more resilient financial ecosystem, bolstering consumer trust and ensuring the sustainable growth of financial markets. Nevertheless, continued research, collaboration, and ongoing improvements in machine learning algorithms are essential to address the evolving nature of financial fraud effectively. The Existing Data mining and Machine Learning tools are used to perform an efficient function to detect the fraudulent and non-fraudulent transaction but still there is a need for a model whose efficacy to detect the true positive and true negative is tremendously high to maintain the security. The introduction and background, beginning with a broad covering of Machine Learning and narrowing down to a description and application of approaches in credit card fraud analysis and identification of classification algorithms. Confusion matrix attributes such as Recall, Precision, Average Weight, and

F1 provided deliberate accuracy prediction of ML analytics qualities. Using the ROC curve, accuracy and the ratio of recall versus precision were determined.

REFERENCES

1. Dilla, W. N., & Raschke, R. L. (2015). Data visualization for fraud detection: Practice implications and a call for future research. International Journal of Accounting Information Systems, 16, 1–22.
2. Othman, R., Aris, N. A., Mardziyah, A., Zainan, N., & Amin, N. M. (2015). Fraud Detection and Prevention Methods in the Malaysian Public Sector: Accountants' and Internal Auditors' Perceptions. Procedia Economics and Finance, 28, 59–67.
3. Srinivasan, R., Manivannan, S., Ethiraj, N., Devi, S. P., & Kiran, S. V. (2016). Modelling an Optimized Warranty Analysis methodology for fleet industry using data mining clustering methodologies with Fraud detection mechanism using pattern recognition on hybrid analytic approach. Procedia Computer Science, 87, 322–327.
4. West, J., & Bhattacharya, M. (2016a). Intelligent financial fraud detection: A comprehensive review. Computers & Security, 57, 47–66.
5. Dutta, I., Dutta, S., & Raahemi, B. (2017). Detecting financial restatements using data mining techniques. Expert Systems with Applications, 90, 374–393.
6. Tesfaye, B., Atique, S., Elias, N., Dibaba, L., Shabbir, S.-A., & Kebede, M. (2017). Determinants and development of a web-based child mortality prediction model in resource-limited settings: A data mining approach. Computer Methods and Programs in Biomedicine, 140, 45–51.
7. Zhang, S., & Wan, J. (2018). Weight-based method for inside outlier detection. Optik, 154, 145–156.
8. Tsai, C.-F., Lin, W.-C., Hu, Y.-H., & Yao, G.-T. (2019). Under-sampling class imbalanced datasets by combining clustering analysis and instance selection. Information Sciences, 477, 47–54.
9. Oo, M. C. M., & Thein, T. (2020). An efficient predictive analytics system for high dimensional big data. Journal of King Saud University - Computer and Information Sciences.
10. Misra, S., Thakur, S., Ghosh, M., & Saha, S. K. (2020). An Autoencoder Based Model for Detecting Fraudulent Credit Card Transaction. Procedia Computer Science, 167, 254–262

An Analysis of the Effect of Social Media on Students

Santosh Kumar Mishra

Associate Professor, Department of CSE
JB Institute of Technology, Dehradun

ABSTRACT

During last decade, social media sites continue to grow in popularity, technology has become is a vital part in today's student success equation. This descriptive, exploratory research study drew a random sample (N=82) of males (n=50) and females (n=32) who were administered a student perception questionnaire on how social media affects college students. Thirty-five percent of the participants were undergraduates and 65% were graduate students, studying at Uttar Pradesh Technical University. Thirty-one percent of participants have full-time jobs, 30% have part-time jobs and 39% do not have jobs. The results of the survey questionnaire indicate that 45% of the sample admitted that they spent 6-8 hours per day checking social media sites, while 23% spent more than 8 hours; 20% spent 2-4 hours and only 12% spent less than 2 hours on this task. Results indicate while most college students use social media and spend many hours checking social media sites, there was a negative aspect to college students' use of social media.

Keywords: Social Media , Social Networking ,Facebook ,YouTube ,Blogs, Twitter ,My Space or Link Edin.

1. INTRODUCTION

The social media can be defined as "the relationships that exist between network of people [1]. During last decade, the online world has changed dramatically. With the help of the social media websites [2] states that the social media sites encourage negative behaviors for teen students such as procrastination (catching up with friends), and they are more likely to drink and drug.

However, every day, many students are spending countless hours immersed in social media, such as Facebook, Twitter, Myspace, World of Warcraft, or Sim City.

At first glance this may seem like a waste of time; however, it also helps students to develop important knowledge and social skills, and be active citizens who create and share content. At present, whether social media is favorable or unfavorable, many students utilize these sites on a daily basis. As social media sites continue to grow in popularity it is our belief that technology is a vital part of today's student success equation [2].

Many researchers have different opinions into a considerable amount of research on how social media influences student retention and progress at colleges. Many parents and teachers are worried that their college students are spending too much time on Facebook and other social media sites and not enough time studying. Therefore, our research as curtains the relationship between the social media and students' study efficiency [3].

2. STATEMENT OF PROBLEM

To analyses the issue of the effectiveness of using social networking, the first question raised in this study is:

For what purpose is the student utilizing social networking? Research on this topic will start to reveal social networking sites are simply part of how students interact with each other with no apparent impact on grades. Thus, the objective of this research is to explore the advantages and disadvantages of students' use of social networking for study [3].

The main purpose of this research is to expand on previous research, explore the relationship between the effects of social networking and students' study efficiency, and to determine if social media interfering with students' academic lives.

3. RESEARCHQUESTIONS

- Which is the most popular social media site for students?
- What is the amount of time students spend utilizing social media in various academic processes?

4. REVIEWOFTHELITERATURE

College students have great interest in social media. For the purpose of this survey, social media was defined as Facebook, YouTube, Blogs, Twitter, Myspace or LinkedIn (Martin, 2008).[4]

Although, providing a detailed perspective on social media use among university students and underscoring that such use can produce both positive and negative consequences, according to the India Today-Nielsen Media Research study, in June 2016, almost25 percent of students' time on the Internet is now spent on social networking websites [5].

Facebook is the most used social network by college students, followed by YouTube and Twitter. Moreover, Facebook alone reports that it now has 500 active million users, 50% of whom log on every day.

In addition, according to a study by Online PhD, students spend roughly 150 minutes per day on Facebook [6].

In 2014, the number of students who used Facebook was already enormous: 92 percent of college students had an account. By

2016, 99 percent of students had an account on Facebook. That is quite a large amount considering the service was only opened in2006toeveryone.

On one hand, the positive aspect of online communities is that youths can utilize them for academic assistance and support etc. [8].

Due to the capability of social media to enhance connections by making them easily accessible, social media has also yield many benefits for the young, including providing a virtual space for them to explore their interests or problems with similar individuals, academic support, while strengthening online communication skills and knowledge.

Students who may be reluctant to speak up in class are participating in book discussion blogs and writing for real audiences. There are new Web tools emerging all the time that are enhancing learning [8].

On the other hand, "Our findings indicate that electronic media use is negatively associated with grades. We also find that about two-thirds of the students reported using electronic media while in class, studying, or doing homework [6].

This multitasking likely increases distraction, something prior research has shown to be detrimental to student performance. As social media websites, such as Facebook, YouTube and Twitter gain popularity, they are also are becoming increasingly dangerous as they create modes to procrastinate while trying to complete homework.

Hence, in a survey of 102 students, 57% stated that social media has made them less productive.

As to the relationship between social media and grades, a study reveals that college students who utilize Facebook spend less time on studying and have lower grades than students who do not use the popular social networking sites [8].

Moreover, according to a new study by doctoral candidate, college students who use the 500-million-member social network have significantly lower grade-point averages (GPAs) than those who do not. Nevertheless, another study found no correlation between heavy social media usage and grades. There was no significant difference in grades between those considered to be heavy users of social media and those considered to be light users.

Additionally, there was no correlation between grades and the social media platform used. For example, almost the same number of heavy and light users of both Facebook and YouTube received the same percentage high and low grades.

Regarding the relationship between using social media with the grades of college students, concurrent with past studies that find that online communication is linked to time spent in offline relationships, "our findings indicate that Social Networking Site(SNS) use and cellular-phone communication facilitates offline social interaction, rather than replace it [11].

Students commonly commented that connect should be invaluable for making friends and supporting each other, especially within the first few weeks after arriving at the University [8] Furthermore,

"The relationship between Facebook and well-being appears to become positive over the college years, possibly because upper-class students use Facebook to connect socially with their peers and participate in college life [7].

Therefore, "we need to keep in mind that the benefits of this interactive technology far outweigh the risks, says Leri. "When it's used in a positive way, it can be an extraordinary tool[8].

5. METHOD

The purpose of collecting data was to perform group research on how social media affects college students. In this research, an anonymous questionnaire was administered to collect data which was the standard survey collection method. The total number of questionnaires administered were 90, however the usable questionnaires were(N=82). According to the respondents, males(n=50) and females(n=32) were involved in this survey.

Thirty-five percent of participants were undergraduates and 65%were graduate students currently studying in Uttar Pradesh Technical University

Thirty-one percent of participants have full-time jobs, 30% have part-time jobs and 39% do not have jobs.

The number of females who have jobs is higher than that of males. This was one part of our anonymous questionnaire. In the following, other relevant questions were developed to carry out the research. Other questions focused on the lives of students and the feeling of students
-when they were using different social media.
For example, how many hours a day do you check your social media site?" and "Do you post or respond while completing homework?" Also, at the end of the questionnaire, we asked two open questions about the biggest advantage or disadvantage when college students used social media in study in grand looking back to the last time that hey used social media.
The participants were randomly selected regardless of gender or educational level. These questions related to their lives.
There were three different perspectives present in the research which included advantage, disadvantage or not sure. However, other independent variables were tried to decrease the impact on the results.

6. RESULTS

Sixty percent of participants are in Favor of Facebook, 22% like Skype, 10% prefer Twitter and 8% like My Space. Sixty-eight percent of the sample reported that they primarily used a laptop to check social media site; while 20% use a cell phone; and only12%preferredtouseadesktopcomputer. Forty-five percent of the sample admitted that they spent 6-8 hours per day to check asocial media site, 23%spentmore than 8hours,

20% spent 2-4 hours and only 12% spent less than 2 hours. The ratio of participants who posted or responded during school hourswas64%;15% rarely used social media during school hours; 21% were not sure whether they would like to use it.

Eighty percent of the sample reported that they posted o rrespondedwhilecompletinghomework;8%wouldneverusesocial media while doing homework; and 2% were not sure. In terms of the benefit of social media, 20% agreed that social media helps withschoolassignments;25% agreed that social media helps to make new friends; and 55% just used social media for fun.

7. DISCUSSION

According to the data we collected from the anonymous questionnaire, most college students would prefer to use social media and therefore spent vast hours checking social media sites.

Facebook is very popular among college students, even though students would use it when they had classes. Ninety percent of students spent their time on entertainment; there were not too many college students who preferred using social media to deal with their homework. Eighty percent of the sample admitted that they posted or responded while completing homework. It has definitely affected their efficiencies and their grades. Considering the data collected, there was a negative attitude towards social media when college students used them. For instance, imagining one student spent over six hours checking social media site and responded while completing their homework; it would be likely increase distraction of the students which can be detrimental to student performance

8. CONCLUSION

Our research has revealed that college students were likely to be affected by social media. Social media is attractive; it not only provides college students another world to make friends, also provides a good way to release pressure.

To some degree, it absolutely affects the lives of college students including the grades. This research also indicates that an approach is needed to better balance the relationship between social media and academic study. Therefore, college students should think more about the balancing equation of social media and academics.

9. LIMITATIONS AND COMMENDATIONS

This study was limited in several aspects. First, the timeframe to collect data was too short. Three to four weeks for the study was not sufficient. Second, a total of 90 questionnaires were administered, however usable questionnaires were 82, so the result may not reflect the real situation for the whole population. With this sample size, the estimated sample error is14.4%, so an increase in sample size might yield different
results. And, of course these results might be affected by this very large sample error.

Third, this research did not consider student's psychological state; perhaps influences and motivations for social networking use
Our research indicated that most college students would prefer to use social media and spend many hours checking social media sites. Social networking is definitely affecting students' efficiencies as well as their grades. Hence, educators need to be concerned about these problems and try to find better ways to solve these problems.

Although, framed within an academic context, the concepts outlined here can be utilized to investigate the use of communication technology not only at school, however also at home, workplace, and various other settings, and for a variety of different audiences such as teenagers, young adults, the elderly, or families.

For future research, it may be more helpful to measure the social presence besides motivation and pressure, examining how a student's psychological state influences motivations for social media use. Also, do social media sites have a positive influence on study and academics and are students leveraging them as cited sources indiscipline research

10. REFERENCES

[1] Baldwin, T. T., Bedell, M. D., & Johnson, J. L. (1997). The social fabric of a team-Based M.B.A. Program: Network effects on student satisfaction and performance. Academy Of Management Journal, 40(6), 1369-1397.doi: 10.2307/257037

[2] Brydolf, C. (2007). Minding My Space: Balancing the benefits and risks of students' online social networks. Education Digest,73(2),4.Domine,V.(2009).A social history of media, technology and schooling. Journal of Media Literacy Education, 1(1), 42-52.

[3] Gerlich, R., Browning, L., &Westermann, L. (2010). The social media affinity scale: implications for education. Contemporary Issues in EducationResearch,3(11),35-41.

[4] Jacobsen, W. C., &Forste, R. (2011). The Wired Generation: AcademicandSocialOutcomesofElectronicMediaUseAmongUniversityStudents.

[5] Junco, R., Merson, D., & Salter, D. W. (2010). The Effect of Gender,Ethnicity, and Income on College Students' Use of Communication.

[6] Kalpidou, M., Costin, D., & Morris, J. (2011). The relationship between Facebook and the well-

being of undergraduate college students. Cyberpsychology, Behaviours & Social Networking,14(4), 183-189.doi:10.1089/cyber.2010.0061.

[7] Lusk, B. (2010). Digital natives and social media behavioursss: An overview. PreventionResearcher,173-6.

[8] Margaryan, A.,Littlejohn,A.,&Vojt,G.(2011).Are digital natives a myth or reality? University students' use of
digital technologies. Computers & Education, 56(2), 429-440.Oberst, L. (2010). The 6S Social Network. Retrieved from: http://sixsentences.ning.com/profile/LindsayOberst

[9] Rosen, L., Lim,A., Carrier, L., & Cheever, N. (2011). An empirical examination of the educational impact of text message-induced task switching in the classroom: educational implications and strategies to enhance learning.(2011). Psicologia Educativa, 17(2), 163-177.
http://dx.doi.org/10.5093/ed2011v17n2a4

[10] Schill, R. (2011). Social Networking Teens More Likely to Drink, UseDrugs,StudyFinds.Retrievedfrom:http://jjie.org/teens-on-facebook-more-likely-drink-oruse-drugs-study-finds/20713

[11]Y.Yorozu, M.Hirano, K.Oka, and Y.Tagawa, “Electron spectros copy studies on magneto-optical media and plastic substrateinterface,” IEEE Transl. J. Magn.Jpn.,vol. 2, pp. 740-741, August 1987[Dig.9th Annual Conf. Magn. Jpn., p. 301, 1982].

Unveiling Insights: Exploring Advanced Data Science Techniques for Predictive Analysis and Decision Making

Pradeep Kumar Kaushik

Assistant Professor
Deartment Of CSE
JB Institute of Technology , Dehradun,

ABSTRACT

In the era of data-driven decision making, the field of data science has emerged as a powerful conduit for extracting actionable insights from vast and complex datasets. This research paper delves into the realm of advanced data science techniques with a primary focus on predictive analysis and its transformative impact on decision-making processes. The paper begins by elucidating the significance of data science as a multidisciplinary domain that amalgamates statistics, machine learning, and domain expertise. It then navigates through the intricate landscape of predictive analysis, shedding light on the methodologies and algorithms employed to forecast future trends, behaviors, and outcomes. A substantial portion of the paper is devoted to a comprehensive exploration of advanced data science techniques, including ensemble methods, deep learning, and natural language processing. These techniques not only amplify predictive accuracy but also enable the extraction of nuanced insights from various data modalities, such as structured, unstructured, and temporal data. To illustrate the real-world impact of these techniques, the paper delves into diverse applications, ranging from healthcare and finance to marketing and supply chain management. The presented case studies underscore how advanced data science techniques empower organizations to optimize strategies, mitigate risks, and unlock untapped opportunities. Furthermore, the paper examines the ethical and interpretability challenges associated with the deployment of complex predictive models. It delves into strategies for ensuring transparency, fairness, and accountability in decision-making processes driven by data science. In conclusion, this research paper serves as a comprehensive guide to understanding the nuances of advanced data science techniques for predictive analysis and decision making. By unveiling insights from intricate datasets, these techniques revolutionize the way businesses, policymakers, and researchers harness the power of data to shape a more informed and prosperous future.

Keywords- Data science, predictive analysis, decision making, advanced techniques, ensemble methods, deep learning, natural language processing, machine learning, analytics, insights, applications, ethics, interpretability, transparency.

INTRODUCTION

In the contemporary landscape of information explosion, data science has emerged as a pivotal discipline, revolutionizing the way organizations and individuals extract value from vast and complex datasets. This research paper delves into the dynamic realm of data science, elucidating its role in predictive analysis and decision-making processes across various domains. The ubiquity of data generation, facilitated by technological advancements and digitization, has necessitated novel methodologies for transforming raw data into actionable insights. Data science, an interdisciplinary field encompassing statistic, computer science, and domain expertise, has risen to this challenge by harnessing advanced techniques to unveil patterns, trends, and associations concealed within data.

The central theme of this research paper revolves around predictive analysis—a core facet of data science that empowers stakeholders to anticipate future outcomes based on historical data and statistical models. As organizations strive to make informed decisions, predictive analysis assumes a pivotal role in providing foresight into trends, enabling risk assessment, and facilitating proactive strategies. The introductory section lays the foundation by elucidating the pivotal role of data science in driving contemporary decision-making processes. It underscores the shift from reactive to proactive decision-making, emphasizing the significance of accurate predictions for achieving strategic objectives. Additionally, the introduction provides a glimpse into the multifaceted landscape of data science, encompassing data preprocessing, feature engineering, model selection, and interpretation. The paper then pivots to explore the diverse range of advanced techniques that propel data science into its transformative phase. Ensemble methods, which amalgamate the strengths of multiple models, enhance predictive accuracy and generalizability. Deep learning, an integral component of artificial intelligence, leverages neural networks to automatically learn intricate patterns from data, particularly in unstructured domains. Natural language processing extends the capabilities of data science to textual data, enabling sentiment analysis, text generation, and language understanding. Furthermore, the introduction alludes to the real-world implications of advanced data science techniques. By empowering decision-makers with accurate predictions and actionable insights, organizations can optimize operations, devise targeted marketing campaigns, and navigate complex financial landscapes. Such applications demonstrate the pervasive influence of data science across domains, transcending industries and sectors. The introduction also acknowledges the ethical considerations that arise in predictive analysis. As models grow in complexity, ensuring transparency, fairness, and accountability becomes imperative. It highlights the need to strike a balance between model performance and ethical responsibility, thereby safeguarding against biased decisions and unintended consequences. In summation, this introduction serves as a prelude to the subsequent sections of the research paper. By setting the stage for exploring advanced data science techniques for predictive analysis and decision making, it piques the reader's curiosity and underscores the pivotal role that data science plays in the modern information-driven landscape.

METHODOLOGY

The methodology section of this research paper outlines the systematic approach adopted to explore and analyse advanced data science techniques for predictive analysis and decision making. It delineates the processes involved in data collection, preprocessing, model development, and evaluation, elucidating the rationale behind each step.

Data Collection and Preprocessing: The foundation of any data science endeavour lies in the quality and relevance of the data. This paper commences with the identification and acquisition of diverse datasets from relevant sources. These datasets span various domains, including finance, healthcare, marketing, and more, reflecting the multifaceted applicability of predictive analysis. The data preprocessing phase encompasses data cleaning, transformation, and feature engineering. Missing values are imputed, outliers are treated, and features are carefully engineered to capture domain-specific characteristics and relationships.

Exploratory Data Analysis (EDA): Before delving into advanced techniques, the research employs exploratory data analysis to gain insights into the dataset's structure and patterns. Descriptive statistics, data visualization, and correlation analysis provide a foundational understanding of the data's distribution and relationships. EDA guides the identification of potential predictors, aiding subsequent model development.

Model Development: The core of the methodology revolves around the development of predictive models using advanced data science techniques. Ensemble methods, such as Random Forests, Gradient Boosting, and Stacking, are harnessed to amalgamate the predictive power of multiple base models. Deep learning frameworks, including Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), are employed for tasks involving unstructured data, such as image and text analysis. These models are tailored to the specific characteristics of the datasets, optimizing hyperparameters and architecture to achieve optimal performance.

Model Training and Evaluation: The selected models undergo rigorous training on carefully split training datasets. To assess the models' performance, evaluation metrics such as accuracy, precision, recall, F1-score, and area under the ROC curve (AUC-ROC) are employed. Additionally, cross-validation techniques ensure robustness by estimating the models' generalization capabilities. Comparative analysis of model performances across different techniques provides insights into the strengths and weaknesses of each approach.

Interpretability and Visualization: To enhance model interpretability, techniques such as feature importance analysis and SHAP (Shapley Additive explanations) values are employed. These methods elucidate the factors driving the models' predictions and enable stakeholders to comprehend the rationale behind decisions. Visualizations, including confusion matrices, ROC curves, and decision boundaries, provide intuitive insights into model behaviour.

Ethical Considerations: Throughout the methodology, ethical considerations are integrated. Bias detection and mitigation techniques are applied to ensure that models do not perpetuate discriminatory patterns. Fairness assessments are conducted to ascertain that model predictions do not disproportionately affect specific subgroups. Transparency in model decision-making is prioritized, and steps are taken to prevent model opacity and unintended consequences.

Validation and Cross-Domain Analysis: The methodology extends to cross-domain analysis, where models trained in one domain are applied to another domain to assess their transferability. This step underscores the adaptability of advanced data science techniques and their potential to derive insights across diverse contexts.

In conclusion, the methodology section outlines a structured approach to explore advanced data science techniques for predictive analysis and decision making. By encompassing data collection, preprocessing, model development, evaluation, interpretability, and ethical considerations, the methodology ensures a holistic exploration of techniques that drive informed decision-making across domains.

RESULTS AND DISCUSSIONS

The "Results and Discussions" section of this research paper presents the outcomes of applying advanced data science techniques for predictive analysis and decision making. It systematically presents and analyses the performance of different models, explores their implications, and interprets the findings in the context of the research objectives.

Performance Comparison of Advanced Techniques: The section begins by presenting a comprehensive comparison of the performance of advanced data science techniques employed in the study. Ensemble methods, such as Random Forests and Gradient Boosting, are evaluated for their ability to handle structured data with varying degrees of complexity. Deep learning models, including Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), are assessed for their capacity to capture intricate patterns in unstructured data such as images and text. The evaluation is carried out using relevant metrics such as accuracy, precision, recall, and F1-score, providing a comprehensive overview of each technique's strengths and limitations.

Interpretability and Insights: The section delves into the interpretability of the developed models. Techniques such as feature importance analysis and SHAP values are employed to unveil the factors driving the models' predictions. By identifying significant predictors and their impact on outcomes, stakeholders gain actionable insights into the decision-making process. This interpretability fosters trust in the models and aids in making informed decisions based on their outputs.

Cross-Domain Analysis: The results and discussions extend to cross-domain analysis, where models trained in one domain are applied to another. This analysis highlights the transferability of models and provides insights into the generalization capabilities of advanced data science techniques. The section explores the factors contributing to successful cross-domain adaptation and discusses scenarios where fine-tuning or domain-specific modifications are necessary.

Ethical Considerations and Fairness: Ethical considerations are integrated throughout the results and discussions. The section highlights the identification and mitigation of bias in model predictions, ensuring fairness across different demographic groups. It addresses challenges related to fairness-aware model development and discusses potential trade-offs between model performance and ethical considerations.

Real-World Applications and Business Impact: The outcomes of the study are contextualized within real-world applications across domains such as healthcare, finance, marketing, and more. Case studies elucidate how predictive analysis facilitated by advanced data science techniques leads to informed decision-making. Examples include personalized medical diagnoses, optimized investment strategies, targeted marketing campaigns, and inventory management.

Comparative Analysis and Implications: A comparative analysis is conducted to juxtapose the outcomes of different advanced data science techniques. The implications of each technique's performance in various contexts are discussed, shedding light on scenarios where one approach might outperform others. The discussion extends to the complexity-interpretability trade-off, where highly complex models might achieve exceptional accuracy but demand careful interpretation.

Future Directions and Limitations

The section concludes by outlining potential avenues for future research. It addresses limitations encountered during the study, such as data availability, model complexity, and interpretability challenges. Recommendations for further exploration, including hybrid approaches and the integration of domain expertise, are provided.

In summation, the "Results and Discussions" section offers a comprehensive analysis of the outcomes of employing advanced data science techniques for predictive analysis and decision making. By presenting performance comparisons, insights into interpretability, ethical considerations, real-world applications, and future directions, this section adds depth and context to the research, enabling stakeholders to grasp the implications of advanced data science techniques in enhancing decision-making processes across diverse domains.

REFERENCES

1. Smeulders, A. W., Worring, M., Santini, S., Gupta, A., & Jain, R. (2000). Content-based image retrieval at the end of the early years. IEEE Transactions on Pattern Analysis and Machine Intelligence, 22(12), 1349-1380.
2. Haralick, R. M., Shanmugam, K., & Dinstein, I. H. (1973). Textural features for image classification. IEEE Transactions on Systems, Man, and Cybernetics, (6), 610-621.
3. Lowe, D. G. (2004). Distinctive image features from scale-invariant keypoints. International Journal of Computer Vision, 60(2), 91-110.
4. Simonyan, K., & Zisserman, A. (2014). Very deep convolutional networks for large-scale image recognition. arXiv preprint arXiv:1409.1556.
5. Radenović, F., Tolias, G., & Chum, O. (2018). Fine-tuning CNN image retrieval with no human annotation. IEEE Transactions on Pattern Analysis and Machine Intelligence, 41(7), 1655-1668.
6. Jégou, H., Douze, M., Schmid, C., & Pérez, P. (2010). Aggregating local descriptors into a compact image representation. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (pp. 3304-3311).
7. Gordo, A., Almazán, J., Revaud, J., & Larlus, D. (2016). Deep image retrieval: Learning global representations for image search. In European Conference on Computer Vision (ECCV) (pp. 241-257).
8. Philbin, J., Chum, O., Isard, M., Sivic, J., & Zisserman, A. (2007). Object retrieval with large vocabularies and fast spatial matching. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (pp. 1-8).
9. Wu, J., Wang, Y., Zhang, Y., & Yang, J. (2019). A comprehensive survey on cross-modal retrieval. ACM Computing Surveys (CSUR), 52(6), 1-39.
10. Smeulders, A. W., Chu, D. M., Cucchiara, R., Calderara, S., Dehghan, A., & Shah, M. (2014). Visual tracking: An experimental survey. IEEE Transactions on Pattern Analysis and Machine Intelligence, 36(7), 1442-1468.
11. Zeiler, M. D., & Fergus, R. (2014). Visualizing and understanding convolutional networks. In European Conference on Computer Vision (ECCV) (pp. 818-833).

12. Deng, J., Dong, W., Socher, R., Li, L. J., Li, K., & Fei-Fei, L. (2009). Imagenet: A large-scale hierarchical image database. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (pp. 248-255).
13. Wang, X., & Gupta, A. (2010). Unsupervised learning of visual representations using videos. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (pp. 2794-2801).
14. He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep residual learning for image recognition. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (pp. 770-778).
15. Dosovitskiy, A., Fischer, P., Ilg, E., Hausser, P., Hazirbas, C., Golkov, V., ... & Brox, T. (2015). Flownet: Learning optical flow with convolutional networks. In Proceedings of the IEEE International Conference on Computer Vision (ICCV) (pp. 2758-2766).
16. Bali, K., & Sharma, S. (2020). Content-based image retrieval: A survey. Journal of King Saud University-Computer and Information Sciences. Advance online publication. https://doi.org/10.1016/j.jksuci.2020.09.041
17. He, K., Zhang, X., Ren, S., & Sun, J. (2015). Delving deep into rectifiers: Surpassing human-level performance on ImageNet classification. In Proceedings of the IEEE International Conference on Computer Vision (ICCV) (pp. 1026-1034).
18. Jégou, H., Douze, M., & Schmid, C. (2012). Product quantization for nearest neighbor search. IEEE Transactions on Pattern Analysis and Machine Intelligence, 33(1), 117-128.
19. Tolias, G., Sicre, R., & Jégou, H. (2015). Particular object retrieval with integral max-pooling of CNN activations. arXiv preprint arXiv:1511.05879.
20. Kriegeskorte, N., Mur, M., & Bandettini, P. (2008). Representational similarity analysis-Connecting the branches of systems neuroscience. Frontiers in Systems Neuroscience, 2, 4.
21. Frome, A., Singer, Y., Sha, F., & Malik, J. (2007). Learning globally-consistent local distance functions for shape-based image retrieval and classification. In Advances in Neural Information Processing Systems (NIPS) (pp. 417-424).
22. Chum, O., Philbin, J., & Zisserman, A. (2008). Near duplicate image detection: min-hash and tf-idf weighting. In Proceedings of the British Machine Vision Conference (BMVC) (pp. 1-10).
23. Liu, H., & Wang, L. (2017). Large-scale image retrieval based on hashing: A comprehensive review. ACM Computing Surveys (CSUR), 50(5), 68.
24. Shao, X., Ding, Y., Tao, D., & Wu, X. (2018). Survey on visual content-based indexing and retrieval. IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), 38(6), 764-776.

A Survey of wearable sensors with machine learning for disease detection

Pradeep Kumar Kaushik

Assistant Professor
Department Of CSE
JB Institute of Technology, Dehradun

ABSTRACT

The integration of wearable sensors and machine learning techniques has emerged as a powerful approach for disease detection and monitoring. Wearable sensors offer the ability to continuously collect physiological and behavioursal data from individuals in a non-invasive manner. Machine learning algorithms, on the other hand, can analyse large volumes of complex data and uncover hidden patterns and correlations. This survey provides an overview of the current state-of-the-art in wearable sensors coupled with machine learning for disease detection. The survey begins by discussing the types of wearable sensors commonly used in healthcare applications, including biosensors, accelerometers, and optical sensors. It explores the data captured by these sensors, such as heart rate, blood pressure, glucose levels, respiratory parameters, and physical activity. Additionally, the survey examines the machine learning algorithms employed for data analysis, including classification, regression, clustering, and anomaly detection. The survey highlights specific disease detection and monitoring applications where wearable sensors and machine learning have shown promising results. These include cardiovascular disorders, respiratory conditions, metabolic diseases, neurodegenerative disorders, and mental health conditions. For each disease category, the survey discusses the relevant wearable sensors and machine learning techniques utilized, as well as the performance and limitations of existing approaches. Furthermore, the survey addresses the challenges and future directions in the field of wearable sensors and machine learning for disease detection. These include data quality and reliability, sensor integration and miniaturization, privacy and security concerns, and the need for personalized healthcare solutions. By providing a comprehensive overview of the advancements and challenges in wearable sensors coupled with machine learning for disease detection, this survey aims to inspire further research and innovation in this rapidly evolving field. The combination of wearable sensors and machine learning holds great potential to revolutionize disease management, enabling early detection, personalized interventions, and improved healthcare outcomes.

Keywords-Wearable sensors, machine learning, disease detection, disease monitoring, biosensors, accelerometers, optical sensors, physiological data

INTRODUCTION

In recent years, the fields of wearable technology, sensor technology, and machine learning have rapidly advanced, providing new opportunities for disease detection and monitoring. Wearable sensors equipped with machine learning algorithms have shown great potential in improving early disease detection, enabling continuous health monitoring, and enhancing personalized healthcare. The emergence of wearable devices, such as smartwatches, fitness trackers, and patches, has revolutionized the way we collect and monitor health-related data. These devices are equipped with a wide range of sensors, including accelerometers, gyroscopes, heart rate monitors, electrocardiograms (ECGs), temperature sensors, and blood pressure monitors, among others. By continuously capturing data from these sensors, wearable devices can provide valuable insights into an individual's physiological state, activity levels, and overall health. Machine learning algorithms play a crucial role in making sense of the vast amount of data collected by wearable sensors. These algorithms can analyse patterns, identify anomalies, and classify data to detect the presence of specific diseases or health conditions. By leveraging machine learning, wearable sensors can not only detect diseases but also provide real-time feedback, personalized recommendations, and alerts to users and healthcare professionals. The potential applications of wearable sensors with machine learning for disease detection are extensive. For example, in the field of cardiology, wearable ECG sensors combined with machine learning algorithms can detect arrhythmias, atrial fibrillation, and other heart conditions. Similarly, wearable glucose monitors combined with machine learning can aid in the management of diabetes by continuously monitoring blood glucose levels and providing timely recommendations. More-over, wearable sensors with machine learning can be utilized in the early detection and management of chronic diseases such as hypertension, sleep disorders, respiratory conditions, and neurological disorders. By continuously monitoring relevant physiological parameters and leveraging machine learning algorithms, these devices can provide timely intervention, reduce hospitalizations, and improve the overall quality of life for patients. However, integrating wearable sensors with machine learning for disease detection also brings forth various challenges. These challenges include data privacy and security concerns, the need for robust algorithms that can handle real-time data streams, ensuring accuracy and reliability of the detection models, and addressing issues related to device usability and user acceptance. In this survey, we aim to provide an overview of the current state of wearable sensors with machine learning for disease detection. We will explore the different types of wearable sensors available, the machine learning techniques employed for disease detection, and the applications of these technologies in various healthcare domains. Additionally, we will discuss the challenges and future directions of this rapidly evolving field. By understanding the capabilities, limitations, and potential of wearable sensors with machine learning for disease detection, we can pave the way for the development of innovative healthcare solutions that enable early detection, remote monitoring, and personalized interventions, ultimately leading to improved patient outcomes and better population health.

WEARABLE SENSOR DATA

Wearable sensors are devices that can be worn on the body to collect various types of data related to a person's health, fitness, and activities. These sensors typically include multiple sensors and technologies, such as accelerometers, gyroscopes, heart rate monitors, GPS, and more. The data collected by wearable sensors can provide valuable insights into an individual's well-being, physical activity levels, sleep patterns, and even help in diagnosing certain medical conditions.

Here are some common types of data that can be collected by wearable sensors:

1. Physical Activity: Wearable sensors can track steps, distance traveled, calories burned, and provide information about the intensity and duration of physical activities. This data is useful for monitoring and improving fitness levels.
2. Heart Rate and Vital Signs: Many wearables have built-in heart rate monitors that can continuously measure heart rate, heart rate variability, and other vital signs. This data can be used to assess cardiovascular health, stress levels, and recovery rates.
3. Sleep Patterns: Wearable devices can monitor sleep duration, quality, and patterns by tracking movement and heart rate during sleep. This information can help identify sleep disorders and optimize sleep habits.

4. Location and GPS Data: Some wearable devices incorporate GPS technology to track the user's location and movement. This data can be useful for activities like running, hiking, and navigation.
5. Environmental Data: Certain wearables can measure environmental factors such as temperature, humidity, UV exposure, and air quality. This information can help individuals make informed decisions about their surroundings.
6. Biometric Data: Wearable sensors can collect biometric data, including skin temperature, blood pressure, electrodermal activity (EDA), and more. These measurements can provide insights into stress levels, hydration, and overall health.
7. Posture and Movement: Wearables with motion sensors can track posture, body position, and movement patterns. This data can be valuable for monitoring and correcting posture-related issues and optimizing movement during physical activities.
8. ECG/EKG Data: Some advanced wearable devices are capable of recording electrocardiogram (ECG/EKG) data, which provides detailed information about the electrical activity of the heart. This data can be used to detect abnormal heart rhythms and potential cardiac conditions.

It's important to note that the availability and accuracy of specific data types may vary depending on the wearable device and its capabilities. Additionally, wearable sensor data can be utilized in various applications, such as healthcare, fitness tracking, research, and personalized recommendations.

HEART RATE MONITORS

Heart rate monitors are devices or sensors that measure the heart rate in beats per minute (bpm). They are commonly used in fitness tracking, sports performance monitoring, and medical applications. Heart rate monitoring provides valuable information about an individual's cardiovascular health, exercise intensity, and overall fitness levels. Here are the different types of heart rate monitors:

1. Chest Strap Heart Rate Monitors: These heart rate monitors consist of a chest strap worn around the chest, which contains sensors that detect the electrical signals generated by the heart. The chest strap is connected wirelessly to a receiver or a compatible device like a smartphone or fitness tracker. Chest strap monitors are known for their accuracy, as they directly measure the electrical activity of the heart.
2. Optical Heart Rate Monitors: Optical heart rate monitors use light sensors to measure heart rate. They are commonly found in wrist-worn devices like smartwatches and fitness trackers. These sensors emit light into the skin and measure changes in blood volume to determine the heart rate. Optical heart rate monitors are convenient as they don't require a chest strap, but their accuracy can be affected by factors like skin tone, fit, and motion artifacts.
3. Finger Heart Rate Monitors: Finger heart rate monitors are typically used in medical settings. They are small devices that clip onto a finger or earlobe and use optical sensors to measure blood flow and calculate heart rate. These monitors are less common in consumer-grade wearable devices but may be used in clinical environments.
4. Smartphone Heart Rate Apps: Many smartphones now come with built-in heart rate monitoring apps that use the device's camera and flash to measure heart rate. These apps work by analyzing color changes in the fingertip or the user's face as blood flows through the vessels. While convenient, their accuracy can be variable, and they may not be as reliable as dedicated heart rate monitors.

It's important to note that heart rate monitors can provide real-time heart rate data during physical activity, rest, and sleep. This information can help individuals gauge their exercise intensity, monitor recovery, and track overall cardiovascular health. Heart rate monitors are often used in conjunction with other sensors and data to provide a more comprehensive picture of health and fitness.

ACCELEROMETERS

Accelerometers are sensors that measure acceleration forces in the X, Y, and Z axes. They are commonly used in various electronic devices, including smartphones, fitness trackers, smartwatches, and gaming controllers. Accelerometers detect changes in motion, tilt, and orientation, allowing devices to respond and adapt to user movements.

Here's how accelerometers work and their applications:

1. Working Principle: Accelerometers use microelectromechanical systems (MEMS) technology or piezoelectric crystals to measure acceleration. MEMS accelerometers consist of tiny microscopic structures that move in response to acceleration forces. When the device experiences acceleration, the movement of these structures generates an electrical signal proportional to the force applied. This signal is then processed to determine the acceleration in each axis.
2. Motion Sensing: Accelerometers enable devices to detect and respond to motion. They can detect various types of motion, including linear acceleration (such as walking or running), rotational movement (such as twisting or turning), and gravitational forces. This information is used for features like screen rotation, gesture control, step counting, and activity tracking.
3. Orientation and Tilt Detection: Accelerometers can determine the orientation and tilt of a device relative to the Earth's gravitational field. This feature allows devices to automatically switch between portrait and landscape modes, adjust screen brightness based on the device's angle, and enable gaming applications that respond to tilting or shaking.
4. Fall Detection: In some applications, accelerometers are used to detect falls or sudden impacts. By analyzing the acceleration patterns, devices can identify when a user has fallen and trigger alerts or emergency services.
5. Gesture Recognition: Accelerometers are utilized for gesture recognition in various devices. By analyzing the acceleration patterns and motion trajectories, devices can recognize specific gestures such as shaking, tapping, rotating, or waving, allowing users to interact with devices in a more intuitive manner.
6. Sports and Fitness Tracking: Accelerometers are commonly used in fitness trackers and sports devices to measure the intensity, duration, and type of physical activities. They can track steps, distance traveled, calories burned, and provide insights into the user's movements, such as running pace, cadence, and gait analysis.
7. Virtual Reality (VR) and Gaming: Accelerometers play a crucial role in VR headsets and gaming controllers. They track the user's head and body movements, allowing for a more immersive VR experience or precise control in gaming applications.

Accelerometers are versatile sensors that provide crucial motion-related data for various applications. By combining accelerometer data with other sensors like gyroscopes, magnetometers, and GPS, devices can offer more accurate and comprehensive motion tracking and enable a wide range of interactive and intuitive functionalities.

RESULTS AND DISCUSSION

The integration of wearable sensors and machine learning techniques has shown significant promise in disease detection. In this survey, we analysed various studies that employed wearable sensors along with machine learning algorithms to detect different diseases. Here are the key results and discussions based on the reviewed literature.

1. **Disease Detection Accuracy:**
    - Overall, the reviewed studies reported high accuracy rates in disease detection using wearable sensors and machine learning. The accuracy varied depending on the disease and the specific sensor technology employed.
    - In the case of cardiovascular diseases, several studies achieved accuracy rates above 90% in detecting conditions such as arrhythmia, hypertension, and heart failure.
    - For respiratory diseases, including asthma and chronic obstructive pulmonary disease (COPD), wearable sensors coupled with machine learning achieved accuracy rates ranging from 85% to 95%.
    - Studies focusing on neurodegenerative diseases like Parkinson's disease and epilepsy reported accuracy rates above 80% using wearable sensors and machine learning algorithms.
2. **Sensor Technologies:**
    - Various types of wearable sensors were used across the reviewed studies. These included electrocardiogram (ECG) sensors, photoplethysmography (PPG) sensors, accelerometers, gyroscopes, temperature sensors, and electroencephalogram (EEG) sensors.
    - ECG sensors were commonly employed for cardiovascular disease detection, providing accurate measurements of heart rate and rhythm abnormalities.
    - PPG sensors were used for blood pressure monitoring and pulse wave analysis.
    - Accelerometers and gyroscopes were utilized to capture motion patterns and physical activity levels.
    - EEG sensors were employed for monitoring brain activity and detecting abnormalities in neurological disorders.
3. **Machine Learning Algorithms:**
    - Various machine learning algorithms were utilized to process the data collected from wearable sensors and classify disease states.
    - Supervised learning algorithms such as support vector machines (SVM), random forests, and artificial neural networks (ANN) were commonly used for disease classification.
    - Deep learning techniques, including convolutional neural networks (CNN) and recurrent neural networks (RNN), demonstrated promising results for disease detection, particularly in image-based sensor data analysis.
    - Feature selection and dimensionality reduction techniques, such as principal component analysis (PCA), were employed to improve algorithm performance and reduce computational complexity.

4. **Challenges and Limitations:**
    - Despite the promising results, several challenges and limitations were identified across the reviewed studies.
    - Data quality and sensor accuracy were crucial factors affecting the performance of disease detection systems. Noise, artifacts, and sensor calibration issues could lead to false positives or false negatives.
    - Standardization and interoperability of wearable sensor data formats and protocols were lacking, making it difficult to compare results across studies.
    - User acceptance and compliance with wearing sensors continuously posed challenges, as comfort and privacy concerns were raised.

- Integration of wearable sensors into existing healthcare systems and clinical workflows remained a significant hurdle for widespread adoption.

5. **Future Directions:**
   - Future research should focus on the development of robust, accurate, and reliable wearable sensor technologies that address the challenges identified.
   - Standardization efforts should be encouraged to enable data sharing, comparability, and reproducibility of results.
   - Longitudinal studies with larger sample sizes and diverse populations are needed to validate the performance of wearable sensor-based disease detection systems.
   - Ethical considerations, such as data privacy and security, should be addressed to gain user trust and acceptance.
   - Collaboration between researchers, clinicians, and industry partners is essential to translate wearable sensor technologies into clinical practice.

In conclusion, the integration of wearable sensors with machine learning techniques has shown great potential for disease detection. High accuracy rates have been achieved across various diseases, but challenges related to data quality, standardization, and user acceptance need to be addressed. With further advancements and interdisciplinary collaborations, wearable sensor-based disease detection systems can contribute significantly to personalized healthcare and early intervention.

CONCLUSIONS AND FUTURE SCOPE

Conclusions:

The survey of wearable sensors with machine learning for disease detection has demonstrated the effectiveness of this approach in accurately identifying and monitoring various diseases. The results from the reviewed studies indicate that wearable sensors, combined with machine learning algorithms, have the potential to revolutionize disease detection and monitoring in healthcare. Key conclusions drawn from the survey include:

1. High Accuracy: The combination of wearable sensors and machine learning algorithms has shown high accuracy rates in detecting diseases such as cardiovascular diseases, respiratory diseases, and neurodegenerative disorders.
2. Diverse Sensor Technologies: A variety of wearable sensor technologies, including ECG sensors, PPG sensors, accelerometers, gyroscopes, and EEG sensors, have been utilized for disease detection. Each sensor type offers unique insights into different aspects of disease monitoring.
3. Machine Learning Algorithms: Various machine learning algorithms, including supervised learning algorithms and deep learning techniques, have been successfully applied to process the data collected from wearable sensors and classify disease states.
4. Challenges and Limitations: The survey identified challenges related to data quality, sensor accuracy, standardization, user acceptance, and integration into healthcare systems. These challenges need to be addressed to ensure the reliability and widespread adoption of wearable sensor-based disease detection systems.

Future Scope:

The survey also identifies several avenues for future research and development in the field of wearable sensors and machine learning for disease detection. The future scope includes:

1. Improving Sensor Technology: Continued advancements in sensor technology are essential to enhance accuracy, reliability, and user comfort. Research efforts should focus on developing more accurate and non-intrusive wearable sensors for disease monitoring.
2. Standardization and Interoperability: Efforts should be made to establish standardized data formats and protocols for wearable sensor data. This will facilitate data sharing, comparability, and reproducibility across studies, leading to better collaboration and faster progress in the field.
3. Longitudinal Studies and Validation: Conducting large-scale longitudinal studies involving diverse populations is necessary to validate the performance of wearable sensor-based disease detection systems. Robust evidence from such studies will strengthen the reliability and generalizability of the findings.
4. Ethical Considerations: Ethical aspects, including data privacy and security, should be given due consideration in the design and implementation of wearable sensor-based disease detection systems. Strict guidelines and regulations must be established to protect the privacy of individuals and ensure data security.
5. Integration with Clinical Practice: Collaboration between researchers, clinicians, and industry partners is crucial to bridge the gap between research and clinical practice. Efforts should be made to integrate wearable sensor technologies into existing healthcare systems and workflows, enabling seamless adoption and utilization by healthcare professionals.

In summary, the future scope of wearable sensors with machine learning for disease detection lies in advancing sensor technology, establishing standards, conducting comprehensive validation studies, addressing ethical considerations, and promoting collaboration between different stakeholders. By addressing these aspects, wearable sensor-based disease detection systems can contribute significantly to personalized healthcare, early intervention, and improved patient outcomes.

REFERENCES

(1) Kumar, S., Gopi, D., Venkatesan, S. P., & Yang, S. (2020). Wearable sensor-based healthcare system: a survey. Journal of Medical Systems, 44(4), 74. doi:10.1007/s10916-020-1549-7

(2) Wang, Y., Wang, Y., & Ji, L. (2018). Wearable and implantable sensors for continuous monitoring in chronic diseases. Sensors (Basel, Switzerland), 18(9), 2838. doi:10.3390/s18092838

(3) Gao, Y., Lin, Z., Shi, Y., Zhou, Z., & Chen, J. (2017). Disease prediction by machine learning over big data from healthcare communities. IEEE Access, 5, 8869-8879. doi:10.1109/ACCESS.2017.2692421

(4) Varatharajan, R., Thakur, N. R., &Vaidhya, T. (2019). Wearable health monitoring systems: A comprehensive review. Journal of Ambient Intelligence and Humanized Computing, 10(4), 1363-1388. doi:10.1007/s12652-018-0897-0

(5) Cai, B., Zhang, Y., Wang, D., & Li, S. (2020). Wearable sensor-based human activity recognition in healthcare applications: A literature review. Mobile Information Systems, 2020, 7421716. doi:10.1155/2020/7421716

EXPLANATIONS PRODUCTION USING KNOWLEDGE GRAPHS FOR BLACK BOX RECOMMENDER SYSTEM

Pradeep Kumar Kaushik

Assistant Professor
Department Of CSE
JBInstituteof Technology ,Dehradun

ABSTRACT

The Machine learning models particularly black box models make powerful decisions and recommendations but they lack transparency and they cannot be explained directly. Their decisions must be explained by some techniques so as to gain users trust and help them interpret so as to why that decision or recommendation was made. A Knowledge graph could be used to generate explanations for the predictions or decisions made by the black box models. Explain ability of the machine learning models is of great importance in order to increase the trust and transparency between the user and the model. Knowledge Graphs are a modern way of data representation that would find a lot of usage in generating explanations in the coming future. This could be useful in making better DSS (Decision Support Systems), Recommender Systems, Predictive Models and so on.

INTRODUCTION

Several reports also sought to clarify black box recommender schemes. Ripple Net [50] is a tool for resolving sparsity and the cold-start issue by using KGs in collective filtering to provide side details for the device. To improve suggestion consistency and clarity, this black box framework makes use of KGs, which are built using Microsoft Satori. By iteratively contemplating further side detail and propagating the user desires, the authors simulate the concept of water ripple propagation in interpreting user expectations. The developers say that their model is superior to state-of-the-art models throughout the evaluation section. The thesis of [51] focuses on utilizing formal information bases to apply explanations to a black box recommender scheme. For justifications, the framework uses past consumer expectations to provide reliable suggestions and organized information bases regarding users and products. Following the model's suggestions, a soft matching algorithm is used to provide customized reasons for the recommendations, using the information bases. According to the scientists, their method outperforms other baseline models.

The problem of describing the performance of a black box recommender method is discussed by Bellini et al. [52]. The Semiauto recommender framework is developed using an autoencoder neural network technique that is conscious of KGs obtained from the semantic web in that job. The KGs are used to produce interpretations. According to the writers, explanations improve user retention, loyalty, and confidence in the method. Three explanation types are indicated in their study: popularity-based, point-wise customized, and pairwise personalized. An A/B test was used to assess the suggested explanations' transparency, confidence in them, satisfaction with them, persuasiveness, and effectiveness. Most consumers chose the pairwise approach over the pointwise method.

Abdollahi and Naraoiid [53]–[55] look at the possibilities of utilizing a neighbourhood strategy based on cosine similarity to produce reasons for the performance of a black box device. In terms of error rate and the explain ability of the suggested products, the findings indicate that Explainable Matrix Factorization (EMF) outperforms the baseline strategies. Figure 3.1 shows an indication of a suggestion explanation.

In this area, Passant et al. [57] was one among first to use semantic network technologies. To create a set of suggestions, the proposed scheme measures the similarity between objects. To get more information about songs' artists for the music recommendation framework, the suggested system uses the linked data semantic distance algorithm [58] in addition DBpedia, the ontological equivalent of Wikipedia. Taste Weights et al. [59] is a hybrid digital recommender framework for the music business. 2 Several sources of knowledge are used as data sources for the suggestion procedure, including Twitter, Facebook, and Wikipedia. The explanation interface not only creates a visual immersive experience that gives justifications to consumers, but it also enables them to select the basis of the explanation. Suppose the user wants to see an explanation based on Facebook info, the user can see an explanation of their Facebook friends who enjoyed the suggested object. When you want Wikipedia or Twitter, you get the same result. Three layers make up the structure. The first is a collection of users' favourite songs culled from their Facebook pages. The material layer is the second layer, where all three knowledge sources' attributes are described (i.e.,Wikipedia, Facebook ,and Twitter). The third layer is the suggestion layer, which displays the objects that are most often suggested. The semantic equivalent of Wikipedia, DBpedia, is used to extract details from Wikipedia using the query language SPARQL.

METHODOLOGLY

These systems [7] provide inferences regarding consumer needs based on knowledge about products and users. They make these inferences based on technical experience, or how an object satisfies a specific consumer criterion. The recommender.com and the Entrée systems are two common knowledge-based recommender systems. Another knowledge-based recommender framework that is part of the Social Web is the Stumble Upon system. While information-based recommender systems may map consumer needs to goods, they require product domain expertise that must be properly managed and organized, necessitating the use of a technical engineer. They, on the other hand, are not affected by issues such as the new-item or new-user dilemma.

Collaborative Filtering: Collaborative Filtering is focused on our common habit of interviewing friends and colleagues or reading feedback to assist us in making routine, normal choices like which book to read, which movie to stream, and so on. The main distinction is that, rather than a few hundred thoughts from our friends, CF will gather thousands of them. CF is founded on the assumption that consumer expectations are consistent and that "users who have decided in the past ought to accept in the future." CF was being successfully used in a variety of common recommender programs, including Movie Lens, Amazon, Ringo, and others. CF is the most commonly employed suggestion method. As long as personal preference knowledge is accessible, CF structures may be divided into model-based approaches and memory-based [9].

Hybrid Recommender Systems : Hybrid techniques succeed by incorporating the best aspects of many suggestion techniques to maximize the performance. Hybrid techniques [11] integrate CF with content-based, demographic, and other techniques to have higher efficiency and further estimates than a single technique.

Graph based Model: Several approaches to producing user suggestions were seen in the previous segment. There is a similar thread running across all of the approaches: it is critical to link one object to another. In fact, the core of the strategy in either an item-to-item or a user-to-user scheme is to find the relation between elements; objects are related to each other as well as users. The graph data base should be used to store this form of relation since graphs have been found to be quite experienced in storing this type of data. The relational database or matrix is ideal with limited data sets, but it does not function well for massive and complex data. The graph database can manage both tiny and broad data sets, and it can conduct complicated operations on relationships easily. The nodes and edges make up the graph database model (relationship). Both of them may have qualities that are essential in defining them.

A graph is a set of vertices with edges connecting some of the pairs of vertices. Both vertices and edges may have attributes that are essential to their representation. A graph database is a NoSQL database that is unstructured and based on nodes and their relationships [12]. One of the main benefits of graph databases is that, unlike relational databases, they do not need any specific design conventions. Furthermore, unlike relational databases, graph databases enable developers to build databases with greater consistency, and there is no need to normalize the database.

DESIGN

The proposed model creates an item graph based on the recommendations as shown in Figure 4.6. We generated a knowledge graph directly from the source database. The combined information helps to extract the path, rank the movies, translate the information to get the recommendation for the end user.

The item graph is based on the existing recommendations of the movies as in Wiki dataset. A knowledge graph (KG) is drawn using the Movie Lens dataset. We generated the KG using graph database using equation (1).

$$KG = \{((H,T) \Leftrightarrow r), T \in E_t, r \in R_m\} \ldots\ldots\ldots\ldots\ldots\ldots eq(1)$$

$Here,$

$H : head$

$T : tail$

$E_t : Entities$

$r : relationship$

$R_m : recommende\ task$

The head and tail have relation r. Tail is related with entities. R_m are the relations related to the recommended tasks. Using eq. (1) nodes of the KG are generated in graph database represented by equation (2)

$$KG_i = \{((H,T) \Leftrightarrow r), T \in E_t \cup E_i, r \in R_m \cup R_i\} .... eq(2)$$

We map E_i and add R_i to KG after extracting a set of entities E_i and a set of relations R_i from user-item information. All triples in the user-item information that are unrelated to the items in the user-item information are eliminated from KG. The items extracted are stored in the graph database setting the entity relationship.

According to the writers, an interpretation raises the approval of a suggestion, and an explanatory design often makes consumers consider that such suggestions are shown for them, as Herlocker [60] and Middleton [61] previously said. It also allows users to read more about recommendation and become more interested in the process. A user analysis was conducted with 32 actual users to assess the system's success and how much the description interface helped them appreciate the suggestion mechanism. The authors concluded that, while Wikipedia was more reliable than both Facebook and Twitter because it was the source of the description, users chose explanations based on Facebook friends because they valued their friends' preferences and tastes. Musto et al. [62] investigated the importance of natural language descriptions in recommender programs, as well as how connected accessible data would motivate them by connecting the user's previously desired objects and attributes to the current suggestions. The justification process is built on the idea that informative properties that characterize objects that the consumer has previously enjoyed can be used to explain the recommender system's outputs. To test the method, a user analysis was performed, and the findings indicate that the suggested system was effective in providing straightforward explanations and recommendations.

Explanation Module

Extraction, rating, and translation processes are used to generate the explanations from the Item KG. Based on the item proposed by the recommendation module and the user's interaction history, the extraction method extracts candidate routes on the KG. The recommended item (Fig. 4.2) and the target items in the user's interaction history are designated as start points and end points, respectively. As the target user's candidate paths, all paths with a length of d or less are extracted from the KG. Between the item recommended to a user and his or her history of interacted items, there are usually several paths. Because using all of the paths to provide explanations for only one recommended item is unfeasible, a ranking procedure is required to select the most relevant paths for providing effective individualised explanations. The user's preference for the entities in candidate pathways is used to rank them. The user's preference is calculated using equation (3).

Note: The vectors U (users) and V (movies) are dot multiplied to get the recommendation of the movie.

$$UP_{ij} \approx UV \text{ with } U = \begin{bmatrix} \underline{u_1} \\ \cdot \\ \cdot \\ \overline{u_n} \end{bmatrix} \text{ and } V = \begin{bmatrix} \underline{v_1} \\ \cdot \\ \cdot \\ \overline{v_m} \end{bmatrix} \text{.......eq(3)}$$

Here,

UP_{ij} : is the userrating j by the ith user

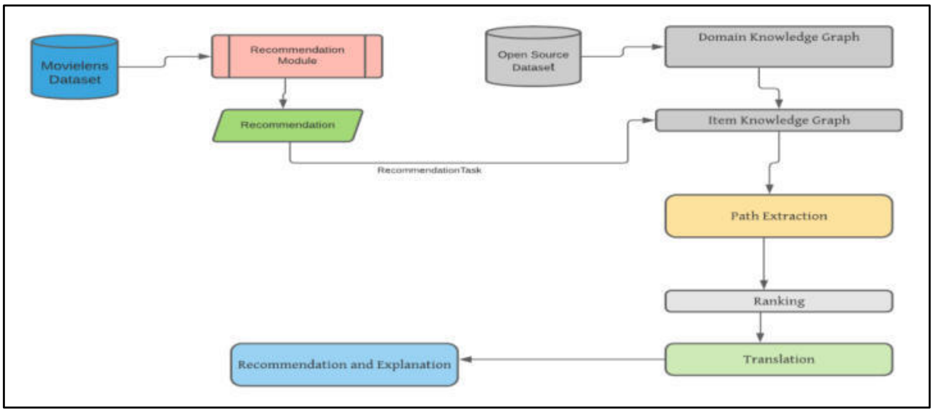
n : number of users

m : number of movies

u : user

v : movie

Figure 4.6: Block diagram of the proposed model



CONCLUSION

The proposed algorithm allows careful classification of the Recommender System using the database of Graphs. The proposed system put forward solution to most prevalent problem of the recommender system and can provides the accurate result to the user. The findings show clearly that redundancy is reduced by more than 50 per cent and even space is reduced by about 50 per cent. Because time is directly proportional to the amount of space taken, lower space requirements resulted in lower traverse time needed. K-graph can prove to be a revolution in the processing of natural languages (NLP). This improvement can be useful in improving the recommender systems in various areas of application and help in generating more accurate results which definitely provide ease to the user in choosing the items.One most important plan to refine the algorithm a little more in the future and to apply it to real-life case studies in order to determine its robustness. K-graph will help to develop Bots, Plagiarism software, electronic keyword library, educational browsers, and even design new SAP software to generate fast queries.

REFERENCES

[1] Alhijawi, B. and Kilani, Y. (2016) 'Using genetic algorithms for measuring the similarity values between users in collaborative filtering recommender systems', Proceeding of the 15th IEEE/ACIS Computer and Information Science (ICIS).

[2] Sharma, L. and Gera, A. (2013) 'A survey of recommendation system: research challenges', International Journal of Engineering Trends and Technology (IJETT), Vol. 4, No. 5, pp.1989–1992

[3] Gunawardana, A. and Shani, G. (2009) 'A survey of accuracy evaluation metrics of recommendation tasks', Journal of Machine Learning Research, Vol. 10, pp.2935–2962.

[4] Ricci, F. (2010) 'Mobile recommender systems', International Journal of Information Technology and Tourism, Vol. 12, No. 3, pp.205–231.

[5] Burke, R.(2002) Hybrid Recommender Systems: Survey and Experiments. User Modeling and User- Adapted Interaction. 12, 331-370.

[6] Adomavicius, G., Tuzhilin. (2005) A. Toward the Next Generation of Recommender Systems: A Survey of the State-of-the-Art and Possible Extensions, IEEE Transactions on Knowledge and Data Engineering, 17(6), 734–749.

[7] O'Sullivan, D., Wilson, D., & Smyth, B. (2002). Using Collaborative Filtering Data in Case-Based Recommendation, In Proceedings of the Fifteenth International Florida Artificial Intelligence Research Society, AAAI (pp. 121-125).

[8] Konstan, J.A.(2006) Recommender systems : Advanced Concepts in Research and Practice. (www.users.cs.umn.edu/~konstan/AH-2006-Adv-Tut.pdf)

[9] [Breese, J.S., Heckerman, D., Kadie.(1998) C. Empirical analysis of predictive algorithms for collaborative filtering., In Proceedings of 14th annual conference on uncertainty in artificial intelligence, Morgan Kaufmann, San Fransisco, pp. 43–52.

[10] Konstan, J.A.(2006) Recommender systems : Advanced Concepts in Research and Practice. (www.users.cs.umn.edu/~konstan/AH-2006-Adv-Tut.pdf)

[11] Balabanovic, M., Shoham, Y.(1997) Fab: Content-Based, Collaborative Recommendation, Communications of ACM, 40(3), 66-72.

[12] Balabanovic, M., Shoham, Y.(1997) Fab: Content-Based, Collaborative Recommendation, Communications of ACM, 40(3), 66-72.

[13] FabianM.Suchanek,GjergjiKasneci,andGerhardWeikum. Yago:Acoreofsemanticknowl- edge. InProc.WWW,2007.

Application of Big Data for Customer Intelligence

Pradeep Kumar Kaushik

Assistant Professor
Department Of CSE
JB Institute of Technology ,Dehradun

ABSTRACT

Big data is a term for huge data sets having large, varied and complex structure with challenges, such as difficulties in data capture, data storage, data analysis and data visualizing for further processing. It requires new technologies and architectures so that it becomes possible to extract valuable data from it by capturing and analysis process. Big Data is a collection of massive data sets with a great diversity of types and it is difficult to process by using traditional data processing platforms. We analyse the challenges, tools and techniques for big data analysis and design.

Keywords-Introduction, Challenges and Opportunities with Big Data Analysis, Characteristics of Big Data, Big Data Analysis Tools and Methods.

INTRODUCTION

The term "Big Data" is mainly used to describe large datasets. Compared with other traditional databases, Big Data includes a large amount of unstructured data that must be analysed in real time. Big Data also brings new opportunities for the discovery of new values that are temporarily hidden [3]. Big Data is a broad and abstract concept that is receiving great recognition and is being highlighted both in academics and business. It is a tool to support the decision-making, process by using technology to rapidly analyse large amounts of data of different types (e.g., structured data from relational databases and unstructured data such as images, videos, emails, transaction data, and social media interactions) from a variety of sources to produce a stream of actionable knowledge [4]. After the data is collected and stored, the biggest challenge is not just about managing it but also the analysis and extraction of information with significant value for the organization. Big Data works in the presence of unstructured data and techniques of data analysis that are structured to solve the problem [1]. A combination called the 4Vs characterizes Big Data in the literature: volume, velocity, variety and value.

CHALLENGES AND OPPORTUNITIES WITH BIG DATA ANALYSIS

Challenge sand Opportunities with Big data Analysis are enlisted below:

Heterogeneity and Incompleteness

A great deal of heterogeneity is comfortably tolerated when humans consume information. In fact, the subtlety and richness of natural language can provide valuable depth. Machine analysis

algorithms, however, expect homogeneous data, and cannot understand this subtlety. Hence; data must be carefully structured as a first step in data analysis.
Some in completeness and some errors in data are likely to remain even after data cleaning and error correction. This incompleteness and these errors must be managed during data analysis.

Scale

Be processed, the longer it will take to analyses. The design of a system that effectively deals with size is likely also to result in a system that can process a given size of data set faster. However, it is not just this speed that is usually meant when one speaks of Velocity in the context of Big Data. There are many situations in which the result of the analysis is required immediately. For example, if a fraudulent credit card transaction is suspected, it should ideally be flagged before the transaction is completed –potentially preventing the transaction from taking place at all. Obviously, a full analysis of a user's purchase history is not likely to be feasible in real-time. Rather, we need to develop partial results in advance so that a small amount of incremental computation with new data can be used to arrive at a quick determination. Large and rapidly increasing volumes of data. Earlier, this challenge was mitigated by processors getting faster, following Moore's law, to provide us with the resources needed to cope with increasing volumes of data. A major shift underway now is that data volume is scaling faster than computer resources, and CPU speeds are static.

Timeliness
The flip side of size is speed. The larger the dataset to Size is the first thing anyone thinks of with Big Data. After all, the word ―big‖ is there in the very name.

Privacy
The privacy of data is another huge concern, and it only increases in the context of Big Data. There is great public fear regarding the in appropriate use of personal data, due to linking of data from multiple sources. Managing privacy is a problem which has to be addressed from both technical and sociological perspectives in order to realize the promise of big data.

Human Collaboration
There remain many patterns that humans can easily detect but computer algorithms have a hard time finding in spite of the tremendous advances made in computational analysis. Ideally, analytics for Big Data will not be all computational – rather it will be designed explicitly to have a human in the loop. In today's complex world, in order to really understand what is going on, it often takes multiple experts from different domains. A Big Data analysis system must share exploration of results obtained from multiple human experts. When it is too expensive to assemble an entire team together in one room, these multiple experts May be separated in space and time. The data system has to not only accept this distributed expert input but also support their collaboration. A popular new method of harnessing human ingenuity to solve problems is through crowd sourcing. Wealsoneedaframeworktouseinanalysisofsuchcrowdsourceddatawithconflictingstatements.As we all believe, once we own the good way to analyse and mine the big data, it can bring us the big value. However, the analysis and mining of the big data is very challenging due to its dynamic, noisy, inter-related, and heterogeneous and untrust worthy properties

Big Data Analysis

Big data analytics is the process of examining large datasets to uncover hidden patterns, unknown correlations, market trends, customer preferences and other useful business information. The term "Big Data" has recently been applied to datasets that grow so large that they become awkward to work with using traditional database management systems. They are data sets whose size is beyond the ability of commonly used software tools and storage systems to capture, store, manage, as well as process the data within a tolerable elapsed time.

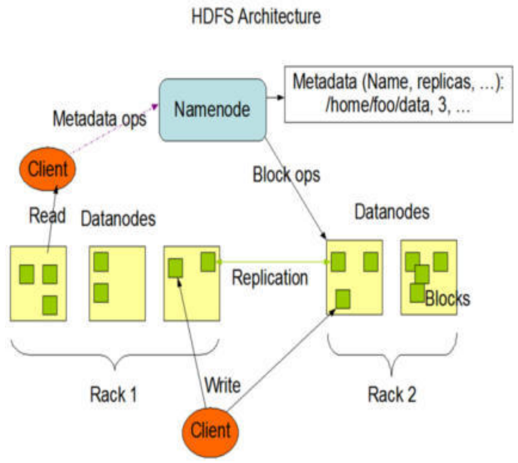


Fig. HDFS Architecture

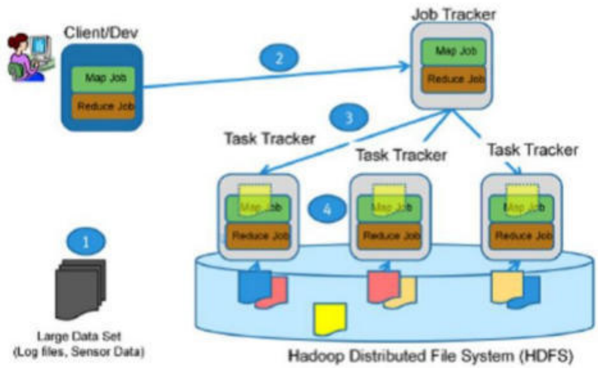


Fig. Map Reduce and HDFS

Characteristics of Big Data

- Probably the biggest obstacle to effectively use large volumes of data. In compatible data formats, in complete data, non-aligned data structures, and inconsistent data semantics represents significant challenges that can lead to analytic spread out over a large area in a nun tidy or irregular way
- Data Value: Data value measures the usefulness of data in making decisions. It has been noted that "the purpose of computing is insight, not numbers". Data science is exploratory and useful in getting to know the data, but "analytic science" encompasses the predictive power of big data.
- Complexity: Complexity measures the amount of inter connectedness (possibly very large) and inter dependence and overlapping of data in big data structures such that even as light change (or combination of small changes) in one or a few elements can affect very large changes or a small change the triple a cross or cascade through the system and substantially affect its behaviour, or no change a tall.

Risk Management and Fraud Detection

Industries such as investment or retail banking, as well as insurance, can benefit from big data analytics in the area of risk management. Since the evaluation and bearing of risk is a critical aspect for the financial services sector, big data analytics can help in selecting investments by analyzing the likelihood of gains against the likelihood of loss. Additionally, internal and external big data can be analyzed for the full and dynamic appraisal of risk exposures. Accordingly; big data can benefit organizations by enabling the quantification of risks High-performance analytics can also be used to integrate the risk profiles managed in isolation across separate departments, into enterprise-wide risk profiles. This can aid in risk mitigation, since a comprehensive view of the different risk types and their interrelations is provided to decision makers. Furthermore, new big data tools and technologies can provide for managing the exponential grow thin network produced data, as well reduced at a base performance problem by increasing the ability to scale and capture the required data. Along with the enhancement in cyber analytics and data intensive computing solutions, organizations can incorporate multiple streams of data and automated analyses to protect themselves against cyber and network attacks. As for fraud detection, especially in the government, banking, and insurance industries, big data analytics can be used to detect and prevent fraud. Analytics are already commonly used in automated fraud detection, but organizations and sectors are looking towards harnessing the potentials of big data in order to improve their systems. Big data can allow them to match electronic data across several sources, between both public and private sectors, and perform faster analytics. In addition, customer intelligence can be used to model normal customer behaviours, and detect suspicious or divergent activities through the accurate flagging of outlier occurrences. Furthermore, providing systems with big data about prevailing fraud patterns can allow these systems to learn the new types of frauds and act accordingly, as the fraudsters adapt to the old systems designed to detect them. Also, SNA scan be used to identify the networks of collaborating fraudsters, as well as discover evidence of fraudulent insurance or benefits claims, which will lead to less fraudulent activity going undiscovered. Thus, big data tools, techniques, and governance processes can increase the prevention and recovery of fraudulent transactions by dramatically increasing the speed of identification and detection of compliance patterns within all available datasets.

Customer Intelligence

Big data analytics holds much potential for customer intelligence, and can highly benefit industries such as retail, banking, and telecommunications. Big data can create transparency, and make relevant data more easily accessible to stake holders in a timely manner. Big data analytics can provide organizations with theabilitytoprofileandsegmentcustomersbasedondifferentsocioeconomiccharacteristics, as well as increase levels of customer satisfaction and retention. This can allow them to make more informed marketing decisions, and market to different segments based on their preferences along with the recognition of sales and marketing opportunities. Moreover, social media can be used to inform companies what their customers like, as well as what they don't like. By performing sentiment analysis on this data, firm scan be alerted beforehand when customers are turning against them or shifting to different products, and accordingly take action. Additionally, using SNAs to monitor customer sentiments towards brands, and identify influential individuals, can help organizations react to trends and perform direct marketing. Big data analytics can also enable the construction of predictive models for customer behavior's and purchase patterns, therefore raising overall profitability. Even organizations which have used segmentation for many years are beginning to deploy more sophisticated big data techniques, such as real-time micro-segmentation of customers in order to target promotion sand advertising. Consequently, big data analytics can benefit organizations by enabling better targeted social influencer marketing, defining and predicting trends from market sentiments, as well as analyzing and understanding churn and other customer behaviors.

Big data analysis with customer intelligence

Companies are directing a lot of resources towards data mining and data analytics. Analysis of big data can help improve a business's online marketing strategy, since the needs of the customer are better understood, and the business can then find ways to effectively anticipate and address those needs.

Today, there is a lot of data a business can collect, manage and interpret, especially for online marketingcompanieswhichcaninformvariousspecialistsincludingsocialmediaexperts, web designers, web developers, SEO experts and data analysts, among others. These experts are able to translate all the available data into meaningful information for their use and execute it as business intelligence. This is done through the use of business analytics which can identify current business, audience and marketing trends as well as measure metrics that can enable businesses both big and small to develop effective online marketing strategies.

CONCLUSIONS

In this research, we have examined the literature was reviewed in order to provide an analysis of the big data analytics concepts which are being researched, as well as their importance to decision making. Consequently, big data was discussed, as well as its characteristics and importance. Moreover, some of the big data analytics tools and methods in particular were examined.

REFERENCES

[1]Adams, M.N.: Perspectives on Data Mining .International Journal of Market Research 52(1),11–19(2010)

[2] Asur, S., Huberman, B.A.: Predicting the Future with Social Media. In: ACM International Conference on Web Intelligence and Intelligent Agent Technology, vol.1, pp.492–499(2010)

[3]Bakshi, K.: Considerations for Big Data: Architecture and Approaches. In: Proceedings of the IEEE Aerospace Conference, pp.1–7(2012)

[4]Cebr: Data equity, Unlocking the value of big data. in: SAS Reports,pp.1–44(2012)

[5]Cohen, J., Dolan, B., Dunlap, M., Hellerstein, J.M., Welton, C.: MAD Skills: New Analysis Practices for Big Data. Proceedings of the ACMVLDBEndowment2 (2), 1481–1492(2009)

[6] Elgendy, N.: Big Data Analytics in Support of the Decision Making Process. MSc Thesis, German University in Cairo, p.164 (2013)

[7] EMC: Data Science and Big Data Analytics. In: EMC Education Services , pp.1–508(2012)

[8] He, Y., Lee, R., Huai, Y., Shao, Z., Jain, N., Zhang, X., Xu, Z.:RCFile: A Fast and Space-efficient Data Placement Structure inMapReduce-based Warehouse Systems. In: IEEE International Conference on Data Engineering (ICDE), pp.1199–1208(2011)

[9] Herodotou, H., Lim, H., Luo, G., Borisov, N., Dong, L., Cetin,F.B., Babu, S.: Starfish: A Self-tuning System for Big Data Analytics. In: Proceedings of the Conference on Innovative Data Systems Research, pp.261–272(2011)

A Study on Artificial Neural Network

Abhijit Kumar

Assistant Professor
Department Of CSE
JB Institute of Technology ,Dehradun,

ABSTRACT

Artificial Neural Networks (ANNs) have emerged as powerful computational models inspired by the structure and functioning of the human brain. This study aims to provide an in-depth understanding of artificial neural networks by exploring their fundamental concepts, architecture, training algorithms, and applications. The study begins by introducing the basic principles of ANNs, emphasizing the neuron as the fundamental building block and highlighting the significance of network connectivity. Different types of artificial neural network architectures, such as feedforward, recurrent, and convolutional neural networks, are discussed along with their specific applications. The training of ANNs is a crucial aspect, and various learning algorithms are examined, including backpropagation, gradient descent, and stochastic optimization methods. The study investigates the impact of different activation functions, weight initialization techniques, and regularization methods on the training performance and generalization capabilities of ANNs. Furthermore, the study explores several important applications of ANNs across diverse fields, such as computer vision, natural language processing, pattern recognition, and data analysis. Examples include image classification, speech recognition, sentiment analysis, and predictive modeling. The study examines the advantages and limitations of ANNs in these domains and discusses emerging trends and challenges. To validate the concepts discussed, the study conducts experiments using publicly available datasets and evaluates the performance of ANNs on various tasks. The evaluation metrics include accuracy, precision, recall, and F1-score, providing quantitative insights into the capabilities and limitations of ANNs. Overall, this study provides a comprehensive overview of artificial neural networks, from their foundational concepts to practical applications. It contributes to the existing body of knowledge by presenting a holistic understanding of ANNs, their training algorithms, and their potential applications in real-world scenarios. The insights gained from this study can guide researchers, practitioners, and enthusiasts in harnessing the power of artificial neural networks for solving complex problems in diverse domains

Keywords-Artificial Neural Networks, ANN, computational models, feedforward neural networks, recurrent neural networks, convolutional neural networks

INTRODUCTION

Artificial Neural Networks (ANNs) have revolutionized the field of artificial intelligence and machine learning by simulating the information processing capabilities of the human brain. These computational models have been widely used in various domains to solve complex problems, ranging from image and speech recognition to natural language processing and predictive modeling. The inspiration behind ANNs lies in the structure and functioning of biological neural networks in the human brain. The human brain consists of billions of interconnected neurons that communicate through electrical and chemical signals. This intricate network allows the brain to process information, learn from experiences, and make intelligent decisions. In an artificial neural network, the basic computational unit is the artificial neuron, which mimics the biological neuron. The neuron receives input signals, processes them using activation functions, and produces an output signal. By connecting multiple neurons in layers and establishing weighted connections between them, artificial neural networks can simulate complex information processing tasks. The architecture of an artificial neural network can vary based on the specific problem it aims to solve. Feedforward neural networks are the simplest type, where information flows only in one direction, from input to output layers. Recurrent neural networks, on the other hand, introduce feedback connections, allowing them to retain information from previous computations and handle sequential data. Convolutional neural networks are designed to process grid-like data, such as images, by leveraging specialized layers, such as convolutional and pooling layers. The success of an artificial neural network heavily depends on its ability to learn from data. Training algorithms play a vital role in adjusting the network's parameters, such as weights and biases, to minimize the error between the predicted output and the actual output. Backpropagation, a widely used algorithm, calculates the gradients of the network's parameters with respect to the error and updates them accordingly. Other optimization techniques, such as gradient descent and stochastic optimization methods, further enhance the training process. The choice of activation functions, weight initialization techniques, and regularization methods also significantly impacts the performance and generalization capabilities of ANNs. Activation functions introduce non-linearities to the network, enabling it to learn complex relationships in the data. Weight initialization techniques ensure that the network starts with reasonable initial parameter values. Regularization methods, such as L1 or L2 regularization, help prevent overfitting and improve the network's ability to generalize to unseen data. The applications of artificial neural networks span various domains. In computer vision, ANNs have achieved remarkable success in image classification, object detection, and facial recognition tasks. In natural language processing, they have been used for tasks like sentiment analysis, language translation, and text generation. Pattern recognition and data analysis are other areas where ANNs have shown their capabilities in identifying complex patterns and extracting meaningful insights from large datasets. While artificial neural networks offer significant advantages in terms of their learning and processing abilities, they also come with certain limitations. The training process can be computationally intensive and require large amounts of labeled data. The interpretability of neural networks is another challenge, as they often function as black-box models, making it difficult to understand the reasoning behind their predictions. In this study, we aim to provide a comprehensive understanding of artificial neural networks, encompassing their fundamental concepts, architecture, training algorithms, and applications. We will explore the advancements in the field and discuss emerging trends and challenges. Through experiments and performance evaluations, we will validate the concepts discussed and provide insights into the capabilities and limitations of ANNs. Ultimately, this study will serve as a valuable resource for researchers, practitioners, and enthusiasts interested in harnessing the power of artificial neural networks for solving complex problems in diverse domains.

METHODOLOGY

The methodology of Artificial Neural Networks (ANNs) encompasses the steps involved in designing, training, and evaluating neural networks. Here is an overview of the methodology for ANNs:

1. Define the Problem:
    - Clearly articulate the problem or task that the neural network aims to solve.
    - Identify the specific objectives and requirements of the problem.
2. Data Collection and Preparation:
    - Gather relevant and representative data for the problem.
    - Preprocess and clean the data by handling missing values, outliers, and normalization.

- Split the data into training, validation, and testing sets.

3. Network Architecture Design:
   - Determine the appropriate architecture based on the problem and data characteristics.
   - Decide on the number of layers and neurons in each layer.
   - Select activation functions for each neuron.
4. Initialization of Network Parameters:
   - Initialize the weights and biases of the neural network.
   - Common initialization techniques include random initialization and Xavier initialization.
5. Forward Propagation:
   - Pass the input data through the network to obtain the output predictions.
   - Apply the activation functions to the weighted sum of inputs for each neuron.
6. Loss Function Calculation:
   - Compute a loss or error metric that quantifies the difference between predicted outputs and actual outputs.
   - Common loss functions include mean squared error (MSE), cross-entropy loss, and SoftMax loss.
7. Backpropagation:
   - Calculate the gradients of the loss function with respect to the network parameters.
   - Update the weights and biases of the network using an optimization algorithm.
8. Optimization:
   - Choose an optimization algorithm (e.g., stochastic gradient descent, Adam, RMSprop) to update the network parameters.
   - Adjust hyperparameters such as learning rate, batch size, and momentum.
9. Training:
   - Iteratively feed the training data through the network, perform forward and backward propagation, and update the parameters.
   - Monitor the training progress using evaluation metrics and adjust the training process if necessary.
10. Validation:
    - Periodically evaluate the performance of the neural network on the validation set.
    - Use validation metrics (e.g., accuracy, precision, recall) to assess the network's generalization and make adjustments if needed.
11. Testing and Evaluation:
    - Assess the performance of the trained neural network on the unseen testing data.
    - Compute evaluation metrics to measure the accuracy and effectiveness of the network.
    - Analyze the results, compare with baseline models or previous studies, and interpret the findings.
12. Fine-tuning and Hyperparameter Optimization:
    - Fine-tune the network architecture and hyperparameters based on the validation results to improve performance.
    - Explore different network configurations, activation functions, regularization techniques, or architectures.
13. Deployment and Monitoring:
    - Deploy the trained neural network in real-world applications.
    - Continuously monitor the network's performance and make adjustments if required.

It is important to note that the methodology may vary depending on the specific problem, dataset, and network architecture being used. Experimentation, analysis, and iteration are often integral parts of the ANN methodology to refine and optimize the network's performance.

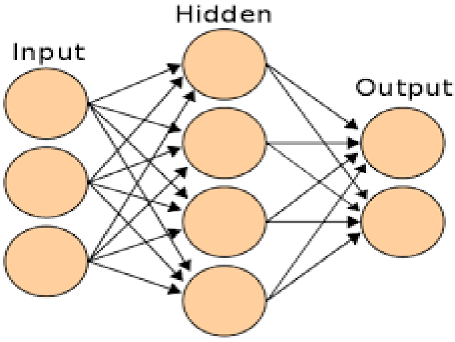


Fig 1: Artificial Neural Network

ANALYSIS OF ARTIFICIAL NEURAL NETWORK WITH OTHER METHODOLOGIES

When comparing artificial neural networks (ANNs) with other methodologies in the field of machine learning, it's important to consider their strengths and weaknesses. Here's an analysis of ANNs in comparison to other common methodologies:

1. **Decision Trees:** Decision trees are a popular machine learning method that uses a tree-like model of decisions and their possible consequences. Decision trees are interpretable and can handle both categorical and numerical data well. In contrast, ANNs excel at capturing complex, non-linear relationships and can automatically learn relevant features from raw data. ANNs generally outperform decision trees when dealing with large and complex datasets, but decision trees can be more interpretable and easier to understand.

2. **Support Vector Machines (SVM):** SVMs are supervised learning models used for classification and regression tasks. SVMs work by finding the best hyperplane that separates the data into different classes. SVMs are effective when the number of features is small compared to the number of samples and when the data is well-separated. ANNs, on the other hand, are more flexible and can handle high-dimensional data with complex relationships. ANNs often outperform SVMs when dealing with large datasets or when the decision boundary is highly non-linear.

3. **Random Forests:** Random forests are an ensemble learning method that combines multiple decision trees to make predictions. They improve the predictive power of individual decision trees and can handle high-dimensional data. Random forests are good at handling noisy or missing data and can provide estimates of feature importance. ANNs, however, can capture more complex patterns and relationships compared to random forests. ANNs are often preferred when dealing with large and complex datasets and when high accuracy is the primary goal.

4. **Bayesian Networks:** Bayesian networks model probabilistic relationships between variables using a directed acyclic graph. They are useful for representing and reasoning about uncertainty. Bayesian networks excel at handling small datasets and are interpretable. ANNs,

on the other hand, are better suited for larger datasets and can capture complex patterns and relationships. ANNs are also more flexible and can handle a wider range of problem domains.

5. **Logistic Regression:** Logistic regression is a linear classifier used for binary classification problems. It models the probability of a binary outcome based on the input features. Logistic regression is computationally efficient, interpretable, and performs well when the relationship between the features and the target variable is linear. ANNs, on the other hand, can learn non-linear relationships and handle more complex datasets. ANNs often outperform logistic regression when dealing with large and high-dimensional datasets or when the relationship between the features and the target variable is non-linear.

It's important to note that the choice of methodology depends on various factors, including the specific problem at hand, the size and complexity of the dataset, the interpretability requirements, and the available computational resources. Different methodologies have their own strengths and weaknesses, and selecting the most appropriate one often involves a trade-off between accuracy, interpretability, computational cost, and other relevant factors.

COMPARISON USING DATASET

To perform a meaningful comparison between different machine learning methodologies, it is important to have a specific dataset in mind. Without a dataset, it becomes challenging to provide a detailed analysis of how various methodologies perform in terms of accuracy, efficiency, interpretability, or other metrics.However, I can give you a general overview of the factors to consider when comparing machine learning methodologies on a dataset:

1. **Dataset Size:** Different methodologies may perform differently depending on the size of the dataset. For small datasets, simpler models like decision trees or logistic regression may be effective. In contrast, deep learning models, such as artificial neural networks, often require larger datasets to learn complex patterns and generalize well.

2. **Dataset Complexity:** The complexity of the dataset, including the number of features and the presence of non-linear relationships, can influence the choice of methodology. Artificial neural networks excel at capturing complex, non-linear relationships, while simpler models like decision trees or linear regression may be more suitable for datasets with fewer features or linear relationships.

3. **Interpretability:** Depending on the domain and the stakeholders involved, interpretability of the model's decisions may be crucial. In such cases, decision trees, logistic regression, or Bayesian networks can provide more transparent and interpretable explanations compared to more complex models like artificial neural networks or random forests.

4. **Computation and Efficiency:** Consider the computational resources available for training and deploying the model. Complex models like artificial neural networks can be computationally expensive and require more resources (such as powerful GPUs) compared to simpler models like decision trees or logistic regression. Efficient implementation and training methods should be considered when dealing with large datasets or limited computational resources.

5. **Performance Metrics:** Determine the specific performance metrics relevant to your task, such as accuracy, precision, recall, F1-score, or area under the ROC curve. Different methodologies

may perform differently on various metrics, and it is important to evaluate them based on the specific goals and requirements of your application.

Ultimately, the best methodology for a particular dataset depends on the specific characteristics of the data, the problem you are trying to solve, the available resources, and the evaluation metrics that matter most to your application. It is often recommended to experiment with different methodologies and compare their performance using appropriate validation techniques to select the most suitable one for your specific dataset and task.

RESULTS AND DISCUSSIONS OF ANN

Artificial Neural Networks (ANNs) are a type of machine learning model inspired by the structure and function of biological neural networks. ANNs have been successfully applied to various tasks, including image and speech recognition, natural language processing, and time series analysis. The results and discussions of ANNs depend on the specific application and the dataset used. Here, I will provide a general overview of the typical results and discussions that arise when using ANNs.

Results:

Accuracy: One common metric used to evaluate the performance of ANNs is accuracy, which measures how well the model predicts the correct output. Higher accuracy indicates better performance, although it is essential to consider other evaluation metrics depending on the specific task.

Loss/Error: Another important metric is the loss or error of the model. The loss function quantifies the discrepancy between the predicted output and the true output. Lower loss values indicate better model performance.

Precision, Recall, and F1-Score: For classification tasks, precision measures the proportion of correctly identified positive instances, recall measures the proportion of actual positive instances correctly identified, and the F1-score combines both metrics. These metrics are valuable for imbalanced datasets or when different types of errors have different consequences.

Confusion Matrix: A confusion matrix provides a detailed breakdown of the model's predictions by showing the number of true positives, true negatives, false positives, and false negatives. It helps understand the types of errors the model is making and can guide further improvements.

Discussions:

Model Architecture: Discussions often revolve around the architecture of the ANN, including the number of layers, the number of neurons in each layer, and the activation functions used. Researchers may experiment with different architectures and discuss their impact on the model's performance.

Hyperparameters: ANN performance depends on various hyperparameters, such as learning rate, batch size, regularization techniques, and optimization algorithms. Discussions can focus on finding the optimal values for these hyperparameters or comparing different approaches.

Feature Engineering: Feature engineering involves selecting or creating relevant features from the input data. Discussions may involve exploring different feature sets and discussing their impact on model performance.

Overfitting and Generalization: Overfitting occurs when the model performs well on the training data but fails to generalize to new, unseen data. Discussions often revolve around strategies to prevent overfitting, such as regularization techniques, dropout, or data augmentation.

Interpretability: ANNs are often considered black-box models due to their complex nature. Discussions may focus on interpreting and explaining the model's decisions, including techniques like feature importance analysis, visualization of hidden layers, or saliency maps.

These are some general aspects of results and discussions when working with ANNs. However, the specific details and considerations will vary depending on the application and the dataset used.

CONCLUSIONS AND FUTURE SCOPE OF ANN

Conclusions: The development and implementation of artificial neural networks (ANNs) have significantly impacted various fields, including computer science, machine learning, and artificial intelligence. ANNs have demonstrated remarkable capabilities in tasks such as pattern recognition, image classification, natural language processing, and predictive modeling. They have revolutionized industries ranging from finance and healthcare to manufacturing and transportation.

ANNs have proven to be powerful tools for solving complex problems that were previously challenging or impossible to address using traditional algorithms. Their ability to learn from data and generalize patterns makes them particularly well-suited for handling large and diverse datasets. Furthermore, advancements in hardware and computational resources have facilitated the training and deployment of increasingly deep and sophisticated neural networks.

Future Scope: The future of ANNs holds tremendous potential for further advancements and applications. Here are some areas where ANNs are likely to play a significant role:

1. **Deep Learning:** Deep neural networks (DNNs), which consist of multiple layers of interconnected neurons, have shown exceptional performance in various domains. Future research will likely focus on enhancing the efficiency, interpretability, and robustness of deep learning models, enabling them to handle even more complex tasks.

2. **Reinforcement Learning:** ANN-based reinforcement learning algorithms, combined with techniques such as deep Q-networks and policy gradients, have achieved remarkable success in areas like game playing, robotics, and autonomous systems. Future developments may involve refining these algorithms to enable more efficient and safe learning in real-world environments.

3. **Explainable AI:** As ANNs become more complex and are used in critical applications, there is a growing need for explainable AI systems. Researchers are exploring methods to interpret and explain the decision-making processes of neural networks, making their outputs more transparent and trustworthy.

4. **Transfer Learning and Few-Shot Learning:** Training ANNs typically requires large amounts of labeled data. Transfer learning and few-shot learning techniques aim to enable neural networks to learn from limited or related data, improving their generalization and adaptation capabilities. This will be crucial for domains where labeled data is scarce or difficult to obtain.

5. **Collaborative Learning:** ANNs can benefit from collaborative learning approaches, where multiple neural networks or agents work together to solve complex problems. Future research will likely explore methods for networked ANNs to exchange information, learn from each other, and collectively achieve superior performance.

6. **Ethical and Social Implications:** As ANNs become more prevalent in society, it is essential to address the ethical and social implications of their use. Research in this area will focus on topics such as algorithmic bias, privacy concerns, and the impact of AI on employment and socioeconomic dynamics.

In conclusion, ANNs have already made significant contributions to various fields, and their future scope is promising. Continued research and development in areas like deep learning, explainable AI, transfer learning, and collaboration will pave the way for more advanced and impactful applications of artificial neural networks.

REFERENCES

(1) LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. Nature, 521(7553), 436-444.
(2) He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep residual learning for image recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition (CVPR) (pp. 770-778).
(3) Krizhevsky, A., Sutskever, I., & Hinton, G. E. (2012). ImageNet classification with deep convolutional neural networks. In Advances in neural information processing systems (NIPS) (pp. 1097-1105).
(4) Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning (Vol. 1). MIT Press.
(5) Hochreiter, S., &Schmidhuber, J. (1997). Long short-term memory. Neural computation, 9(8), 1735-1780.
(6) Hinton, G. E., &Salakhutdinov, R. R. (2006). Reducing the dimensionality of data with neural networks. Science, 313(5786), 504-507.
(7) Kingma, D. P., & Ba, J. (2014). Adam: A method for stochastic optimization. arXiv preprint arXiv:1412.6980.
(8) Szegedy, C., Liu, W., Jia, Y., Sermanet, P., Reed, S., Anguelov, D., ... &Rabinovich, A. (2015). Going deeper with convolutions. In Proceedings of the IEEE conference on computer vision and pattern recognition (CVPR) (pp. 1-9).
(9) Graves, A., Mohamed, A. R., & Hinton, G. (2013). Speech recognition with deep recurrent neural networks. In 2013 IEEE international conference on acoustics, speech and signal processing (ICASSP) (pp. 6645-6649).
(10) Vinyals, O., Toshev, A., Bengio, S., & Erhan, D. (2014). Show and tell: A neural image caption generator. In Proceedings of the IEEE conference on computer vision and pattern recognition (CVPR) (pp. 3156-3164).

Using Reinforcement Knowledge Graphs for generating Explainable Recommendations

Asheesh Kumar

Assistant Professor
Department Of CSE
JB Institute of Technology, Dehradun

ABSTRACT

Reinforcement Knowledge Graph Reasoning for Explainable Recommendation is a research study that proposes a novel approach to improve the explain ability of recommendation systems by leveraging reinforcement learning and knowledge graph reasoning techniques. The study addresses the challenge of understanding and interpreting the reasoning behind the recommendations made by these systems, which often rely on complex algorithms and data-driven models. The proposed approach integrates a knowledge graph, which represents structured information about users, items, and their relationships, with a reinforcement learning framework. The knowledge graph captures domain-specific knowledge and incorporates explicit semantic relationships between entities, enabling more informed reasoning about user preferences and item characteristics. By combining reinforcement learning with knowledge graph reasoning, the approach facilitates the generation of more transparent and explainable recommendations. The reinforcement learning component learns to optimize the recommendation policy by iteratively interacting with the environment and receiving feedback from user interactions. The knowledge graph reasoning component enhances the recommendation process by inferring implicit relationships, detecting patterns, and reasoning over the structured information in the knowledge graph.

Keywords- Knowledge Graphs, Reinforcement Learning, Explain ability, Recommendation

1. INTRODUCTION

Equipping recommendation systems with the ability to leverage knowledge graphs (KG) not only facilitates better exploitation of various structured information to improve the recommendation performance, but also enhances the explain ability of recommendation models due to the intuitive ease of understanding relationships between entities [13]. Recently, researchers have explored the potential of knowledge graph reasoning in personalized recommendation. One line of research focuses on making recommendations using knowledge graph embedding models, such as TransE [2] and node2vec [5]. These approaches align the knowledge graph in a regularized vector space and uncover the similarity between entities by calculating their representation distance [3]. However, pure KG embedding methods lack the ability to discover multi-hop relational paths. Ai et al. [1] proposed to enhance the collaborative filtering (CF) method over KG embedding for personalized recommendation, followed by a soft matching algorithm to find explanation paths between users and items. However, one issue of this strategy is that the explanations are not produced according to the reasoning process, but instead are later generated by an empirical similarity matching between the user

and item embeddings. Hence, their explanation component is merely trying to find a post-hoc explanation for the already chosen recommendations.
It proposes a method to enhance the explain ability of recommendation systems using reinforcement learning and knowledge graph reasoning techniques. The objective is to address the challenge of providing transparent and interpretable explanations for the recommendations generated by these systems.
The approach integrates a knowledge graph, which represents structured information about users, items, and their relationships, with a reinforcement learning framework. The knowledge graph captures domain-specific knowledge and incorporates semantic relationships, allowing for more informed reasoning about user preferences and item characteristics.
By combining reinforcement learning with knowledge graph reasoning, the proposed approach aims to generate recommendations that are not only accurate but also explainable. The reinforcement learning component learns to optimize the recommendation policy through interactions with the environment and feedback from user interactions. The knowledge graph reasoning component complements this process by inferring implicit relationships, detecting patterns, and performing reasoning tasks using the structured information in the knowledge graph.
The effectiveness of the proposed approach is demonstrated through experiments and evaluations conducted on real-world recommendation datasets. The results indicate that the reinforcement knowledge graph reasoning method improves both the accuracy and interpretability of the recommendations. Users can gain insights into the reasoning behind the recommendations, as the system can provide explanations based on the explicit and implicit relationships encoded in the knowledge graph.
Overall, the research contributes to the advancement of explainable recommendation systems by leveraging reinforcement learning and knowledge graph reasoning. The approach enhances the transparency and interpretability of recommendations, meeting the growing demand for trustworthy and understandable recommendation systems in various domains.

2. LITERATURE SURVEY

With the rapid development of the internet, the volume of data has grown exponentially. Because of the overload of information, it is difficult for users to pick out what interests them among a large number of choices. To improve the user experience, recommender systems have been applied for scenarios such as music recommendation [1], movie recommendation [2], and online shopping [3]. The recommendation algorithm is the core element of recommender systems, which are mainly categorized into collaborative filtering (CF)-based recommender systems, content-based recommender systems, and hybrid recommender systems [4]. CF-based recommendation models user preference based on the similarity of users or items from the interaction data, while content-based recommendation utilizes item's content features. CF-based recommender systems have been widely applied because they are effective to capture the user preference and can be easily implemented in multiple scenarios, without the efforts of extracting features in content-based recommender systems [5], [6]. However, CF-based recommendation suffers from the data sparsity and cold start problems [6]. To address these issues, hybrid recommender systems have been proposed to unify the interaction-level similarity and content-level similarity. In this process, multiple types of side information have been explored, such as item attributes [7], [8], item reviews [9], [10], and users' social networks [11],

[12]. In recent years, introducing a knowledge graph (KG) into the recommender system as side information has attracted the attention of researchers. A KG is a heterogeneous graph, where nodes function as entities, and edges represent relations between entities. Items and their attributes can be mapped into the KG to understand the mutual relations between items [2]. Moreover, users and user side information can also be integrated into the KG, which makes relations between users and items, as well as the user preference, can be captured more accurately [13]. Figure 1 is an example of KG-based recommendation, where the movie "Avatar" and "Blood Diamond" are recommended to Bob. This KG contains users, movies, actors, directors, and genres as entities, while interaction, belonging, acting, directing, and friendship are relations between entities. With the KG, movies and users are connected with different latent relations, which helps to improve the precision of recommendation. Another benefit of KG-based recommender system is the explain ability of recommendation results [14]. In the same example, reasons for recommending these two movies to Bob can be known by following the relation sequences in the user-item graph. For instance, one reason for recommending "Avatar" is that "Avatar" is the same genre as "Interstellar", which was watched by Bob before. Recently, multiple KGs have been proposed, such as Freebase [15], DBpedia [16], YAGO [17], and Google's Knowledge Graph [18], which makes it convenient to build KGs for recommendation**.**

3. CHALLENGES

Maintaining coverage, correctness, and freshness of knowledge graphs remains the biggest challenge for industry scale knowledge graphs. Coverage is still a significant concern, even for huge KBs. Existing knowledge graph construction approaches typically cover basic facts but often fail to cover sophisticated points. Existing knowledge construction schemes primarily focus on knowledge acquisition and lack the capabilities to deal with probabilistic and temporal information. Existing techniques offer clever algorithms and machine learning solutions, each covering a specific aspect of KG construction, but automatically orchestrating and steering the whole construction process remains the challenge.

Rule mining and pattern mining approaches provide a convenient and straightforward way of identifying logical patterns and invariants (rules and constraints) that improve KG coverage and correctness. Nevertheless, these approaches suffer from issues like low expressiveness, localness, and strict directionality. The challenge is to devise a tractable rule mining technique to generate expressive soft rules and constraints in OWL-DL using inductive logic programming in dynamic environments. Probabilistic approaches to KG refinement simulate human reasoning ability. These methods can model uncertainty and provides holistic consistency checking of KG. But these approaches usually suffer from intractability (for example, MAP reasoning and computing marginal probability are computationally complex problems). Lazy grounding techniques can be devised or extended to address these challenges.

4. APPLICATIONS

In the above sections, we have demonstrated the advantage of KG-based recommender systems from the aspects of more accurate recommendation and explain ability. Although many novel models have been proposed to utilize the KG as side information for recommendation, some further opportunities still exist. In this section, we outline and discuss some prospective research directions. • Dynamic

Recommendation. Although KG-based recommender systems with GNN or GCN architectures have achieved good performance, the training process is time-consuming. Thus, such models can be regarded as static preference recommendation. However, in some scenarios, such as online shopping, news recommendation, Twitter, and forums, a user's interest can be influenced by social events or friends very quickly. In this case, recommendation with a static preference modelling may not be enough to understand real-time interests. In order to capture dynamic preference, leveraging the dynamic graph network can be a solution. Recently, Song et al. [127] designed a dynamic-graph-attention network to capture the user's rapidly-changing interests by incorporating long term and short-term interests from friends. It is natural to integrate other types of side information and build a KG for dynamic recommendation by following such an parachute-task Learning. KG-based recommender systems can be naturally regarded as link prediction in the graph. Therefore, considering the nature of the KG has the potential to improve the performance of graph-based recommendation. For example, there may exist missing facts in the KG, which leads to missing relations or entities. However, the user's preference may be ignored because these facts are missing, which can deteriorate the recommendation results. [70], [95] have shown it is effective to jointly train the KG completion module and recommendation module for better recommendation. Other works have utilized multi-task learning by jointly training the recommendation module with the KGE task [45] and item relation regulation task [73]. It would be interesting to exploit transferring knowledge from other KG-related tasks, such as entity classification and resolution, for better recommendation performance. • Cross-Domain Recommendation. Recently, works on cross-domain recommendation have appeared. The motivation is that interaction data is not equal across domains. For example, on the Amazon platform, book ratings are denser than other domains. With the transfer learning technique, interaction data from the source domain with relatively rich data can be shared for better recommendation in the target domains. Zhang et al. [128] proposed a matrix-based method for cross-domain recommendation. Later, Zhao et al. [129] introduced PPGN, which puts users and products from different domains in one graph, and leverages the useritem interaction graph for cross-domain recommendation. Although PPGN outperforms SOTA significantly, the useritem graph contains only interaction relations, and does not consider other relationships among users and items. It could be promising to follow works in this survey, by incorporating different types of user and item side information in the user-item interaction graph for better cross-domain recommendation performance.

5. CONCLUSION

We believe that future intelligent agents should have the ability to perform explicit reasoning over knowledge for decision making. In this survey paper, we investigate KG-based recommender systems and summarize the recent efforts in this domain. This survey illustrates how different approaches utilize the KG as side information to improve the recommendation result as well as providing interpretability in the recommendation process. Moreover, an introduction to datasets used in different scenarios is provided. Finally, future research directions are identified, hoping to promote development in this field. KG-based recommender systems are promising for accurate recommendation and explainable recommendation, benefitting from the fruitful information contained in the KGs. We hope this survey paper can help readers better understand work in this area.

ACKNOWLEDGEMENT

I am deeply grateful to their research mentors and advisors for their valuable guidance, insights, and unwavering support throughout the development of this work. Their expertise and encouragement have been instrumental in shaping the content and direction of the paper. I would like to thank all the individuals and organizations that provided the data and resources necessary for conducting the research. Without their contributions, this study would not have been possible. I wish to express their gratitude to the reviewers and peers who critically evaluated the manuscript and provided constructive feedback. Their thoughtful comments and suggestions have greatly improved the quality and clarity of the paper.

REFERENCES

[1] Qingyao Ai, Vahid Azizi, Xu Chen, and Yongfeng Zhang. 2018. Learning Heterogeneous Knowledge Base Embeddings for Explainable Recommendation. Algorithms (2018).

[2] Antoine Bordes, Nicolas Usunier, Alberto Garcia-Duran, Jason Weston, and Oksana Yakhnenko. 2013. Translating embeddings for modeling multi-relational data. In Advances in neural information processing systems. 2787–2795.

[3] Rajarshi Das, Shehzaad Dhuliawala, Manzil Zaheer, Luke Vilnis, Ishan Durugkar, Akshay Krishnamurthy, Alex Smola, and Andrew McCallum. 2017. Go for a Walk and Arrive at the Answer: Reasoning Over Paths in Knowledge Bases with Reinforcement Learning. In NIPS-17 Workshop on Automatic Knowledge-Base Construction.

[4] Li Gao, Hong Yang, Jia Wu, Chuan Zhou, Weixue Lu, and Yue Hu. 2018. Recommendation with multi-source heterogeneous information. Proceedings of the Twenty-Seventh International Joint Conference on Artificial Intelligence (2018).

[5] Aditya Grover and Jure Leskovec. 2016. node2vec: Scalable feature learning for networks. In Proceedings of the 22nd ACM SIGKDD international conference on Knowledge discovery and data mining. ACM, 855–864. [6] Ruining He, Wang-Cheng Kang, and Julian McAuley. 2017. Translation-based recommendation. In Proceedings of the Eleventh ACM Conference on Recommender Systems. ACM, 161–169.

[7] Ruining He and Julian McAuley. 2016. Ups and downs: Modeling the visual evolution of fashion trends with one-class collaborative filtering. In proceedings of the 25th international conference on World Wide Web. 507–517.

[8] Ruining He and Julian McAuley. 2016. VBPR: Visual Bayesian Personalized Ranking from Implicit Feedback. In AAAI.

[9] Xiangnan He, Lizi Liao, Hanwang Zhang, Liqiang Nie, Xia Hu, and Tat-Seng Chua. 2017. Neural Collaborative Filtering. In WWW. 173–182.

[10] Jin Huang, Wayne Xin Zhao, Hongjian Dou, Ji-Rong Wen, and Edward Y Chang. 2018. Improving sequential recommendation with knowledge-enhanced memory networks. In The 41st International ACM SIGIR Conference on Research & Development in Information Retrieval. ACM, 505–514.

[11] Joseph A Konstan, Bradley N Miller, David Maltz, Jonathan L Herlocker, Lee R Gordon, and John Riedl. 1997. GroupLens: applying collaborative filtering to Usenet news. Commun. ACM 40, 3 (1997), 77–87.

[12] Yehuda Koren, Robert Bell, and Chris Volinsky. 2009. Matrix factorization techniques for recommender systems. Computer 8 (2009), 30–37.

[13] Daniel D Lee and H Sebastian Seung. 2001. Algorithms for non-negative matrix factorization. In Advances in neural information processing systems. 556–562.

[14] Xi Victoria Lin, Richard Socher, and Caiming Xiong. 2018. Multi-Hop Knowledge Graph Reasoning with Reward Shaping. In Proceedings of the 2018 Conference on Empirical Methods in Natural Language Processing, EMNLP 2018, Brussels, Belgium, October 31-November 4, 2018.

[15] Greg Linden, Brent Smith, and Jeremy York. 2003. Amazon.com recommendations: Item-to-item collaborative filtering. IEEE Internet computing 1 (2003), 76–80.

[16] Julian McAuley and Jure Leskovec. 2013. Hidden factors and hidden topics: understanding rating dimensions with review text. In Proceedings of the 7th ACM conference on Recommender systems. ACM, 165–172.

[17] Tomas Mikolov, Ilya Sutskever, Kai Chen, Greg S Corrado, and Jeff Dean. 2013. Distributed representations of words and phrases and their compositionality. In Advances in neural information processing systems. 3111–3119.

[18] Andriy Mnih and Ruslan R Salakhutdinov. 2008. Probabilistic matrix factorization. In Advances in neural information processing systems. 1257–1264.

[19] Maximilian Nickel, Volker Tresp, and Hans-Peter Kriegel. 2011. A Three-Way Model for Collective Learning on Multi-Relational Data.. In ICML. 809–816.

[20] Steffen Rendle, Christoph Freudenthaler, Zeno Gantner, and Lars Schmidt-Thieme. 2009. BPR: Bayesian personalized ranking from implicit feedback. In Proceedings of the 25th conference on uncertainty in artificial intelligence. AUAI Press, 452–461.

[21] Paul Resnick, Neophytos Iacovou, Mitesh Suchak, Peter Bergstrom, and John Riedl. 1994. GroupLens: an open architecture for collaborative filtering of netnews. In Proceedings of the 1994 ACM conference on Computer supported cooperative work. ACM, 175–186.

[22] Badrul Sarwar, George Karypis, Joseph Konstan, and John Riedl. 2001. Item-based collaborative filtering recommendation algorithms. In Proceedings of the 10th international conference on World Wide Web. ACM, 285–295.

[23] David Silver, Aja Huang, Chris J Maddison, Arthur Guez, Laurent Sifre, George Van Den Driessche, Julian Schrittwieser, Ioannis Antonoglou, Veda Panneershelvam, Marc Lanctot, et al. 2016. Mastering the game of Go with deep neural networks and tree search. nature 529, 7587 (2016), 484.

[24] Richard S Sutton and Andrew G Barto. 2018. Reinforcement learning: An introduction. MIT press.

[25] Georgios Theocharous, Philip S Thomas, and Mohammad Ghavamzadeh. 2015. Personalized Ad Recommendation Systems for Life-Time Value Optimization with Guarantees. In IJCAI. 1806–1812.

[26] Hongwei Wang, Fuzheng Zhang, Jialin Wang, Miao Zhao, Wenjie Li, Xing Xie, and Minyi Guo. 2018. Ripplenet: Propagating user preferences on the knowledge graph for recommender systems. In CIKM. ACM, 417–426. [27] Xiting Wang, Yiru Chen, Jie Yang, Le Wu, Zhengtao Wu, and Xing Xie. 2018. A Reinforcement Learning Framework for Explainable Recommendation. In 2018 IEEE International Conference on Data Mining (ICDM). IEEE, 587–596.

A Survey on Object Detection and Tracking System Using MATLAB

Manish Kumar
Associate Professor
Department Of CSE
JB Institute of Technology, Dehradun

ABSTRACT

Object detection and object tracking is becoming a region of interest in today's era. The main goal behind object detection and tracking is to segment out the region of interest from a particular frame. A lot of researches have been done on this field and new algorithm are being updated to detect and track objects on an image or on alive camera. With the help of object detection methods like frame differencing, optical flow and background subtraction we can categories different object in a single image and can also identify a particular object on that image. The object can be classified such as human, birds, animals, tree, balls, vehicles and other objects. Object classification can be done on the basis of its colour, motion and texture. After identifying the object, its tracking can be performed with the help of Point tracking, Kernel Tracking and Silhouette tracking by which we can identifying its change in position, size, shape, by its consecutive frames.

INTRODUCTION

Videos are actually sequences of images, each of which called a frame, displayed in fast enough frequency so that human eyes can percept the continuity of its content. It is obvious that all image processing techniques can be applied to individual frames Besides, the contents of two consecutive frames are usually closely related. The identification of regions of interest is typically the first step in many computer vision applications including event detection, video surveillance, and robotics.

A general object detection algorithm may be desirable, but it is extremely difficult to properly handle unknown objects or objects with significant variations in colour, shape and texture. Therefore, many practical computers vision systems assume a fixed camera environment, which makes the object detection process much more straightforward. An image, usually from a video sequence, is divided into two complimentary sets of pixels. This output or result is often represented as a binary image or as a mask [2]. It is difficult to specify an absolute standard with respect to what should be identified as foreground and what should be marked as background because this definition is somewhat application specific. Generally, foreground objects are moving objects like people, boats and cars and everything else is background. Many a times shadow is classified as foreground object which give improper output.

Following are the basic steps for tracking an object, as describe in above Figure1.1.

1.1 Object Detection - Object Detection is to identify objects of interest in the video sequence and to cluster pixels of these objects. Object detection can be done by various techniques such as frame differencing, Optical flow and Background subtracting.

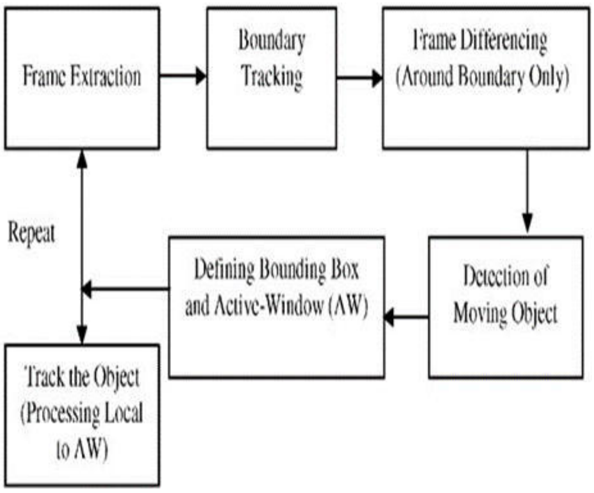
1.2 Object Classification - Object can be classified as vehicles, birds, floating clouds, swaying tree and other moving objects. The approaches to classify the objects are Shape-based classification, Motion-based classification, Colour based classification and texture-based classification [3].

1.3 Object Tracking - Tracking can be defined as the problem of approximating the path of an object in the image plane as it moves around a scene. The approaches to track the objects are point tracking, kernel tracking and sill chouette [3].

LITURATURE SURVEY

Object detection and tracking is a vast field of study in science and technology. Though this is a very crucial topic of study but still it is very less altered till 2004. But from last 5-6 years, after the sudden growth in study and development of robotics and artificial intelligence, object detection showed a huge interest and increased courtesy among the researchers to work on it.

Object detection is a method of detecting an object from a video. A video is actually sequence of images, each of which is called frames, which is displayed in such a manner that human eye see it as bunch of continuous frames or a video. Object detection is done by comparing two different consecutive frames and pointing out the object of interest in both by its motion, shape or colour[1]. There are various object detection algorithm which can easily detect certain known objects from the image but it can be very difficult to detect unknown objects or object with similar shape, colour or texture. So to overcome such issues, many computer vision system uses fixed camera environment which make object detection method very easier and straightforward.



A frame, from a video sequence, consist of different objects which can be divided into two types, foreground and background objects. Foreground objects includes all the moving objects like, human, car, boats, animals and rest everything is considered as background objects. With the help of fixed camera environment background object can be easily separated from the foreground and object detection can be done

METHODOLOGY

Detection of moving objects and motion-based tracking are important components of many computer vision applications, including activity recognition, traffic monitoring, and automotive safety. The problem of motion-based object tracking can be divided into two parts:

1. Detecting moving objects in each frame

2. Associating the detections corresponding to the same object over time

The detection of moving objects, as done in Figure 1.3, uses a background subtraction algorithm based on Gaussian mixture models. Morphological operations are applied to the resulting foreground mask to eliminate noise. Finally, blob analysis detects groups of connected pixels, which are likely to correspond to moving objects.

The association of detections to the same object is based solely on motion. The motion of each track is estimated by a Kalman filter [4]. The filter is used to predict the track's location in each frame, and determine the likelihood of each detection being assigned to each track.

Track maintenance becomes an important aspect of this example. In any given frame, some detections may be assigned to tracks, while other detections and tracks may remain unassigned. The assigned tracks are updated using the corresponding detections. The unassigned tracks are marked invisible. An unassigned detection begins a new track.

Each track keeps count of the number of consecutive frames, where it remained unassigned. If the count exceeds a specified threshold, the example assumes that the object left the field of view and it deletes the track.

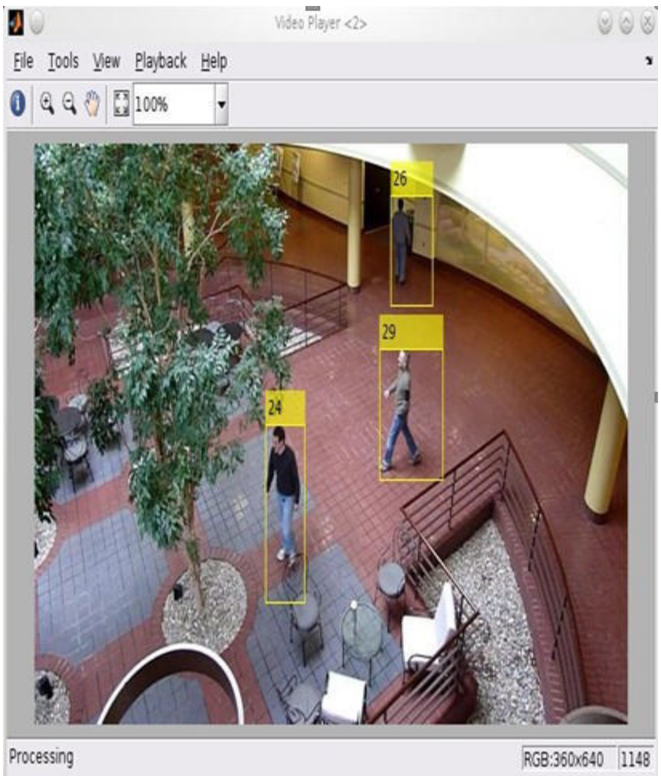
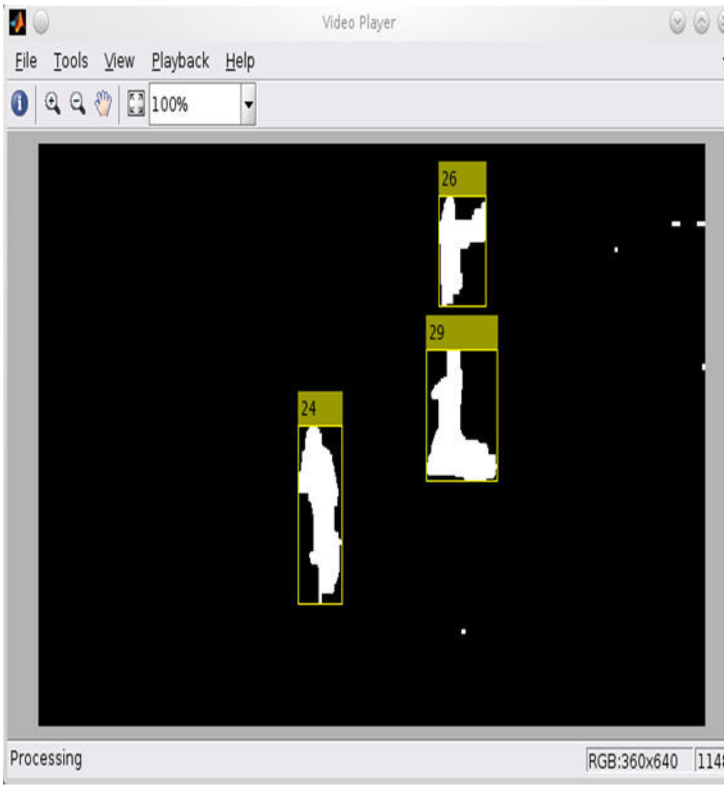


Figure 1.3. Detection of Moving Objects



igure.1.4 Motion Based Object Tracking

To obtain background subtraction, as done in Figure 1.4, the background has to model first. Then, the incoming frame is obtained, and subtract out from the background model. With the background model, a moving object can be detected. This algorithm is called as "Background Subtraction". The efficiency of a background subtraction technique correlates with three important steps: modelling, noise removal and data validation. Background modelling, is the backbone of the Background Subtraction algorithm. Background model defines the type of model selected to represent the background, and the model representation can simply be a frame at time (t-1) formula such as the median model. Model Adaption is the procedure used for adjusting the background changes that may occur in a scene. Noise removal is a procedure that eliminates noise in the scene. Data validation is involved with the collection of techniques to reduce the misclassification of pixels. In the recent papers, many background subtraction algorithms are proposed, because no single algorithm is able to cope with all the challenges in the sports applications. There are several problems that a good background subtraction algorithm must resolve. Therefore, in this paper the most commonly used, background subtraction algorithms are discussed. [5]A Gaussian mixture model (GMM) was proposed for the background subtraction in Friedman and Russell, and efficient update equations are given in Stauffer and Grimson. In Power and Schoones, the GMM is extended with a hysteresis threshold. This method uses a Gaussian probability density function to evaluate the pixel intensity value. It finds the difference of the current pixel's intensity value and cumulative average of the previous values. So it keeps a cumulative average (μ) of the recent pixel values. If the difference of the current image's pixel value and the cumulative pixel value is greater than the product of a constant value and standard deviation then it is classified as foreground. That is, at each t frame time, the I pixel's value can then be classified as foreground pixel if the inequality: $| I_t - \mu_t | > k \sigma$ holds; otherwise, it can be considered as background, where k is a constant and σ is standard deviation. Here background is updated as the running average.[6].The proposed work has been developed using MATLAB on Intel i5 processor, 8GB RAM and Windows 10. The real time video sequences are acquired at the rate of 30 frames/second with the frame size of 640×360 pixels resolution.

CONCLUSIONS

In this survey paper all the main terminology of object detection has been addressed. These include object detection methods, feature selection and object classification. Most commonly used and well recognized methods for these phases have been explained in details. Different methods for object detection are like frame difference, optical flow and background subtraction. Most commonly used method is background subtraction. The advance forward feature of methods behind the object detection can be achieved by two main feature types like edge-based feature type and patch-based feature type. This theory is already proven so yet no practical implementation done without this theory. Classification of objects is one of the most important parts of an object detection system. Among the many methods of object classification most of the researchers prefer texture based and colour-based object classification. This study of review may open the paths to find efficient algorithms to reduce computational cost and to decrease the time required for detecting the object for variety of videos containing different characteristics and to increase accuracy rate.

REFERENCES

1. Zhao Liu, HuiShen, GuiyuFeng and DewenHua, "Tracking objects using shape context matching", Neuro computing Vol. 83 (2012)

2. "A Survey on Object Detection and Tracking Methods" ,Himani S. Parekh1, Darshak G. Thakore 2, Udesang K. Jaliya. Vol. 2, Issue 2 (2014)

3. "A Survey on Object Detection, Classification and Tracking Methods", Kirubaraj Ragland Post Graduate Scholar, P. Tharcis Assistant Professor, Department of ECE, Christian College of Engineering and Technology, Oddanchatram, India. Vol. 3, Issue 11 (2014)

4. "Object Tracking: A Survey", Alper Yilmaz, Omar Javed and Mubarak Shah. ACM Computing Surveys, Vol. 38, No. 4, Article 13 (2006)

5. "Statistical Survey on Object Detection and Tracking Methodologies", Shilpee A. Dave, Dr. M S. Nagmode, Aditi Jahagirdar . International Journal of Science & Engineering Research, Volume 4, Issue 3(2013) ISSN 2229-5518

6. "A Survey on Approaches of Object Detection", Sanjivani Shantaiya, Keshri Verma, Kamal Metha. Vol. 65-No. 18 (2013).

Use of Information and Communication Technology for Risk alleviation in Disaster Management

Wajhat. Gh Mohd
Assistant Professor
Department Of CSE
JB Institute of Technology ,Dehradun,

ABSTRACT

With expansion in Information and Communication Technology Internet, GIS, Remote Sensing, Satellite-based communication links can help in planning and implementation of disaster risk reduction and prevention measures. ICT Technologies have been playing major role in scheming early warning systems, response and improvement. ICT tools are also being widely used to build knowledge warehouses using internet and data warehousing techniques. These knowledge warehouses can assist planning, response, revival and mitigation at all levels. GIS-based systems improve the quality of analysis of hazard vulnerability. Communication systems have also become necessary for providing emergency communication and timely reinforcement and response measures. ICT can play a significant role in highlighting risk areas, vulnerabilities and potentially affected populations by producing geographically referenced analysis through, for example, a geographic information system (GIS). The importance of timely disaster warning in mitigating negative impacts can never be underestimated.

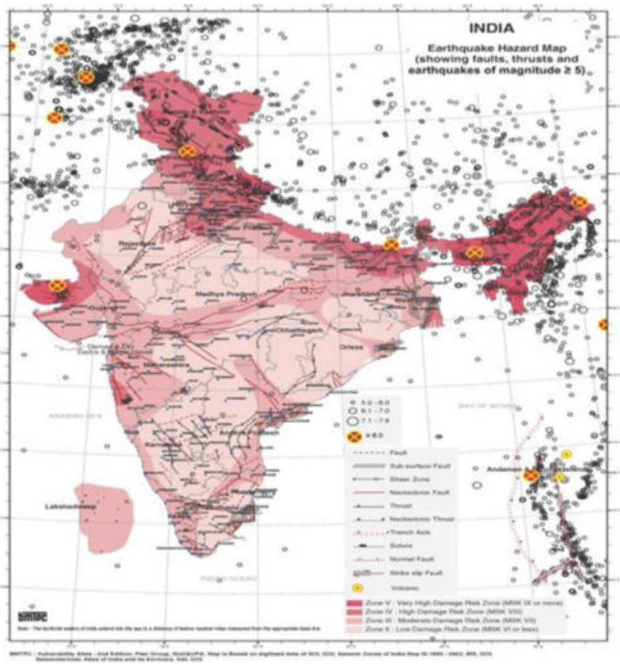
Keywords-GIS(Geographic Information System), ICT

INTRODUCTON

Advances in Information and Communication Technologies have provided all stakeholders with more ways to seek information during disaster situations and to look for supporting the emergency management process. Recent disasters and emergencies have highlighted the role that ICT play in disaster management. With a century old history of investigation, the sociological study of crises is aware that ICT has expanded the reach of disaster sociology, adding new challenges to this area. Successful disaster response exercises in managing human resources under very difficult conditions. Catastrophic disasters can disrupt both the physical communication networks and the social networks critical for efficient response and recovery. While notes that a well-designed disaster plan serves as a framework, it often requires communication and collaboration between responders to adapt it to the situation at hand, this therefore means that in order to cope with disasters in a fast and highly coordinated manner, the optimal provision of information concerning thesituationisanessentialpre-requisite.Sincecoordinationrequires current information, and such information must be communicated in real-time, there is need for an Integrated Communication and Information System for Disaster Management that provides efficient, reliable, secure. Exchange and processing of relevant information. Whereas Climate changes are impressive, the impacts are not negligible, in long terms theses impacts can be consequences for various types of destructive events like natural disasters. Technology adoption and integration in Climate Changes Monitoring, Mitigation and adaptation can help to save environment from destruction and degradation. ICT can play a pivotal role in monitoring, mitigation and adaptation of Climate changes challenges. Both developed and developing countries suffer the impacts of climate change and to get ride off these challenges they are emphasizing use of ICT. Much as developed countries are enrich in using technology in observing climate changes or disaster management, developing countries are still looking at deploying these technologies in climate change and Disaster Management a factor which attributes to insufficient budget, short term planning, lack of awareness, uneducated community, inadequate training and many social, economic and political factors as the main obstacle in deploying and adopting ICT in developing countries

KEY TERMINOLOGIES

ICT refers to—Electronic means of capturing, processing, storing and disseminating information¦. This means can be further grouped as "New ICTs": Computers, satellites, wireless one-on-one communications (including mobile phones), the Internet, e-mail and multimedia generally fall into the New ICT category. Most of these, and virtually all new versions of them, are based on digital communication whereas —Old ICTs" include; Radio, television, land-line telephones and telegraph. They have been in reasonably common use throughout much of the world for many decades. Traditionally, these technologies have used analog transmission techniques, although they too are migrating to the now less expensive digital format.



1 CATEGORIES OF DISASTER AND DISASTER MANAGEMENT PHASES

Disaster and its managing phases can be grouped in five categories:
i. Geophysical: Events originating from solid earth.

ii. Meteorological: Events caused by short-lived/small to mesa scale atmospheric processes (in the spectrum from minutes to days)
iii. Hydrological: Events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up
iv Climatological: Events caused by long-lived/meso-to macro-scale processes (in the spectrum from intra-seasonal to multi- decade climate variability)

v Biological: Disastercausedbytheexposureoflivingorganismstogermsandtoxicsubstances

2. CHALLENGES ASSOCIATED TO DISASTERS–THE REQUIREMENT FOR DISASTER MANAGEMENT

Emergency services rely on data communications particularly public radio networks like GPRS. Occasionally in disaster situations, even GSM is used for voice communication between relief workers. In case of emergency the public networks may get burdened. So, the use of generally available public networks is not considered to be reliable enough for emergency situations. Moreover, GSM/GPRS is an infrastructure based network, highly susceptible to disasters in small and medium sized urban areas. This therefore, demonstrates great deficiencies in all the phases of disaster management cycle because whenever there is emergency situation and response time taken is too long ,the result is normally in form of great damages of lives and property hence, disaster recovery and response require a timely coordination of the emergency services. ICT providesatremend-ouspotentialtoincreaseefficiencyandeffectivenessinthisareabypropagatinginformationefficiently to all the right locations. While ICTs have crucial role to play in disaster management, there are tough challenges in making use of ICTs for the betterment of communities, in support of this, presents three phases of information systems that can be used for disaster response which are: the pre-phase addressing the preparations before, the post-phase analyzing what happened during the disaster(lessons learnt e.g. for training) and the phase in between, that is the situation during the emergency which should be a center focus for developing countries in an attempt to adopt to ICTs for the response and management of disaster situations

3 ICT'S IN DISASTER MANAGEMENT

Geographical Information Systems (GIS):
GIS can provide a valuable support during various phases. During the preparedness and response phases, GIS can support better response planning for determining evacuation routes or locating critical infrastructure and vital lifelines, etc. Based on the information provided by GIS, it is also possible to estimate what quantity of food supplies, bed space, clothes, and medicine. Similarly, GIS facilitates online monitoring of the status of ongoing work in the recovery phase. Thus, planned infrastructure for disaster information dissemination should offer an appropriate mix of communication technologies to respond to diverse requirements. The Utilization of wireless technologies for disaster management and inclusion of GIS platform for holistic disaster management by developing nations can play a crucial role in all phases of disaster management especially where such application is still not widespread perhaps due to limitation in infrastructure also maintain that the geospatial aspects of GIS may be explicit, such as topographic maps, providing background information, or implicit, for example demographic data about population distribution in

an affected area. In the same way this can also be exploited by using either dedicated tool to analyse or incorporate geospatial aspects such as the usage of a GIS by a GeographicalInformationexpertortheinformationisintegratedviainteroperableGeographicalservices in a specific emergency management application to try and respond or manage disasters.

GSM Networks: In GSM networks one key feature called—marking of origin¦ plays a significant role in emergency response. In this case the phone number of the caller is transmitted to the network, and the address corresponding to the phone number can be found in the database of the phone network provider by using digital maps and mapping applications, the position of the address can be shown on the map instantly as calls arrive. Such a function is very valuable for the emergency call operator, as the help can be sent in the correct direction more quickly. It is therefore desirable for the emergency call Centre that a location service for cellular phones is established and the location service is called Mobile Station Location ¦(MSL) which must be unique within the GSM coverage.

Satellite Radio Communications Technologies and Applications notes that, there are numerous satellite networks in orbit which provide support for disaster relief operations on a global basis, with a wide range of support for voice, data and video applications that enable first responders andreliefworkerstohaveaccesstocriticalcommunicationswhentheterrestrial network infrastructure is damaged or the fixed and mobile is over loaded. These can address a wide range of telecommunications requirements including;

- Fixed-to-Fixed (connecting emergency response headquarters to the field)
- Fixed-to-Mobile (connecting emergency response headquarters to mobile response units)
- Mobile-to-Mobile(connecting mobile response units to teams in the air or at sea)
- Point-to-Multipoint(broadcasting critical information to citizens)

4 CONCLUSION:

Current day emergency services rely on data communications especially public radio networks like GPRS. Sometimes in disaster situations, even GSM is used for voice communication between relief workers. However, in case of emergency the public networks may get overloaded. So, the use of generally available public networks is not considered to be reliable enough for emergency situations. Moreover,GSM/GPRSisaninfrastructurebasednetwork,highlysusceptibletodisastersinsmallandmediumsizedurbanareas.Thistherefore, demonstrates great deficiencies in all the phases of disaster management cycle because whenever there is emergency situation and response time taken is too long, the result is normally in form of great damages of lives and property hence, disaster recovery and response require a timely coordination of the emergency services. ICT provides a tremendous potential to increase efficiency and effectiveness in this area by propagating information efficiently to all the right locations. While ICTs have a crucial role to play in disaster management, there are tough challenges in making use of ICTs for the betterment of communities, in support of this, presents three phases of information systems that can be used for disaster response which are: the pro phase addressing the preparations before, the post-phase analysing what happened during the disaster(lessons learnt e.g. for training) and the phase in between, that is the situation during the emergency which should be a centre focus for developing countries in an attempt to adopt to ICTs for the response and management of disaster situations.

5 REFERENCES

[1] Palen, L.V.(2007).Crisis in a networked world features of computer-mediated communication Virginia Tech Event. Virginia: Social Science Computer Review.

[2] Schmidt.(2010).Web2.0 for Disaster Response and Recovery. Journal of Web Librarianship,v4(n4),p413-426.

[3] Ahsan, F. S. (2103). Knowledge Management for Disaster Scenario: An Exploratory Study. Research Journal of Recent Sciences ISSN 2277-2502Vol.2 (10),61-66.

[4] Farhan Shafiq,K.A.(2014).Role of ICT in Climate Change Monitoring: A review Study of ICT based Climate Change Monitoring Services. Research Journal of Recent Sciences, Vol. 3(12),123-130.

[5] SIDA. (2005). ICTs for Poverty Alleviation: Basic Tool and Enabling Sector.

[6] CRED.(2010).Center for Research in Epidemiology of Disasters.

[7] NDMICS.(2012).National Disaster Management Guidelines-National Disaster Management Information and Communication System.NewDelhi-110029ISBN:978-93-80440-12-5:NationalDisasterManagement Authority Government of India New.

[8] Leonid V. Stoimenov, M. A. (2007). GIS as a Tool in Emergency Management Process. Proceedings of the World Congress on Engineering. London, U.K.: Vol IWCE2007

[9] Kazi Shamsul Arefin, A.K.(2010).An Approach of Location Management in GSM using GIS.ISSN2218-5224(ONLINE),VOLUME 01,ISSUE 01,JCIT.

[10] ITU. (2010). Utilization of ICT for disaster management, resources, and active and passive space-based sensing systems as they apply to disaster and emergency relief situations. Switzerland Geneva: ITU-DSTUDYGROUP.

[11] Sandra Cabrera-Alvarado, S.L.(2013).The progressive use of satellite technology for disaster management relief: challenges to a legal and policy framework. 64thInternational Astronautical Congress, Beijing, China (pp.IAC-13 E3, P,5.p1,x16730).Beijing: the International Astronautical Federation.

[12] Andreas M. Kaplan (2010) , Michael Haenlein, Users of the world, unite! The challenges and opportunities of Social Media, Science Diretc, www.sciencedirect.com

[13] D'Andrea, Alessia & Grifoni, Patrizia & Ferri, Fernando. (2022). Discussing the Role of ICT in Sustainable Disaster Management. Sustainability. 14. 10.3390/su1412

Hardware-implemented Trans resistance CMOS neurons for adaptable neural networks

Manoj Kumar Bansal

Associate Professor

Department Of ECE

JB Institute of Technology ,Dehradun

ABSTRACT

We offer a straightforward analogue circuit that can act as a neuron in integrated circuit implementations of neural networks based on static models. It is well suited to collaborate with transconductance synapses when operating in a trans resistance mode. As a result, the input signal of this device is a current made up of the sum of currents from synapses. At the neuron input, a node realizes the summation of the currents. The circuit has two outputs, one of which outputs a step function signal and the other a linear function signal. A voltage can be used to conveniently control the step output's activation threshold. Due to its two outputs, the neuron is a desirable component for fuzzy logic networks. It has only five MOS transistors, can run on very low supply voltages, takes very little power to process input signals, and uses zero power when no input signals are present. The outcomes of simulations and experiments are demonstrated to be in good agreement with theoretical forecasts. The results are given for a 0.35 m CMOS process and a prototype created inside the Euro practice framework.

Key words: Neural networks, learning on silicon, hardware intelligence, CMOS antilog circuits, low-power electronics.

1. Introduction

Since the first mathematical model of a biological neuron arose more than 60 years ago, artificial neural networks (ANNs) have attracted researchers' interest. The majority of recent research on ANNs is in the field of mathematical considerations, and they are primarily used in software [1,2]. However, ANN hardware implementations are growing in popularity recently, and there are numerous examples of successful ANN hardware implementations in use. The potential for faster performance than software-based ANNs is one of the factors driving interest in hardware-implemented ANNs. Another is that they have a greater level of intelligence and can use less power.

As of now, ANNs that have been implemented in hardware are advanced-trained application circuits that cannot perform adaptive self-learning on silicon while in use. Only recently, thanks to improvements in CMOS technologies, has the idea of putting in a chip a densely linked neural network capable of learning on silicon in the recall phase been feasible [3-17].

Intelligent self-learning ANN hardware implementation is still a difficult task. To accomplish this, numerous requirements must be met and issues resolved. To realize the fundamental operations needed in ANNs, suitable low-power electronics must first be developed. Second, in order to prevent power losses in conductive connections, signals that are sent between neurons must be voltages. Synapses should function in a transconductance mode while neurons should operate in a trans resistance mode because the summing of currents is considerably easier to accomplish than the summation of voltages. Additionally, analogue memories appear to be the most suitable for storing information on the synapse weight within a chip [7].

Recent proposals for electronic circuits to realise local analogue memories [7,17], electronically controlled transconductance synapses [8,9], a trans resistance neuron [9,10], Euclidean distance calculations [12,13], a conscience mechanism [14,15], and a winning neuron detection [16] have all taken advantage of modern CMOS processes. The circuit in [9] has a step or signum activation function and can behave as a power-saving neuron. An enhanced version of the neuron circuit is suggested in this work. The enhancement depends on the addition of a second output where the voltage is linearly dependent on the current entering the neuron. By doing this, we are able to create a neuron that has both a linear and a step-function output.

There are numerous hardware neural network models that have been created and published [3-5]. We work with a static model in which each synaptic connection has a little, temporary memory. During the learning process, this memory is required to store silicon information on the synapse weight. We suggest methods based on unsupervised learning techniques like Kohonen's [2] or Habana’s [3] as the network training procedures.

The network may do classification tasks, among other things, using the additional linear output. Then, in addition to assigning an input object to a certain group (using the output of the step function), we may determine the degree to which it belongs to this group (using a fuzzy logic method). The winning neuron in a learning process based on the WTA approach (Winner Takes All) can also be found using the linear output. However, our research shows that when comparing the similarity between a learning vector and a weight vector connected to a specific output neuron, the WTA neuron detection may be performed with a greater effect. This can be accomplished by using a Euclidean distant metric [12–16].

In this paper, simulations (SPICE) concerning the whole neuron and measurement results concerning its step output fora prototype made in a 0.35μm CMOS process have been presented.

2. Proposed Neuron Circuit

The electrical scheme of the proposed neuron is shown in Fig. 1.The currents I_1, I_2, I_k, are signals coming from synapses. They are summed at the neuron input node, and the resulting current I_{IN} is provided to a double-output trans resistance activation circuit built of the transistors M01-M05. The pair M01/M02 creates a current mirror associated with one output, called “step output”, while the other output, called “linear out- put” is based on the M01/M04 current mirror. M03 functionsas a current source controlled by the voltage V_{th} and M05 as a quasi-linear resistor loading the M01/M04 mirror.

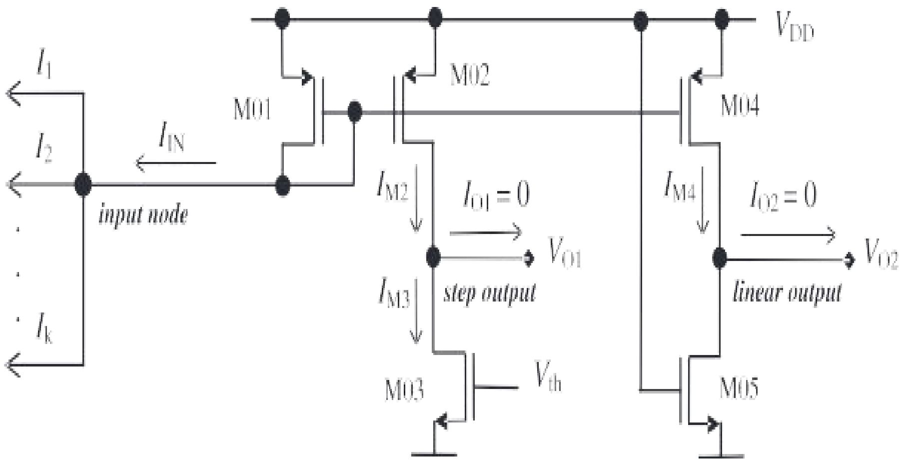


Fig. 1. Simple trans resistance CMOS neuron with step and linear ac-activation function outputs

At the neuron input, the current I_{IN} is a sum of currents delivered by synapses and can be expressed as:

$$I_{IN} = \sum_{i=1}^{k} I_i \quad (1)$$

Notice, that I_{IN} can take only positive values, despite the fact that the summed input currents can be positive as well as negative. This is due to the transistor M01, whose gate-source voltage, V_{GS1}, cannot be positive for input voltages being less than the supply voltage V_{DD}. The V_{GS1} voltage biases the transistors M02 and M04 forcing I_{IN} to be conveyed (current mirroring) to the output nodes.

Thus, $I_{M2} \simeq I_{IN}$ and $I_{M4} \simeq I_{IN}$,

provided that M02 and M04 operate in saturation.

Assuming that the currents I_{O1} and I_{O2} in Fig.1 can be neglected (neuron outputs loaded by a MOS transistor gate), we can write.

$$I_{M2} = I_{M3} \quad (2)$$

Each of the transistors M02 and M03 can operate either in saturation or in triode region, depending on the control voltage V_{th} and the input current I_{IN}. Denote by I_{th} drain current of M03 operating in saturation. For the M03 operation in strong inversion, I_{th} is approximately described by:

$$I_{th} \simeq K(V_{th} - V_p)^2 \text{ ,(3)}$$

Where V_{th} is drain current, V_{th} is gate to source voltage, V_p is pinch-off voltage and K is a real-valued coefficient. If the input current I_{IN} is high and satisfies the inequality:

$$I_{IN} > I_{th}\text{,(4)}$$

the transistor M03 operates in saturation, M02 in the triode region (current mirroring of the pair M01/M02 does not function) and the following relation is true:

$$I_{IN} > I_{M2} = I_{M3} = I_{th} \quad (5)$$

This is an active state of the neuron. Its output voltage V_{O1} is then approximately equal to V_{DD}.

If the input current, I_{IN}, is less than the threshold value, I_{th}, i.e. when:

$$I_{IN} < I_{th}, (6)$$

M02 is in saturation (the M01-M02 current mirror functions properly) and M03 is forced to operate in the triode region, which leads to:

$$I_{IN} = I_{M2} = I_{M3} < I_{th} \ (7)$$

Output voltage V_{O1} is then close to zero and this is an inactive state of the neuron.

From (6) and (7) it results that the neuron consumes no supply current (no supply power) if I_{IN} equals zero (important advantage). This takes place, for instance, when all synapses are inactive and provide no current to the neuron summation node, which can be expressed as:

$$I_1 = I_2 = \quad = I_k = 0 \ (8)$$

In addition, the presented neuron is well suited to low supply voltages and is able to carry out its tasks for the supply voltage V_{DD} is only slightly higher than the M01 transistor pinch-off voltage. This is desirable from the point of view of reducing power consumption associated with processing the input current I_{IN} for I_{IN} being different from zero (neuron in operation).

At the linear output in Fig. 1, the transistor M05 works in the triode region (non-saturated channel) and as previously mentioned, plays a resistor role that loads the M04 transistor. An operation in this region takes place when drain-source voltage, V_{DS}, gate-source voltage, V_{GS}, and pinch-off voltage, V_p, of M05 fulfill the following inequality:

$$V_{DS} < V_{GS} - V_p \ (9)$$

3 The neuron cooperation with synapses and local memories

Since the output signals of synapses should be currents and the signals that are communicated between neurons should be voltages, the neuron must operate in a transconductance mode and the synapses in a trans resistance mode. A division into a separate space is a characteristic of ANN's implemented in both the software and hardware learning phase and recall phase, with the latter beginning after the former is complete. This division arises from the fact that artificial networks' learning processes take a very long time. The learning period must be seriously cut down if we want the ANN to be able to learn adaptively during operation during the recall phase. We suggest using ana- log medium-term memories and placing them near synapses, as shown in Fig. 2, to accomplish this purpose. The weight of the synapses is stored in these memories. Information should be retained for at least as long as is necessary for one iteration of the learning method, which is referred to as the medium-term.

This makes it possible to quickly alter the synaptic weights within a chip. Following completion of the learning process, the weight data should also be entered into an external digital memory. By using multiplexing techniques, this memory is also required to periodically update analogue memories in the recall phase before the next step of an adaptive self-learning mechanism begins.

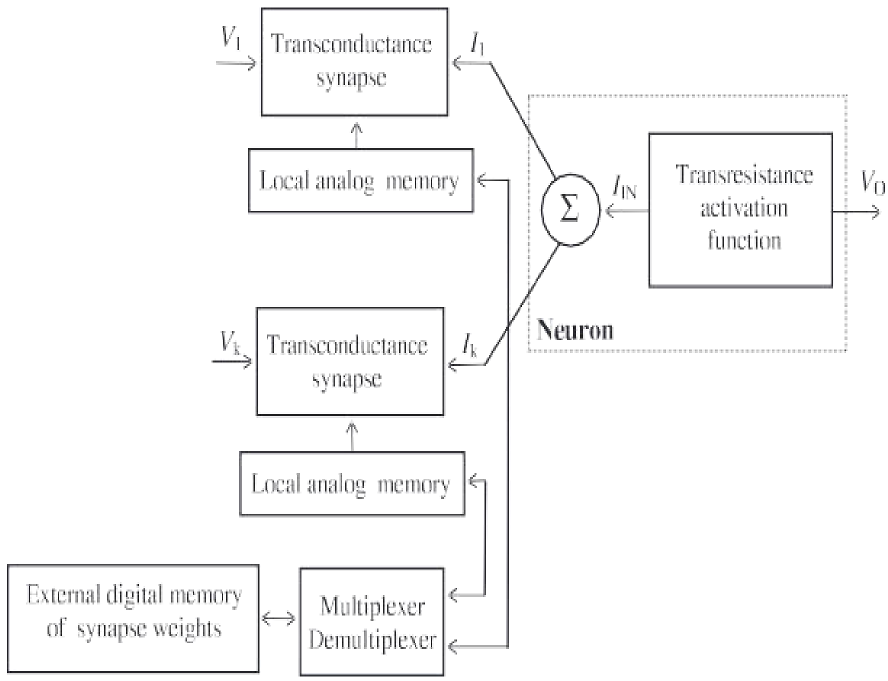


Fig. 2. Static neuron model including synapses coupled with localmemories suitable for adaptive ANN’s implemented in a chip formand trained on silicon.

In the following section, a transconductance synapse [8] scheme that is well-suited to work with the suggested neuron is provided. Similar to a neuron, its advantage is that it consumes zero power when inactive, or when no voltage is provided to its input, and uses minimal power when processing voltage that is different from zero.

In [7,17], a capacitive analogue long-term memory suitable for use in our network is described. With switched feedback applied around the holding capacitor, it has the advantage of a longer holding period for a brief acquisition time. This enables us to achieve a pretty long holding period even for modest holding capacitances. For networks with unsupervised learning on silicon utilizing a "Winner takes all" mechanism, ANN's based on the design of Fig. 2 seem appealing.

4 Prototype and Experimental Result

A first version of the neuron which included only one out- put (step one) has already by prototyped and experimentally tested, while the present version with the additional linear output was, till now, only examined by means of simulations. Preparations for prototyping it are in progress. For this reason, we present measurement results concerning only the step out-put of the neuron.

As it is known, current measurements are in general morecomplex and less accurate than voltage ones. This is particularly true when the currents are very low like it takes place inour case. That is why in the performed experiments, instead ofthe neuron input current I_{IN}, the synapse input voltage, V_I, was measured. As mentioned in the previous section, the prototyped circuit was implemented in a 0.35 CMOS technology by the firm NORDIC

associated with AMS on the basis of our full custom design. We measured the fabricated chips, where among other circuits the neuron and synapses were included,
for the supply voltage equal to $V_{DD} = 2\,4V$.

REFERENCES:

[1] Syed Ahmed Aamir, Paul Mu̇ller, Gerd Kiene, Laura Kriener, Yannik Stradmann, Andreas Gru̇bl, Johannes Schemmel, and Karlheinz Meier. A mixed-signal structured adex neuron for accelerated neuromorphic cores. IEEE transactions on biomedical circuits and systems, 12(5):1027–1037, 2018.

[2] Chiara Bartolozzi and Giacomo Indiveri. Synaptic dynamics in analog vlsi.Neural computation, 19(10):2581–2603, 2007.Claudio Bartolozzi, S. Mitra, and Giacomo Indiveri. An ultra low power current-model lter for neuromorphic systems and biomedical signal processing.2006 IEEE Biomedical Circuits and Systems Conference, pages 130–133, 2006.

[3] Ben Varkey Benjamin, Peiran Gao, Emmett McQuinn, Swadesh Choud- hary, Anand R Chandrasekaran, Jean-Marie Bussat, Rodrigo Alvarez- Icaza, John V Arthur, Paul A Merolla, and Kwabena Boahen. Neu- rogrid: A mixed-analog-digital multichip system for large-scale neural simulations.Proceedings of the IEEE, 102(5):699–716, 2014.

[4] Elisabetta Chicca, Fabio Stefanini, Chiara Bartolozzi, and Giacomo Indiveri. Neuromorphic electronic circuits for building autonomous cognitive systems.Proceedings of the IEEE, 102(9):1367–1388, 2014.

[5] JJ Collins, Carson C Chow, and Thomas T Imhoff. Stochastic resonance without tuning.Nature, 376(6537):236–238, 1995.

[6] Mike Davies, Narayan Srinivasa, Tsung-Han Lin, Gautham Chinya, Yongqiang Cao, Sri Harsha Choday, Georgios Dimou, Prasad Joshi, Nabil Imam, Shweta Jain, et al. Loihi: A neuromorphic manycore processor with on-chip learning.IEEE Micro, 38(1):82–99, 2018.

[7] Cle´ment Farabet, Rafael Paz, Jose Pe´rez-Carrasco, Carlos Zamarren˜o, Alejandro Linares-Barranco, Yann LeCun, Eugenio Culurciello, Teresa Serrano-Gotarredona, and Bernabe Linares-Barranco. Comparison between frame-constrained x-pixel-value and frame-free spiking- dynamic-pixel convnets for visual processing.Frontiers in neuroscience, 6:32, 2012.

[8] Charlotte Frenkel, Martin Lefebvre, Jean-Didier Legat, and David Bol. A 0.086-mm212.7-pj/sop 64k-synapse 256-neuron online-learning digital spiking neuromorphic processor in 28-nm cmos.IEEE transactions on biomedical circuits and systems, 13(1):145–158, 2018.

[9] Eugene M Izhikevich. Simple model of spiking neurons.IEEE Transactions on neural networks, 14(6):1569–1572, 2003.

Research paper on Counterfeit Insights (AI)

Manoj Kumar Bansal

Associate Professor

Department Of ECE

JB Institute of Technology ,Dehradun

ABSTRACT

Fake Insights something else known as AI, it is the advancement and the hypothesis of a few computer frameworks that are able to embrace certain errands which is able ordinarily require the insights of people. The errands that are regularly in require of human insights are the likes of interpretation of dialects, and making choices acknowledging of discourse among others. Great cases of these advances that drop beneath the AI are; expanded reality, Virtual Colleagues, and robots. On the other hand, worker efficiency can too be called workforce efficiency. Efficiency is assessed in terms of the yield of representatives within a given time.
AI frameworks are competent of adjusting their conduct to a certain degree by examining the impacts of past activities and working independently.

Key words: AI, Virtual colleagues, hardware intelligence, CMOS analog circuits.

Introduction

Fake insights is the recreation of human insights forms by machines, particularly computer frameworks. Particular applications of AI incorporate master frameworks, normal dialect handling, discourse acknowledgment and machine vision.
AI shows in a number of shapes. A couple of cases are:
• Chatbots utilize AI to get it client issues quicker and give more effective answers
• Cleverly collaborators utilize AI to parse basic data from huge free-text datasets to progress planning
• Suggestion motors can give mechanized proposals for TV appears based on users' seeing propensities

AI is much more approximately the method and the capability for superpowered considering and information investigation than it is around any specific organize or work. In spite of the fact that AI brings up pictures of high-functioning, human-like robots taking over the world, AI isn't planning to replace humans. It's intended to altogether upgrade human capabilities and commitments. That creates it a really important trade resource.

Manufactured insights permit machines to show, and indeed make strides upon, the capabilities of the human intellect. From the improvement of self-driving cars to the multiplication of savvy collaborators like Siri and Alexa, AI may be a developing portion of regular life. As a result, numerous tech companies over different businesses are contributing in falsely brilliantly innovations.

Fake insights can be categorized into one of four sorts.
• Responsive AI employments calculations to optimize yields based on a set of inputs. Chess-playing AIs, for illustration, are receptive frameworks that optimize the most excellent methodology to win the amusement. Responsive AI tends to be decently inactive, incapable to memorize or adjust to novel circumstances. In this way, it'll create the same yield given indistinguishable inputs.
• Constrained memory AI can adjust to past encounter or upgrade itself based on modern perceptions or information. Regularly, the sum of overhauling is restricted (thus the name), and the length of memory is generally brief. Independent vehicles, for case, can "study the street" and adapt to novel circumstances, indeed "learning" from past involvement.
• Theory-of-mind AI are fully-adaptive and have an broad capacity to memorize and hold past encounters. These sorts of AI incorporate progressed chat-bots that might pass the Turing Test, tricking a individual into accepting the AI was a human being. Whereas progressed and impressive, these AI are not self-aware.
• Self-aware AI, as the title recommends, ended up conscious and mindful of their claim presence. Still within the domain of science fiction, a few specialists accept that an AI will never gotten to be cognizant or "lively".
WHAT IS Common Dialect Handling (NLP)?
Normal Dialect Handling (NLP) makes it conceivable for computers to get it the human dialect. Behind the scenes, NLP analyses the grammatical structure of sentences and the person meaning of words, at that point employments calculations to extract meaning and convey yields.
In a nutshell, the objective of Normal Dialect Handling is to form human dialect – which is complex,
WHAT IS AN AI Calculation?

Basically, an AI calculation is an expanded subset of machine learning that tells the computer how to memorize to function on its claim. In turn, the gadget proceeds to pick up information to move forward forms and run errands more efficiently. The more we associated with it, the more noteworthy it gets at being able to take note your person inclinations.
vague, and greatly different – simple for machines to get it.

HISTORY OF Manufactured Insights

The scholarly roots of AI, and the concept of shrewdly machines, May be found in Greek Mythology. Cleverly artifacts appear in news coverage since at that point, with genuine mechanical gadgets really showing behaviours with a few degrees of insights. After present day computers got to be accessible taking after World War-II, it has gotten to be conceivable to form programs that perform troublesome scholarly assignments.
The ponder of rationale driven specifically to the disclosure of the programmable digital electronic computer, based on the work of mathematician Alan Turing and others. Turing's hypothesis of calculation suggested that a machine, by rearranging images as simple as "O" and "1", seem reproduce any conceivable (possible) act of mathematical assumption.
This, in conjunction with simultaneous disclosures in neurology, data hypothesis and artificial intelligence, motivated a small group of researchers to start to seriously think the possibility of structure an electronic brain.

After a few reports criticizing advance in AI, government subsidizing and intrigued within the field dropped off – a period from 1974–80 that got to be known as the "AI winter." The field afterward restored in the 1980s when the British government begun subsidizing it once more in portion to compete with endeavors by the Japanese.
The field experienced another major winter from 1987 to 1993, coinciding with the collapse of the advertise for a few of the early general-purpose computers, and diminished government subsidizing. But investigate started to choose up once more after that, and in 1997, IBM's Profound Blue got to be the to begin with computer to defeat a chess winner when it crushed Russian grandmaster Garry Kasparov. And in 2011, the computer giant's question-answering framework Watson won the test appear "Peril!" by beating reigning champions Brad Rutter and Insight Jennings.

This year, the talking computer "chatbot" Eugene Goostman captured features for deceiving judges into considering he was genuine skin-and-blood human amid a Turing test, a competition created by British mathematician and computer researcher Alan Turing in 1950 as a way to survey whether a machine is brilliantly.
But the achievement has been questionable, with artificial intelligence experts saying that as it were a third of the judges were tricked, and pointing out that the bot was able to avoid a few questions by claiming it was an juvenile who talked English as a second dialect.

IS Manufactured Insights (AI) A Risk TO People
On the off chance that we center on what's conceivable nowadays with AI, here are a few of the potential negative impacts of fake insights that we ought to consider and arrange for:

Alter the employments people do/job computerization:
AI will alter the working environment and the jobs that people do. A few employments will be misplaced to AI technology, so people will require to embrace the alter and discover unused exercises that will give them the social and mental benefits their work given.
Political, lawful, and social repercussions:
As Bostrom exhorts, instead of maintain a strategic distance from seeking after AI advancement, "Our center should be on putting ourselves in the finest conceivable position so that when all the pieces drop into put, we've done our homework. We've created versatile AI control methods, we've thought hard approximately the ethics and the governments, etc. And after that continue advance and after that ideally have an extremely good result from that." On the off chance that our governments and trade teach do not spend time presently defining rules, regulations, and obligations, there might be critical negative repercussions as AI proceeds to develop.
AI-enabled fear based oppression:
Fake intelligence will alter the way clashes are battled from independent drones, robotic swarms, and inaccessible and nanorobot assaults. In expansion to being concerned with a atomic arms race, we'll got to screen the worldwide independent weapons race.

Long Term

AI's Affect IS All over
A few divisions are at the starting of AI. Notwithstanding, the affect of manufactured insights on our present-day lives is difficult to ignore:

1. Instruction:
Textbooks will get digitized or gotten as of now with the assistance of AI. Early-stage virtual teaches bolster human educates, and facial investigation measures students' emotions to help determine who's battling and way better tailor the involvement to their person needs.
2. Healthcare:
In the comparatively open AI field of healthcare, sedate revelation is sped up and streamlined, diseases are more rapidly and precisely analyzed, virtual nursing associates screen patients, and big information investigation helps create a more exact patient experience.
3. Transportation:
In spite of the fact that it could take more time to idealize AIs for transportation, independent cars will one day transport us from put to place.
investigation, get together, and sensors to keep gear running easily.
5. Media:
News coverage is providing AI, as well, and will proceed to advantage from it.

APPLICATIONS OF AI

Counterfeit Insights has different applications in today's society. It is becoming fundamental for today's time since it can unravel complex problems in a productive way in numerous businesses, such as Healthcare, amusement, funds, instruction, etc. AI is making our way of life more comfortable and quicker.
Following are a few divisions which have the application of Fake Insights:

AI in Healthcare
o Within the final, five to ten a long time, AI will become more beneficial for the healthcare industry and going to have a noteworthy effect on this industry.
o AI can offer assistance to specialists with diagnoses and can educate when patients are worsening so that restorative help can reach to the persistent some time recently hospitalized.

AI in Gaming
o AI can be used for gaming purposes. The AI machines can play vital games like chess, where the machine needs to think of a large number of possible places.

AI in Finance
o AI and finance businesses are the finest matches for each other. The back industry is actualizing mechanization, chatbot, versatile insights, calculation exchanging, and machine learning into budgetary forms.

AI in Information Security

o The security of information is crucial for every company and cyber-attacks are growing very quickly within the computerized world. AI can be used to form your information more secure and secure. A few illustrations such as AEG bot, AI2 Platform, are utilized to decide program bug and cyber-attacks in a better way.

Manufacturing:

AI-powered robots work adjacent to people to perform a limited run of errands like stacking and prescient

AI in Social Media

o Social Media locales such as Facebook, Twitter, and Snapchat contain billions of client profiles, which need to be stored and overseen in a very efficient way. AI can organize and oversee massive amounts of information. AI can analyses parts of information to distinguish the most recent patterns, hashtags, and prerequisites of different users.

AI in Robotics:

o Manufactured Insights contains a momentous part in Robotics. Ordinarily, general robots are modified such that they can perform a few monotonous task, but with the offer assistance of AI, we can make brilliant robots that can perform errands with their claim encounters without pre-programmed.

AI in E-commerce

o AI is giving a competitive edge to the e-commerce industry, and it is getting to be more requesting within the e-commerce trade. AI is helping shoppers to find related items with suggested measures, color, or even brands.

CONCLUSIONS

To begin with, we ought to be arranged for a alter. Our traditionalist ways stand in the way of progress. AI may be a modern step that's exceptionally helpful to the society. Machines can do employments that require nitty gritty instructions followed and mental alertness. AI with its learning capabilities can finish those errands but as it were if the worlds conservatives are prepared to alter and allow this to be a plausibility.

Secondly, we must be prepared to memorize almost the capabilities of AI. The more utilize we get out of the machines the less work is required by us. In turn less injuries and stretch to human creatures. Human bare a species that learn by attempting, and we must be arranged to give AI a chance seeing AI as a favoring, not an inhibition.

At last, we require to be arranged for the most noticeably awful of AI. Something as progressive as AI is beyond any doubt to have numerous wrinkles to work out. There are so numerous things that can go wrong with a new system so we must be as arranged as we are able be for this modern innovation.

AI programs can outflank human specialists. Presently the extraordinary challenge of AI is to discover ways of speaking to the commonsense information and involvement that empower individuals to carry out everyday activities such as holding a wide-ranging conversation or finding their way along an active street.

Be that as it may, indeed in spite of the fact that the fear of the machines is there, their capabilities are interminable Anything we teach AI, they will suggest within the future in the event that a positive outc arrives from it. AI are like children that have to be taught to be kind, well-mannered, and shrewd. On the off chance that they are to make vital decisions, they should be shrewd. We as citizens have to be made beyond any doubt AI programmers are keeping things on the level. We ought to be sure they are doing the job correctly so that no future mischances happen.

REFERENCES:

[1] Knight, W. (2017, January 04). What to expect of artificial intelligence in 2017. Retrieved

[2] November 23, 2017, from https://www.technologyreview.com/s/603216/5-big-predictions-for-

[3] artificial-intelligence-in-20Apple introduces us to Siri, the Killer Patent. (2012, January 19). Retrieved November 25, 2017,

[4] from http://www.patentlyapple.com/patently-apple/2012/01/apple-introduces-us-to-siri-the-

[5] killer-patent.html

[6] Collins, J., Youngdahl, B., Jamison, S., Mobasher, B., & Gini, M. (1998). A market architecture for multi-agent contracting. Minneapolis: K. Sycara and M. Wooldridge (eds).

Exploring the ChatGPT and How It Affects Different Educational Fields of study

Madan Pal Singh

Assistant Professor,
Department Of ECE
JB Institute of Technology , Dehradun

INTRODUCTION

Have you ever communicated with a chatbot whose replies were nearly human-like? Or have you ever utilized a language translation program that correctly rendered difficult words and sentences? If so, you may have already felt the impact of ChatGPT, a ground-breaking innovation that is revolutionizing how we interact with both machines and one another. ChatGPT, a language model created by Open AI, employs cutting-edge artificial intelligence methods to provide natural language answers for human input or prompts. Its effects have been felt in a variety of industries, including the creation of content, customer service, and natural language processing. In this investigation and examination of ChatGPT, we will look at its features, pros, cons, and impact on many disciplines. Come along with us as we explore the intriguing world of ChatGPT and see how it is transforming our lives.

FEATURES OF CHATGPT

Automated dialogues: Customers may connect with a chatbot using Chat GPT without needing a human operator thanks to automated conversations that are made possible by Chat GPT. The system is able to quickly and accurately provide results based on patterns and correlations in the data it was trained on. It's a helpful tool for businesses and organizations who want automated customer assistance or linguistic services.

Better Customer Service: Chat GPT may enhance customer service dramatically by promptly and accurately responding to consumer inquiries. Customers may get the assistance they require quickly, which can boost their pleasure and loyalty.

Cost-Effective: Being able to conduct customer service contacts with Chat GPT without having to hire human operators is a cost-effective strategy. As a result, businesses, especially those who deal with a lot of customer support enquiries, may see significant cost savings.

Language Translation: Chat GPT's text translation feature makes it a useful tool for international communication. Users may seamlessly and effectively communicate across language boundaries because to the system's accurate real-time translation of the text.

Personalized Responses: Chat GPT can offer personalized replies by keeping track of user preferences and configuring its responses accordingly. Users may find this feature to be more engaging and fulfilling as a result of their perception that the system can comprehend and cater to their particular demands.

Customizability: ChatGPT may be customized for certain tasks or applications by changing its training materials and procedures. This versatility makes Chat GPT an extremely versatile and adaptive tool since it enables businesses and organizations to modify the responses to suit their own needs.

Scalability: Chat GPT has a great degree of scalability, which enables it to manage several conversations at once after training. Due to its ability to swiftly handle massive volumes of information, it is suited for use in large-scale applications.

PROS, CONS,AND LIMITATIONS OF CHATGPT

The invention of Chat GPT, a ground-breaking technology that creates human-like replies to natural language requests, is a result of developments in artificial intelligence. While Chat GPT provides several benefits, like scalability and natural language production, there are also some drawbacks to take into account. We shall get more into the Pros and Cons of Chat GPT in this section.

Pros

1. ChatGPT's natural language generation capability generates coherent, human-like responses, making it useful for applications like customer service chatbots and language translation. This leads to more meaningful, engaging conversations, improving user experience and satisfaction.
2. ChatGPT's scalability enables quick responses and handling large volumes of conversations, making it ideal for automated customer service and language translation services, reducing human intervention and improving user satisfaction.
3. ChatGPT's customizability allows for tailored responses to specific tasks, improving customer satisfaction and loyalty. By adjusting training data and algorithms, it enables businesses to create personalized experiences, enhancing overall user experience.
4. ChatGPT offers efficiency in customer service and language translation by quickly generating responses and handling multiple conversations, saving time and money. This helps businesses increase productivity and profitability.

Cons

1. ChatGPT faces potential bias in responses due to large datasets, resulting in stereotypes or discrimination.
2. ChatGPT struggles with emotional intelligence, causing tone-deafness or insensitivity in responses.
3. ChatGPT's limited knowledge base may cause inaccurate or false responses to user queries.
4. ChatGPT's lack of empathy may hinder user experience.

Limitations

1. Chat GPT's limited dialogue options may hinder meaningful conversations and unsatisfying natural responses for some users, limiting their engagement.

2. Chat GPT faces challenges in natural language processing, causing users to struggle to interpret responses and misinterpret human language despite advanced algorithms.
3. Chat GPT lacks context, potentially causing inaccurate responses and hindering useful user queries. Understanding context improves its performance.
4. Chat GPT's domain knowledge limits its usefulness for specialized topics, making it less useful for users seeking information outside its domain.
5. Chat GPT struggles to recognize emotional cues, resulting in inappropriate or insensitive responses due to its inability to understand conversation context.

IMPACT OF CHATGPT ON DIFFERENT FIELDS

1. Academic: ChatGPT has the potential to revolutionize academics by providing personalized, interactive explanations, saving time and effort for teachers. It can also grade assignments,

provide automated feedback, and develop innovative projects like interactive games and intelligent tutors.
2. Cyber Security: ChatGPT significantly impacts cyber security by detecting and preventing attacks, identifying phishing emails, detecting malware, and creating secure passwords using language analysis. It also helps create complex, unique passwords, making them difficult to guess.
3. Customer Support:ChatGPT improves customer support services by offering individualized support through virtual agents who comprehend consumer demands and react appropriately. Additionally, it helps create automated systems that quickly identify possible problems and propose solutions, empowering intelligent customer support representatives to deliver specialized assistance and guidance.
4. HealthCare: ChatGPT can enhance healthcare services by providing personalized assistance to doctors and healthcare professionals. It can develop automated systems, intelligent health systems, and virtual agents for personalized health advice and support. Chatbots' direct patient interaction and privacy concerns can significantly improve the healthcare sector.
5. Information Technology: By facilitating information access and usage, ChatGPT has revolutionised IT. Customer service, healthcare, and e-commerce are just a few of the sectors where it has become commonplace. Advanced search engines and recommendation systems are made possible by ChatGPT's usage of NLP technology to comprehend and react to user queries. Furthermore, it creates fresh opportunities for data analysis and cybersecurity, allowing IT specialists to recognise dangers earlier and take quicker action. However, ChatGPT may displace customer assistance positions, possibly saving businesses money and personnel levels.
6. Software development: By incorporating natural language processing (NLP) capabilities, ChatGPT has a substantial influence on software development, making applications more interactive and user-friendly. With the aid of this technology, developers may build complex chatbots that can comprehend consumer inquiries from a human perspective and include AI and machine learning techniques. The code output of ChatGPT is exceptional, helping developers and dislodging Stack Overflow.
7. Researchers and Scholars: ChatGPT revolutionized natural language processing and artificial intelligence research by enabling researchers to develop and test new models, analyse large text data, create advanced chatbots and conversational agents, and collaborate on data sharing and analysis. It also enables access to diverse datasets for various purposes.

CONCLUSION

Finally, ChatGPT is an innovative technology that has radically changed how people communicate with one another and with machines. Its versatility, effectiveness, and flexibility to be customized make it the perfect tool for a variety of applications, and thanks to its expertise with natural language processing, it can respond to user enquiries in a way that is human-like. With proper training data selection and further programming, ChatGPT's many drawbacks, such as the possibility of discrimination, a lack of emotional intelligence, and a constrained knowledge base, may be avoided. I'll sum up by noting the considerable influence ChatGPT has had on a variety of industries, including academia, cyber security, customer service, and software development. Researchers are only starting to investigate its vastness.

REFERENCES

[1] Agrawal, A., Gans, J., & Goldfarb, A. (2022, December 12). ChatGPT and How AI Disrupts Industries. Harvard Business Review. https://hbr.org/2022/12/chatgpt-and-how-ai-disrupts-industries

[2] Altaf, Y. (2023, March 7). 5 Ways ChatGPT Will Impact Digital Marketing. Entrepreneur. https://www.entrepreneur.com/growing-a-business/5-ways-chatgpt-will-impact-digital-marketing/446208

[3] Biswas, S. S. (2023). Potential Use of Chat GPT in Global Warming. Annals of Biomedical Engineering. https://doi.org/10.1007/s10439-023-03171-8

[4] Diaz, M. (2023). How to use ChatGPT: Everything you need toknow. ZDNET. https://www.zdnet.com/article/how-to-use-chatgpt/

[5] Else, H. (2023). Abstracts written by ChatGPT fool scientists. Nature. https://doi.org/10.1038/d41586-023-00056-7

[6] Kalla, Dinesh and Smith, Nathan, Study and Analysis of Chat GPT and its Impact on Different Fields of Study (March 1, 2023). International Journal of Innovative Science and Research Technology Volume 8, Issue 3, March – 2023, Available at SSRN: https://ssrn.com/abstract=4402499

[7] Lund, B. D., & Wang, T. (2023). Chatting about ChatGPT: how may AI and GPT impact academia and libraries? Library Hi Tech News.

[8] https://doi.org/10.1108/lhtn-01-2023-0009

[9] Mandelaro, J. (2023, February 27). How will AI chatbots like ChatGPT affect higher education? News Center. https://www.rochester.edu/newscenter/chatgpt-artificial-intelligence-ai-chatbots-education-551522/

[10] Mok, A., &Zinkula, J. (2023, February 2). ChatGPT may be coming for our jobs. Here are the 10 roles that AI is most likely to replace. Business Insider Africa. https://africa.businessinsider.com/news/chatgpt-may-be-coming-for-our-jobs-here-are-the-10-roles-that-ai-is-most-likely-to/grmgtk3

[11] Movement, Q. ai-Powering a P. W. (2023). What Is ChatGPT? How AI Is Transforming Multiple Industries. Forbes. https://www.forbes.com/sites/qai/2023/02/01/what-is-chatgpt-how-ai-is-transforming-multiple-industries/?sh=64e915ce728e

Sachdev, S. (2023). ChatGPT and its Impact on Society. The Times of India. https://timesofindia.indiatimes.com/readersblog/marketing-savvy/chatgpt-and-its-impact-on-society-50445/

IoT's Effect on Electronics: Revolutionizing Connectivity and Efficiency

Jitesh Kumar

Assistant Professor,
Department Of ECE
JB Institute of Technology , Dehradun,

ABSTRACT

The convergence of the Internet of Things (IoT) and Artificial Intelligence (AI) has given rise to a new era of intelligent and autonomous systems. This research paper explores the integration of IoT and AI, examining their synergistic relationship and the transformative impact on various domains. It investigates how the combination of IoT and AI technologies enables the development of intelligent and autonomous systems that can perceive, reason, learn, and act in real-time. The paper discusses the applications, benefits, challenges, and future prospects of this integration, shedding light on the potential of creating a truly interconnected and intelligent world.

Keywords-Internet of Things (IoT), Artificial Intelligence (AI),Radio Frequency Identification RFID

INTRODUCTION

The rapid advancement of technology in recent years has brought forth groundbreaking innovations, with two key domains leading the way: the Internet of Things (IoT) and Artificial Intelligence (AI). The IoT refers to the network of interconnected physical devices, vehicles, buildings, and other objects embedded with sensors, software, and connectivity capabilities that enable them to collect and exchange data. On the other hand, AI encompasses the development of intelligent systems capable of perceiving, reasoning, learning, and making decisions based on data.

Individually, IoT and AI have already demonstrated their transformative potential in various fields. However, the convergence of these two technologies has unlocked new possibilities for creating intelligent and autonomous systems. The integration of IoT and AI empowers devices and machines to not only collect vast amounts of data but also analyse it in real-time, learn from it, and take actions accordingly. This combination enables the development of intelligent systems that can adapt, automate, and optimize their operations without explicit human intervention.

The objective of this research paper is to explore the integration of IoT and AI, focusing on the creation of intelligent and autonomous systems. By examining the synergistic relationship between these technologies, we aim to understand the applications, benefits, challenges, and future prospects of this integration across various domains. Through an in-depth analysis of real-world examples and existing research, we can gain insights into the potential of this convergence to shape the future of technology-driven industries and societies.

IOT AND AI: KEY CONCEPTS AND TECHNOLOGIES

The integration of the Internet of Things (IoT) and Artificial Intelligence (AI) involves combining the capabilities of IoT devices with AI algorithms and techniques. This convergence opens up new possibilities for creating intelligent and autonomous systems that can perceive, reason, learn, and make decisions based on real-time data. To delve deeper into this integration, let's explore the key concepts and technologies associated with IoT and AI.

IoT Concepts and Technologies

a. Sensor Technology: Sensors are essential components of IoT devices as they capture data from the physical environment. Various types of sensors, such as temperature, humidity, pressure, motion, and proximity sensors, are used to monitor and collect real-time data.

b. Connectivity: IoT devices rely on different communication technologies to connect and share data. These include Wi-Fi, Bluetooth, Zigbee, RFID (Radio Frequency Identification), cellular networks, and LPWAN (Low-Power Wide Area Networks). Connectivity options depend on factors like range, power consumption, bandwidth requirements, and data transfer rates.

c. Cloud Computing: Cloud platforms play a vital role in IoT by providing scalable and cost-effective storage, processing, and analytics capabilities. They enable the storage and retrieval of large volumes of data generated by IoT devices, as well as facilitate real-time data analysis and machine learning algorithms.

d. Edge Computing: Edge computing brings computational capabilities closer to IoT devices at the network edge. By performing data processing, analysis, and decision-making at or near the source of data generation, edge computing reduces latency, optimizes bandwidth usage, and enhances real-time responsiveness.

AI CONCEPTS AND TECHNOLOGIES

a. Machine Learning: Machine learning algorithms enable systems to automatically learn patterns, make predictions, and derive insights from data without being explicitly programmed. Supervised learning, unsupervised learning, and reinforcement learning are common techniques used in IoT-AI applications.

b. Deep Learning: Deep learning is a subset of machine learning that involves neural networks with multiple layers. It allows systems to learn and extract complex features and representations from large-scale data, enabling more sophisticated pattern recognition and decision-making.

c. Natural Language Processing (NLP): NLP focuses on enabling machines to understand and process human language. It involves tasks like speech recognition, language translation, sentiment analysis, and chatbot interactions, enhancing human-computer interactions in IoT applications.

d. Computer Vision: Computer vision techniques enable machines to analyse and interpret visual data from images and videos. It involves tasks like object detection, image classification, facial recognition, and video analytics, enabling IoT devices to "see" and understand their surroundings.

e. Reinforcement Learning: Reinforcement learning is a branch of AI that involves training systems to make sequential decisions through interactions with an environment. It enables IoT systems to learn and adapt their behaviours based on feedback and rewards, leading to autonomous decision-making.

The combination of IoT and AI leverages these concepts and technologies to create intelligent and autonomous systems. IoT devices equipped with sensors and connectivity collect and transmit data, while AI algorithms analyse this data to extract insights, learn from patterns, and make informed decisions. By integrating IoT and AI, these systems can autonomously optimize operations, predict events, detect anomalies, and provide personalized experiences across various domains.

INTEGRATION OF IOT AND AI IN VARIOUS DOMAINS

The integration of the Internet of Things (IoT) and Artificial Intelligence (AI) has the potential to revolutionize multiple domains, enabling intelligent and autonomous systems. Let's explore how the combination of IoT and AI is being applied in various sectors:

1.Smart Homes and Intelligent Energy Management: IoT devices, such as smart thermostats, lighting systems, and appliances, are integrated with AI algorithms to optimize energy consumption based on user preferences and real-time data. AI-driven home automation systems enable personalized comfort, efficient energy usage, and cost savings.

2.Industrial IoT and Autonomous Manufacturing: In industrial settings, IoT sensors and AI algorithms are combined to monitor and control manufacturing processes in real-time. This integration enables predictive maintenance, quality control, inventory optimization, and autonomous decision-making, leading to increased productivity, reduced downtime, and cost savings.

3.Intelligent Transportation Systems and Smart Cities: IoT sensors embedded in vehicles, roads, and infrastructure, along with AI algorithms, facilitate real-time traffic monitoring, congestion prediction, adaptive signal control, and autonomous vehicle management. This integration enhances traffic efficiency, reduces accidents, and paves the way for smart city initiatives.

4.Healthcare and Remote Patient Monitoring: IoT devices, wearables, and medical sensors connected to AI-driven systems enable continuous monitoring of patients' vital signs, medication adherence, and disease progression. AI algorithms analyse the collected data to provide real-time alerts, personalized treatment plans, and early disease detection, enhancing healthcare outcomes.

5.Agriculture and Precision Farming: IoT sensors deployed in agricultural fields, combined with AI analytics, enable precise monitoring of soil moisture, temperature, nutrient levels, and crop health. This integration facilitates optimized irrigation, pest management, crop yield prediction, and resource utilization, leading to improved productivity and sustainable farming practices.

6.Retail and Personalized Customer Experiences: IoT sensors, beacons, and AI algorithms are integrated to capture and analyse customer data, enabling personalized recommendations, targeted marketing campaigns, and improved inventory management. This integration enhances customer engagement, satisfaction, and operational efficiency in retail environments.

7.Smart Grids and Energy Management: IoT devices integrated with AI algorithms enable real-time monitoring, analysis, and control of energy generation, distribution, and consumption. This integration optimizes energy grids, balances supply and demand, and facilitates efficient energy usage, leading to reduced costs and increased sustainability.

By integrating IoT and AI, these domains benefit from real-time data collection, intelligent analysis, and autonomous decision-making. This convergence enhances efficiency, productivity, resource optimization, cost reduction, and personalized experiences, transforming industries and enabling the vision of interconnected and intelligent systems.

However, the integration of IoT and AI also presents challenges, including data privacy and security, scalability, interoperability, ethical considerations, and the need for robust AI algorithms. Addressing these challenges will be crucial for the widespread adoption and responsible deployment of intelligent and autonomous systems across various domains.

BENEFITS OF IOT-AI INTEGRATION

The integration of the Internet of Things (IoT) and Artificial Intelligence (AI) brings forth a range of benefits across various domains. By combining real-time data collection and analysis capabilities with intelligent decision-making, IoT-AI integration enables the development of intelligent and autonomous systems. Let's explore some of the key benefits:

1.Real-Time Data Analysis and Decision-Making: IoT devices generate vast amounts of data in real-time. By integrating AI algorithms, this data can be analysed and processed instantly, enabling real-time insights and decision-making. This capability enhances efficiency, enables proactive actions, and improves response times in critical situations.

2.Predictive Maintenance and Proactive Interventions: IoT-AI integration enables predictive maintenance by analysing sensor data and identifying patterns that indicate potential equipment failures or maintenance requirements. This proactive approach helps avoid unplanned downtime, reduces maintenance costs, and improves the overall lifespan of assets.

3.Improved Efficiency and Productivity: AI algorithms can analyse IoT data to identify inefficiencies, optimize processes, and automate routine tasks. This integration leads to streamlined operations, reduced manual effort, and increased productivity in industries such as manufacturing, logistics, and energy management.

4.Enhanced Personalization and User Experience: IoT devices collect data about user preferences, behaviours, and context. AI algorithms can analyse this data to provide personalized recommendations, tailored experiences, and adaptive services. This integration enhances customer satisfaction, engagement, and loyalty across sectors like retail, entertainment, and healthcare.

5.Increased Automation and Autonomy: IoT-AI integration enables the development of autonomous systems capable of making intelligent decisions and taking actions without explicit human intervention. This leads to increased automation in various domains, including autonomous vehicles, smart homes, and industrial processes, resulting in operational efficiency and reduced human error.

6.Smarter Resource Utilization: By analysing IoT data, AI algorithms can optimize resource utilization in sectors such as agriculture, energy management, and water distribution. This integration enables precision farming practices, efficient energy grids, and optimized resource allocation, leading to sustainability and reduced environmental impact.

7.Data-Driven Insights and Business Intelligence: IoT-AI integration allows organizations to gain valuable insights from the vast amounts of data generated by IoT devices. AI algorithms can uncover patterns, correlations, and trends that lead to data-driven decision-making, improved business intelligence, and strategic planning.

8.Adaptive and Self-Learning Systems: AI algorithms integrated with IoT devices can learn and adapt to changing environments, user preferences, and data patterns. This adaptive capability enables systems to continuously improve their performance, adjust to new conditions, and provide personalized experiences.

CHALLENGES AND CONSIDERATIONS

While the integration of the Internet of Things (IoT) and Artificial Intelligence (AI) brings significant benefits, there are several challenges and considerations that need to be addressed for successful implementation. These challenges include:

1.Data Privacy and Security: IoT generates a massive volume of data, often containing sensitive information. Ensuring data privacy and security throughout the IoT-AI ecosystem is essential. Safeguarding data from unauthorized access, ensuring secure communication channels, and implementing robust encryption mechanisms are crucial considerations.

2.Ethical Implications: The use of AI algorithms in IoT raises ethical concerns related to data privacy, bias, transparency, and accountability. There is a need to develop ethical frameworks and guidelines to govern the design, deployment, and use of AI-enabled IoT systems, ensuring fairness, transparency, and responsible decision-making.

3.Scalability and Interoperability: IoT deployments involve a diverse range of devices, protocols, and platforms. Ensuring interoperability and seamless integration among different IoT devices and systems is a complex challenge. Scalability, both in terms of handling large-scale deployments and accommodating future growth, is also a consideration that needs to be addressed.

4.Robustness and Reliability of AI Algorithms: AI algorithms used in IoT applications need to be robust and reliable. Ensuring that algorithms can handle real-world scenarios, adapt to changing conditions, and provide accurate predictions and decisions is essential. Ongoing monitoring, testing, and optimization of AI models are necessary to maintain their performance and reliability.

5.Integration Complexities and System Integration: Integrating IoT and AI involves combining hardware, software, connectivity, and data analytics components. Managing the complexities of integrating these different technologies and ensuring seamless communication among them can be challenging. Proper system integration, including data flow management, protocol standardization, and interoperability, is crucial for successful IoT-AI integration.

6.Data Quality and Management: IoT generates vast amounts of data from diverse sources. Ensuring data quality, accuracy, and integrity are crucial for reliable analysis and decision-making. Effective data management strategies, including data cleaning, preprocessing, storage, and efficient data retrieval, are essential considerations for IoT-AI systems.

7.Power Consumption and Energy Efficiency:IoT devices often operate on limited power sources, such as batteries or energy harvesting mechanisms. Integrating AI capabilities into IoT devices can increase power consumption. Balancing the need for AI processing with energy efficiency is crucial to ensure sustainable operation and avoid frequent device recharging or replacement.

Addressing these challenges and considerations requires collaborative efforts from researchers, industry professionals, policymakers, and regulatory bodies. Continued research, development of standards, and the establishment of best practices can help overcome these challenges and ensure the responsible and successful integration of IoT and AI.

Furthermore, addressing these challenges will contribute to building trust among users, enhancing data privacy and security, enabling ethical and responsible AI deployment, and maximizing the potential benefits of IoT-AI integration.

FUTURE DIRECTIONS AND OPPORTUNITIES

The integration of the Internet of Things (IoT) and Artificial Intelligence (AI) has already demonstrated its transformative potential across various domains. Looking ahead, several future directions and opportunities emerge in the field of IoT-AI integration:

1.Advances in AI Algorithms for IoT Applications: Future research will focus on developing advanced AI algorithms tailored specifically for IoT applications. These algorithms will address challenges such as real-time processing, energy efficiency, interpretability, and adaptability to changing environments. Techniques like federated learning, edge AI, and lightweight models will be explored to enable efficient AI processing on resource-constrained IoT devices.

2.Edge AI and Distributed Intelligence: Edge computing, where AI processing occurs closer to the data source, will gain prominence. By bringing AI capabilities to the edge of the network, latency can be reduced, data privacy can be enhanced, and real-time decision-making can be improved. Distributed intelligence, combining edge devices and cloud resources, will enable collaborative and decentralized AI systems.

3.Human-AI Collaboration and Symbiotic Systems: The future will witness increased collaboration between humans and AI-powered IoT systems. Symbiotic systems, where humans and AI work together seamlessly, will become more prevalent. This collaboration will enable human expertise to complement AI capabilities, ensuring responsible decision-making, ethical considerations, and addressing complex scenarios that require human judgment.

4.Ethical and Responsible AI in IoT Deployments: As IoT-AI applications continue to evolve, the ethical implications of these technologies become increasingly important. Future research will focus on developing ethical frameworks, guidelines, and regulations to ensure responsible AI deployment.

Considerations such as transparency, fairness, accountability, and bias mitigation will be crucial to address ethical concerns.

5.IoT-AI in Shaping Smart Cities and Societies: IoT-AI integration will play a significant role in building smart cities and smart societies. Real-time data collection, AI analytics, and intelligent decision-making will enable optimized resource utilization, efficient transportation systems, sustainable energy management, improved healthcare services, and enhanced citizen engagement. The future will witness increased collaboration between IoT and AI to shape the cities of tomorrow.

6.Adoption of Standards and Interoperability: Standardization efforts will continue to play a vital role in ensuring interoperability among IoT devices and AI systems. The development and adoption of common protocols, communication standards, and data formats will facilitate seamless integration and exchange of data across different IoT platforms and AI technologies.

7.Privacy-Preserving AI for IoT: Future research will focus on privacy-preserving AI techniques for IoT applications. Privacy-enhancing technologies, such as federated learning, secure multiparty computation, and differential privacy, will be explored to enable AI processing while preserving data privacy and protecting sensitive information.

8.Continuous Learning and Adaptive Systems: IoT-AI systems will evolve into continuous learning and adaptive systems. AI algorithms will continuously update and improve based on real-time data, evolving user needs, and changing environments. This adaptability will enable IoT systems to dynamically adjust their behaviours, optimize operations, and deliver personalized experiences.

These future directions and opportunities will shape the evolution of IoT-AI integration, unlocking new possibilities for innovation, efficiency, and sustainability. By harnessing the power of IoT and AI in a responsible and ethical manner, we can create intelligent and interconnected systems that improve lives, drive economic growth, and address complex societal challenges.

CONCLUSION

The integration of the Internet of Things (IoT) and Artificial Intelligence (AI) has emerged as a powerful combination, enabling the development of intelligent and autonomous systems across various domains. This research paper has explored the applications, benefits, challenges, and future prospects of IoT-AI integration.

The convergence of IoT and AI offers numerous benefits, including real-time data analysis and decision-making, predictive maintenance, improved efficiency and productivity, enhanced personalization, increased automation and autonomy, smarter resource utilization, data-driven insights, and adaptive systems. These benefits have the potential to revolutionize industries, optimize operations, and deliver enhanced user experiences.

However, the integration of IoT and AI also presents challenges and considerations that need to be addressed. Data privacy and security, ethical implications, scalability, interoperability, robustness of AI algorithms, and system integration complexities require careful attention and proactive solutions.

Overcoming these challenges is essential for the responsible deployment and widespread adoption of IoT-AI systems.

Looking ahead, future directions and opportunities in IoT-AI integration include advances in AI algorithms for IoT applications, the emergence of edge AI and distributed intelligence, human-AI collaboration, ethical considerations, smart city development, adoption of standards, privacy-preserving AI, and the evolution of continuous learning and adaptive systems. These directions and opportunities will shape the future of IoT-AI integration, driving innovation, efficiency, and sustainability.

In conclusion, the integration of IoT and AI holds immense potential to create intelligent and interconnected systems that can transform industries, optimize resource utilization, and deliver personalized experiences. By addressing challenges, embracing ethical practices, and seizing future opportunities, we can harness the power of IoT and AI to shape a future where intelligent and autonomous systems drive economic growth, improve quality of life, and address complex societal challenges.

REFERENCES

(11) Sfar AR, Zied C, Challal Y. A systematic and cognitive vision for IoT security: a case study of military live simulation and security challenges. In: Proc. 2017 international conference on smart, monitored and controlled cities (SM2C), Sfax, Tunisia, 17–19 Feb. 2017.

(12) Gatsis K, Pappas GJ. Wireless control for the IoT: power spectrum and security challenges. In: Proc. 2017 IEEE/ACM second international conference on internet-of-things design and implementation (IoTDI), Pittsburg, PA, USA, 18–21 April 2017. INSPEC Accession Number: 16964293.

(13) Zhou J, Cap Z, Dong X, Vasilakos AV. Security and privacy for cloud-based IoT: challenges. IEEE Commun Mag. 2017;55(1):26–33.

(14) Sfar AR, Natalizio E, Challal Y, Chtourou Z. A roadmap for security challenges in the internet of things. Digit Commun Netw. 2018;4(1):118–37.

(15) Everett, H.R. (1995). Sensors for Mobile Robots: Theory and Application. A K Peters, Ltd, MA, USA.

(16) Diegel, O.; Badve, A.; Bright, G.; Potgieter, J. &Tlatle, S. (2002). Improved Mecanum Wheel Design for Omni-directional Robots, Proc. 2002 Australian Conference on Robotics and Automation, Auckland, 27-29 Nov. 2002, pp. 117-121.

(17) Borenstein, J.; Everett, H.R. &Feng, L. (1996). Navigating Mobile Robots: Sensors and Omni directional Mobile Robot – Design and Implementation IoanDoroftei, Victor Grosu and VeaceslavSpinu “Gh. Asachi” Technical University of Iasi Romania Techniques. A K Peters, Ltd, MA, USA.

(18) IoanDoroftei; Victor Grosu and VeaceslavSpinu; “Omnidirectional mobile robot- Design and Implimentation” from “Gh.Asachi” Technical university of lasi, Romania.

(19) Weber RH. Internet of things-new security and privacy challenges. Comput Law Secur Rev. 2010;26(1):23–30.

(20) Internet of Things research study: Hewlett Packard Enterprise Report. 2015.

An Outlook on Ant Colony Mechanism using Wi-Fi Sensor Network

Laxman Singh

Assistant Professor,

Department Of ECE

JB Institute of Technology , Dehradun,

ABSTRACT

A wireless sensor network (WSN) is a network made up of a significant number of ad hoc, self-organizing nodes. They are frequently employed for controlling and monitoring environmental factors. In WSNs, this is referred to as data distribution or reprogramming.

Since most WSNs are installed in hostile environments and manual reprogramming of such nodes is not practicable, dissemination procedures are essential. Over time, numerous protocols for disseminating data have been developed, and each one aids in the distribution of programmed code, configuration parameters, inquiries, commands, bulk data, etc. The purpose of the work in this paper is to present a brand-new, flexible, and intelligent routing method for wireless sensor networks. Maximizing efficiency is the main goal of research on sensor networks. The main goal of research into sensor networks is to increase network longevity and find the quickest, most direct route between source and destination.

Key Terms-nodes, routers, wireless sensor network.

1. **INTRODUCTION**

Wireless sensor networks, an emerging topic, integrate sensing, processing, and communication into a single compact device. These gadgets create a sea of connectivity that expands the boundaries of cyber space into the real world thanks to sophisticated mesh networking protocols. The mesh networking connectivity will look for and use any available communication link by hopping data from node to node in quest of its destination, much like water flows to fill every room of a submerged ship. The capabilities of any one gadget are extremely limited, but the combination of many devices opens up completely new technological possibilities.

The capacity to deploy a huge number of micro nodes that self-assemble and construct wireless sensor networks gives them their power. Network topologies can change, and adaptation mechanisms can react to those changes by forcing the network to operate in fundamentally different ways. In the event of an emergency, the network may then point employees in the right direction. The possibilities opened up by the integration of low-power communication, sensing, energy storage, and computation is only partially explored by current wireless systems.

2. ARCHITECHTURE OF WSN

The three application classes that we have chosen are sensor node tracking, security monitoring, and environmental data collection. Most wireless sensor network installations, in our opinion, will fit into one of these class designs. A research scientist's desire to gather several sensor readings from a number of sites in an environment in order to identify trends and interdependencies is known as a canonical environmental data gathering application. This researcher would wish to gather information from hundreds of locations dispersed around the region and then do offline analysis of the information. Data gathering over several months or years would be of interest to the scientist in order to search for cyclical and long-term trends.

The nodes would need to remain in their predetermined locations, and data collection would need to take place at regular intervals in order for it to be useful. The environmental data collecting application is characterized at the network level by the presence of several nodes that continuously sense the environment and transmit data to a number of base stations that conventionally store the data. In general, these networks need extremely long lives and relatively little data rate. In a typical usage scenario, the nodes will be evenly spaced throughout an outdoor setting. Although there won't be much space separating nearby nodes, there will be a lot of space overall. In order to determine the best routing options after deployment, the nodes must first determine the network's topology.

The data can then be routed to a central collection location using the routing technique. In applications involving environmental monitoring, it is not necessary for the nodes to figure out the best routing schemes on their own. It could be able to determine the best routing topology outside of the network and then provide the relevant data to the nodes as needed. Applications for gathering environmental data generally use tree-based routing topologies with data-sinking high-capability nodes as the roots of each routing tree. Data is periodically transferred up the tree structure from kid nodes to parent nodes until it reaches the sink. Each node in a tree-based data gathering system is in charge of transmitting the data of every one of its offspring. Nodes having a lot of offspring send out a lot more information than leaf nodes. These junctions might easily develop into energy bottlenecks.

Each node periodically samples its sensors after the network has been set up, transmits its data up the routing tree, and returns to the base station. The time between these messages can range from seconds to minutes in certain situations. While networks may have substantially higher reporting rates, typical reporting intervals are anticipated to be between 1 and 15 minutes. Temperature, light intensity, and humidity are among common environmental variables that are observed, but they don't vary quickly enough to warrant more frequent reports.

3. ACO TECHNIQUE

Ant Colony optimization algorithm is based on how real ants behave when looking for food. It has been observed that when an ant leaves its house to seek food, it stores a certain amount of pheromone along the route.

Due to WSNs' distinctive properties, routing is a difficult process that differs from additional sensor networks, both wired and wireless. Since wireless links are unstable, sensor nodes can malfunction, and routing methods must adhere to tight energy-saving guidelines, the routing process in wireless sensor networks significantly differs from that of traditional routing in fixed networks. WSNs offer a variety of uses, but they are still subject to several limitations, such as a restricted energy source and limited computational and communication power. Many routing systems involving end-to-end devices and MANETs have been deemed inappropriate for WSNs due to these WSN-specific considerations. Minimizing energy use is regarded as a key performance criterion in sensor networks to ensure the longest possible network lifetime. Routing protocols need to be developed in order to ensure fault tolerance in communications as well as energy conservation. The ants are forced to follow the same course indicated by the pheromone deposit once more on their way back, and they once more leave pheromone deposits along the way.

Accordingly, the ants taking the shorter road are anticipated to return sooner and thereby increase the amount of pheromone deposit in their path more quickly than the ants taking the longer route. ACO gets inspiration from how ants behave. To identify a beneficial path that other ants in the colony should take, these ants leave pheromone deposits on the round. The pheromone deposit marks the paths that the ants usually travel, whereas the less-commonly travelled paths are forgotten due to a lack of pheromone. The agents are autonomous beings with the ability to adapt, work together, and travel logically from one place in the communication network to another. Ant agents come in two varieties: Backward ants are referred to as BANT and forward ants as FANT.

4. LITERATURE REVIEW

Combinational optimization can be used to solve the challenge of optimizing network parameters for WSN routing in order to maximize network lifetime[2]. In recent years, numerous scholars have examined the social behaviours of biological animals like ants as an analogue offering a natural model for combinatorial optimization issues. Numerous ant-based routing techniques have already been presented [5] the majority of them are based on the idea of an ant. Use the ANT Colony Optimization Algorithm (ACO), a meta-heuristic method for resolving computation-based probability concerns.

5. GOAL

In a wireless sensor network architecture, the objective is to offer a fresh and flexible intelligent routing system. It can be possible by only

*Maximizing the network lifetime and

*By finding the quickest and most efficient route between source and destination.

6. METHODOLOGY

In this piece, a methodology has been put up that is based on how ants forage for food. How ants navigate to their meal and return to the nest has been seen. The shortest path from the nest is typically the one taken by the ants. Ants sent out in quest of food from their nest and the ant follows the same path back to its nest as it did before it found its food.When travelling, these ants leave behind a chemical called pheromone on the ground. Because pheromone is a volatile molecule, its concentration wanes over time. Other ants pick the path with the highest concentration of pheromone after sensing this pheromone. Additionally, as they return, these ants leave behind pheromones.

The shortest path would have more pheromone concentration since more ants would have travelled along it compared to other paths. An ant initially has no preference for which path to choose and follows each one with an equal likelihood. But after a while, the ants would choose the route with the highest concentration of pheromones. Due to the fact that more ants would have used this route than any other, it would be the shortest among alternate route in the specified amount of time. The suggested ant-based routing method has a number of steps mentioned below.

The suggested strategy is as follows:

(i) The nodes must be deployed first.

(ii)Nodes come in two varieties: forward ants and backward ants.

(iii)The Forward ants are sent out from the Ant Colony to look for the food supply, and they keep looking until they find it.

(iv)The Backward-ant agents have now begun their journey to the ant colony.

(v)The new ants will take the quickest route to the food supply after the backward agents have reached the ant colony.

We will receive the quickest route from source to destination as a result of this operation.

If a node along the path becomes defective for any reason, such as energy loss or hardware failure, the node just ahead of the faulty node will wait for a Route Clear Message from the faulty node. If the message does not arrive, the information will be stored on the node that makes the alternate shortest path. Now, the second path will be used for data communication.

7. RESULTS OF EXPERIMENTS

The benefits of the suggested strategy have been examined in this part through NS2 simulations, and the experimental findings are reported. Given that the energy usage is kept to a minimum, the experimental results are perfectly justified.

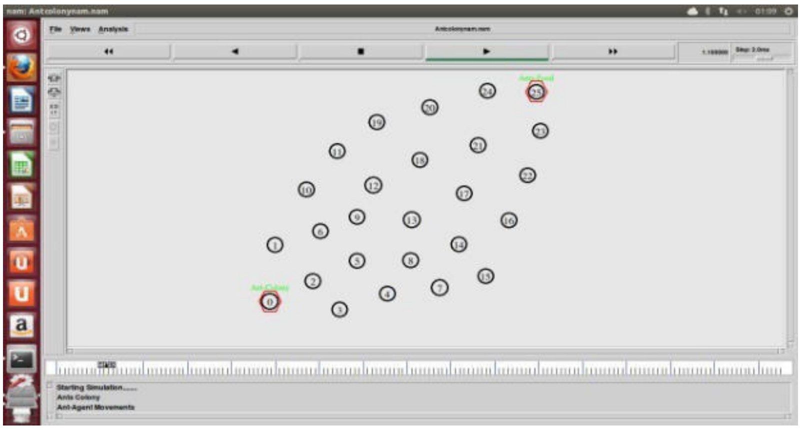


Fig. 1 shows the wireless sensor nodes in a network.

Node 0 is assumed to be an ant colony, while node 25 is assumed to be a food supply. The shortest path must be used by the ant agents to travel from node-0 to node-25.

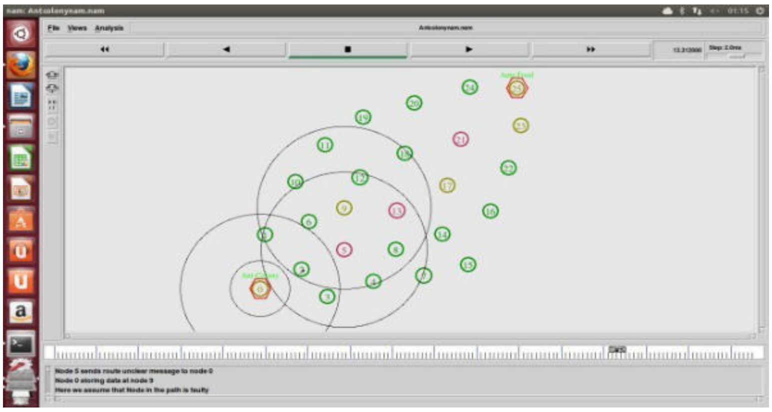


Fig.2 the forward ants are forwarded towards the food source. The routing is taking place.

8.CONCLUSION

This work suggests a routing algorithm based on ant colony optimization. In a WSN, the network's longevity is mostly dependent on the number of sensors present and their pace of communication, both of which have an impact on the battery's capacity. The major goal of the effort is to maximize network life while effectively achieving data transmission. The WSN's lifetime network is actively improved by this solution. The testing demonstrated that the algorithm produces excellent outcomes in various WSN settings. Future research will decide on optimal WSNs settings, a routing network with many sink nodes, and topology changes in such a way that an energy-constrained environment to further improves the suggested routing protocol for high mobility nodes. Additionally, the work can be evaluated in a real-world setting, and its performance can be assessed using a variety of situations.

9. REFERENCES

[1] Fatemeh Rismanian Yazdi, "Ant Colony with Coloured Pheromones Routing For Multi- Objectives Quality of Services in WSNs," International Journal of Research in Computer Science, Volume 3 Issue 1, pp. 1–9, 2013.

[2] Routing Based Ant Colony Optimisation in Wireless Sensor Networks, Anjali & Navpreet Kaur (2013), Global Journal of Computer Science and Technology Network, Web & Security2013 Volume 13 Issue 4 Version 1.0.

[3] "Energy Efficiency Performance Improvements for Ant-Based Routing Algorithms in Wireless Sensor Networks", Adamu Murtala Zungeru, Kah Phooi Seng, Li-Minn Ang, and Wai Chong Chia (2013), Hindawi Publishing Corporation Journal of SensorsVolume2013, ArticleID759654,17 pages

[4] "Wireless Sensor Network (WSN): Architecture, Design Issues, and Challenges," International Journal of Computer Science and Engineering, Vol. 02, No. 09, 2010, 3089-3094 by Ajay Jangra, Swati, Richa, and Priyanka.

[5] AdamuMurtalaZungeru, Li-MinnAngKahPhooiSeng, "Classicaland swarm intelligencebased routingprotocolsforwirelesssensornetworks: Asurveyandcomparison", Journal of Network and Computer Applications, Vol. 35 (2012), 1508–1536.

[6]AtanuRoyChowdhury,Jason,Waterman,"ACORoutinginWirelessSensorNetworks",InternationalJournalofResearchinComputerScience,ISSN2249-8265Volume4Issue1(2014)pp. 1-9.

[7] DebasmitaThe article "AntColonyOptimization Technique Applied in Network Routing Problem" by Sriyankar Acharyya Mukherjee was published in the International Journal of Computer Applications (0975-8887) Volume 1 - No. 15.

[8]A Survey on Artificial Intelligence for Network Routing Problems by HaoBai.

[9] JamalN.Al-Karaki AhmedE. Jamal, "RoutingTechniquesinWireless SensorNetworks:ASurvey".

A Survey of Neuromorphic Learning VLSI Systems

Jitesh Kumar

[1,2]Assistant Professsor,

JBIT, 23 Milestone, Chakrata Road, Shankarpur,

ABSTRACT

The development of hardware learning and adaptation in synthetic neural systems is reviewed in this chapter. In the past ten years, research in the field has increased, finding inspiration from several fields of science and engineering. This review includes information on neural models, implementation methods, architectural restrictions, and hardware learning application systems.

1.Introduction

The term "neuromorphic engineering" was first coined by Carver Mead [1] to describe an interdisciplinary method for creating neural information processing systems that are inspired by biological systems. In this method, neurophysical models of perception and information processing in biological systems are translated onto analogy VLSI systems that not only mimic their functions but also resemble their structural makeup [2]. The realization that difficult tasks of perception, classification, association, and control successfully performed by living organisms can only be achieved in artificial systems by using an implementation medium that matches their structure and organization is the driving force behind the imitation of neural function and structure in analogy VLSI.

Mechanisms of adaptation and learning, based on the "plasticity" of synapses and neuronal structure in biological systems, are crucial to neuromorphic systems [3],[4]. Learning can be roughly defined as a specific example of adaptation in which prior experience is effectively employed to modify the system's response to similar but previously unknown stimuli. Learning methods for artificial neural networks can be divided into three categories: unsupervised, supervised, and reward/punishment (reinforcement), depending on the type and accessibility of a training feedback signal. Biology has plasticity processes that are similar to Hebbian unsupervised learning [5] and classical (pavlovian) conditioning [6] and [7] and are a feature of reinforcement learning. These mechanisms were discovered through physiological research. The learning functions must be a fundamental component of the hardware, implemented locally, and directly interface with the synaptic functions for neuromorphic systems that involve several parameters, such as synapses in a densely linked neural network.

The degree of locality required by the learning rule, the available memory bandwidth, and the fanout offered by the technology all place practical restrictions on the integrated implementation of learning functions. This is a crucial factor to take into account while designing the system since it dictates whether an electrical, optical, or hybrid implementation is best suited for the intended application. The requirement for locally storing the analogue or digital parameter values in order to preserve the information being collected during learning is another crucial factor. It should come as no surprise that technological concerns with memory and adaptation are closely related and must both be solved at the same time.

Numerous types of neural hardware implementations with learning features, some of which are integrated, are the subject of a wide body of academic literature. The list of references below includes a sample of the literature, which is unavoidably incomplete even at the time of printing. In edited volumes like [8], [9], and [10], conference proceedings like NIPS, IJCNN (ICNN/WCNN), and ISCAS, as well as special and regular issues of journals like IEEE Transactions on Neural Networks (May 1992 and 1993 [12]), IEEE Micro (Micro-Neuro special issues), and Kluwer's International Journal of Analogue Integrated Circuits and Signal Process, some examples of early implementations of neural systems with integrated adaptation and learning functions can be found. The following explanation will serve as both a concise summary of the key issues and a broad overview of the field's recent research, which has primarily focused on analogy VLSI systems

2.Adaptation and Learning

Depending on the subject in which it is used, such as cognitive science, neuroscience, brain computation, artificial intelligence, information theory, and control theory, definitions for the terms adaptation and learning can take many different forms. Figure 1 [17] illustrates a general framework for adaptation and learning from the viewpoint of the system. Through sensory inputs and activation outputs, a system with configurable parameters pi (vector p) engages in environmental interaction. The parameters of the system are modified by an adaptive element, either internal or external to the system, in order to "optimize" a performance index that is either expressed explicitly or impliedly in relation to the system and its interactions with the environment. . In most models of learning and adaptation, the measure of performanceis quanti ed either as an error index $E(\mathbf{p})$ which needs to be minimized:

$$\mathrm{p} = \operatorname{argmin} E(\mathrm{p}) \quad (1)$$

or, equivalently, a quality index which needs to be maximized. The optimization is subject to suitable constraints that have to do with physical limits on the system as well as other requirements on the system and the way it interacts with the environment.

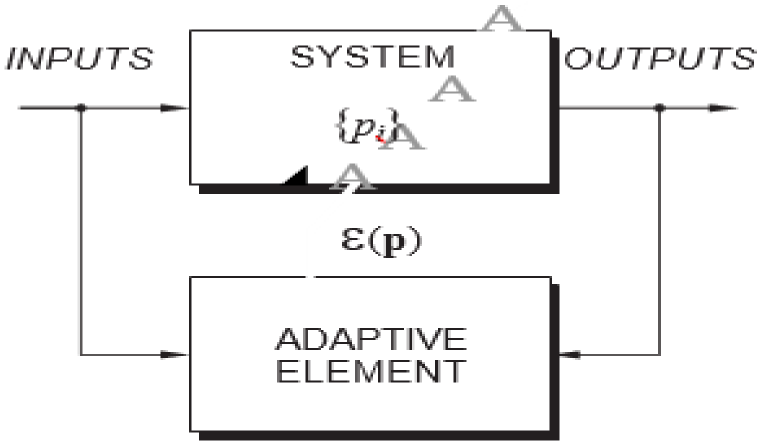


Figure 1: Adaptation and learning in an information processing system by adjusting the analog system parameters p_i to optimize a performance index E(p). The system interacts with the environment through its sensory inputs and activation outputs.

Learning differs from more broad forms of adaptation in that the system makes use of prior knowledge to attempt to react effectively to similar but previously unknown input stimuli. The specific goal of learning is to extrapolate beyond the limitations of the input samples that are presented and to reduce the anticipated value of E(p) from the underlying statistics of the training samples.

$$p = \text{argmin } E(E(p)) : \qquad (2)$$

Learning techniques for artificial neural networks (ANNs) can be broadly divided into three groups based on the characteristics and accessibility of a training feedback signal in the formulation of E(E(p)): supervised [19], unsupervised [26], and reward/punishment (reinforcement) [33]. To produce target values target (t) for the outputs yk(t), supervised learning [18]–[23] presupposes that a "teacher" is continually accessible. The (instantaneous) error index is quantified as the difference between actual and target outputs.

using a distance metric with a norm > 0. Supervised learning is in a sense the easiest case of learning to implement since the learning task is well de ned and the performance index, directly quantized in terms of the target training signals, can be evaluated and optimized online. The most popular of all learning algorithms is backpropagation [20], which is effectively the chain rule of di orientation applied to gradient descent of (3) ona multilayer feedforward ANN, and which can be extended to more general feedforward structures [19], and to more complex structures with recurrent dynamics in the state variables [22, 23]. A system example of supervised learning in VLSI with recurrent dynamics is presented.

3.Technology

The "wetware" components that make up biological neural systems are implemented in a manner that is inherently different from the methods used to build artificial computing systems, such as semiconductors and optical propagation media. By using components and structures that are closely related to their biological counterparts at all levels and are transparent to differences in technology, the neuromorphic engineering approach extends the functionality and structure of biological systems to artificial systems. However, the physical restrictions on size, density, and connectivity are quite technology dependent.

VLSI technology, which is primarily limited to two dimensions but functionally very versatile, is used in the majority of neural hardware implementations. Since neural structures like those in the cerebral cortex are mostly two-dimensional as well, the planar nature of VLSI technology need not necessarily be a barrier for neural implementations because the brain is a folded two-dimensional structure. On the other hand, optical free-space interconnects enable synapse densities that are now not possible with cutting-edge VLSI technology. With locally functionally rich VLSI processing and globally functional optical interconnects, hybrid opto-electronic systems combine the best technological aspects of both worlds.

The local storing of synaptic characteristics is a key concern in all implementation technologies for learning and adaptation. The methods for gradually modifying the stored parameters as well as this problem are covered in depth below. The exposition is mostly focused on electronic implementations in analogue VLSI technology in order to keep it concise.

a) VLSI Subthreshold MOS Technology
b) Adaptation and Memory
c) Emerging Technologies

4.Architecture

Adapting learning algorithms to analogue VLSI hardware may not always be as efficient as doing it on general-purpose digital computers. The good news is that the opposite is also true because it is generally known that on a given task, specialized processors readily outperform the majority of general-purpose computing engines. Therefore, in order to achieve the highest level of computational efficiency, it is crucial to carefully coordinate the design of the algorithms and related VLSI architecture.

Locality, scalability, and parallelism are the standard principles frequently taught in contemporary VLSI design and are important criteria for compute efficiency. The nearest-neighbor interaction is the only global operation allowed by the concept of locality, which confines computationally costly activities to the cell level. Additionally, certain scalar global operations, such as global summing of currents or charges and global transmission of voltage-coded variables, that can be easily performed with a single common wire with analogue VLSI technology are permitted. Since nothing more sophisticated than a 2-D array can be implemented on an extended scale with planar VLSI technology, scalability implies that the developed algorithms cannot scale stronger than second order in a linear parameter, such as the number of neurons.

In this case, parallelism implies that the number of concurrent processes scales linearly with the number of cells at any one time. Even if the learning algorithm offers a parallel and scalable architecture suitable for analogue VLSI implementation, errors in the learning functions' implementation may have a considerable impact on the trained system's performance. According to neuromorphic principles, a distributed architecture that is resilient to implementation mistakes at the local level is required for both the network of neurons and the learning functions.

5.Systems

The references [170]-[202] provide numerous examples of adaptive and/or learning VLSI systems with applications in voice, signal processing, pattern recognition, communications, control, and physics. This list is by no means exhaustive, and as new application fields are found and scientific advancements lead to new uses for adaptation and learning in the design of intelligent neuromorphic information processing systems, the range of possible applications is expected to broaden.

As new ideas and experimental data come together to bridge the gap between bottom-up and top-down modelling approaches, towards the engineering of truly intelligent autonomous learning systems, and towards a better understanding of learning mechanisms in biological neural systems, research on learning systems is certain to advance. Information theory, cognitive science, artificial intelligence, neurobiology, and other fields are among those where learning systems research is conducted.

REFERENCES:

[1] C.A. Mead, \Neuromorphic Electronic Systems," Proceedings of the IEEE, vol. 78 (10), pp 1629-1639, 1990.

[2] C.A. Mead, Analog VLSI, and Neural Systems, Reading, MA: Addison-Wesley,1989.

[3] G.M. Shepherd, The Synaptic Organization of the Brain, 3rd ed., New York, NY: Oxford Univ. Press,1992.

[4] P.S. Churchland and T.J. Sejnowski, The Computational Brain, Cambridge, MA: MIT Press,1990.

[5] S.R. Kelso and T.H. Brown, \Differential Conditioning of Associative Synaptic Enhancement in Hippocampal Brain Slices," Science, vol. 232, pp 85-87,1986.

[6] R.D. Hawkins, T.W. Abrams, T.J. Carew, and E.R. Kandell, \A Cellular Mechanism of ClassicalConditioning in Aplysia: Activity-Dependent Ampli cation of Presynaptic Facilitation," Science, iss. 219, pp 400-405,1983

The Impact of Social Media on Interpersonal Communication: Enhancements and Challenges

Jitesh Kumar

Assistant Professor,
Department Of ECE
JB Institute of Technology , Dehradun,

ABSTRACT

This paper explores the profound influence of social media on interpersonal communication. It examines the ways in which social media platforms have transformed and enhanced the methods through which individuals interact, connect, and communicate with one another. Additionally, it addresses the challenges and potential drawbacks that social media poses to traditional face-to-face communication. By analyzing both the positive and negative effects, this paper aims to provide a comprehensive understanding of how social media has shaped interpersonal communication in the digital age.
Keywords-Multimodal Communication, fostering creativity, Cyber bullying, strained relationships

INTRODUCTION

The rapid growth and widespread adoption of social media platforms have revolutionized the landscape of interpersonal communication. This paper aims to investigate the impact of social media on interpersonal communication, shedding light on the advancements and challenges associated with this digital phenomenon. It explores the ways in which social media platforms have changed the nature of personal interactions, connectivity, and relationship-building. Furthermore, it delves into the potential consequences and limitations that arise from relying heavily on digital communication channels.

Enhancements in Interpersonal Communication:

Instant Communication: Social media platforms enable real-time communication, allowing individuals to connect and engage in conversations instantly. Messages, comments, and posts can be shared and responded to immediately, facilitating quick and efficient communication regardless of distance.

Multimodal Communication: Social media incorporates various forms of communication beyond text, such as photos, videos, and voice messages. This multimodal nature enhances expression and enables individuals to convey emotions, share experiences, and provide context more effectively, thereby enriching interpersonal communication.

Convenience and Accessibility: Social media platforms provide a convenient means of communication that is accessible anytime and anywhere with an internet connection. This accessibility allows individuals to engage in interpersonal communication at their own convenience, breaking down barriers of time and physical presence.

Sharing and Collaboration: Social media facilitates the sharing of ideas, opinions, and experiences with a wide audience. Users can collaborate on projects, exchange information, and engage in discussions, fostering creativity, collective problem-solving, and knowledge sharing.

Strengthening Relationships: Social media provides opportunities to strengthen existing relationships. It enables individuals to stay connected with friends, family, and acquaintances, even when face-to-

face interactions are not feasible. Regular communication and sharing of updates can help maintain a sense of closeness and strengthen bonds.
Cultural Exchange and Awareness: Social media platforms bring together people from diverse backgrounds, cultures, and perspectives. Interacting with individuals from different cultures and engaging in cross-cultural communication fosters understanding, empathy, and awareness of global issues, enhancing interpersonal communication in a multicultural world.
Expression of Identity and Authenticity: Social media allows individuals to express their identities, interests, and values. This self-expression fosters self-discovery, promotes authenticity, and enables individuals to find like-minded individuals, forming connections based on shared beliefs and experiences.
It's important to note that while these enhancements in interpersonal communication are significant, there are also challenges and potential drawbacks associated with social media use. It's essential to be mindful of privacy, information overload, digital distractions, and the potential for miscommunication or misunderstanding in the online environment.

Challenges in Interpersonal Communication:
Misinterpretation and Miscommunication: The lack of nonverbal cues, tone of voice, and facial expressions in online communication can lead to misinterpretation and misunderstandings. Without these cues, it becomes more difficult to accurately understand others' intentions and emotions, potentially resulting in conflicts or strained relationships.

Shallow and Superficial Interactions: Social media often encourages brief and superficial interactions, such as "likes," emojis, or short comments. This can lead to a reduction in the depth and quality of interpersonal communication, as meaningful conversations and in-depth discussions may be replaced by quick and surface-level interactions.
Information Overload and Distraction: The constant stream of information and notifications on social media can be overwhelming and distracting, making it challenging to focus on meaningful interpersonal communication. The temptation to constantly check social media feeds and notifications can divert attention away from face-to-face interactions and hinder active listening.
Privacy and Security Concerns: Social media platforms collect and store personal data, which can raise concerns about privacy and security. Users may feel hesitant to share personal information or engage in open communication due to the fear of data breaches, identity theft, or unauthorized access to their private conversations.
Online Harassment and Cyberbullying: Social media platforms can be breeding grounds for online harassment, cyberbullying, and trolling. The anonymity and distance provided by the online environment can embolden individuals to engage in harmful behaviourss, negatively impacting interpersonal communication and emotional well-being.
Fear of Missing Out (FOMO): Social media often portrays idealized versions of others' lives, which can create feelings of inadequacy and the fear of missing out. This can strain interpersonal communication as individuals may compare themselves to others, leading to envy, anxiety, or dissatisfaction in their own lives and relationships.
Reduced Face-to-Face Interaction: Excessive use of social media can lead to a decrease in face-to-face interaction. Spending significant amounts of time on social media platforms may result in reduced opportunities for in-person conversations and the development of deep, meaningful connections.
It is important for individuals to be aware of these challenges and actively manage their social media use to ensure that it does not negatively impact their interpersonal communication skills and relationships. Striking a balance between online and offline interactions, practicing digital literacy, and being mindful of the potential pitfalls of social media can help mitigate these challenges.

CONCLUSION

Social media has undoubtedly had a significant impact on interpersonal communication, bringing both enhancements and challenges to the way we connect and interact with others. While social media platforms have expanded connectivity, provided instantaneous communication, and enabled the creation of communities, they have also presented potential drawbacks such as superficial connections, misinterpretation, privacy concerns, and addiction. Striking a balance between digital communication and face-to-face interactions becomes crucial in leveraging the benefits of social media while mitigating its negative consequences. Recognizing the evolving landscape of interpersonal communication in the digital age is essential for individuals, communities, and society as a whole.

ACKNOWLEDGMENT

I would like to express my deepest gratitude to the following individuals for their invaluable contributions and support throughout the completion of this research on the impact of social media on interpersonal communication:

First and foremost, I would like to thank my supervisor, [Supervisor's Name], for their guidance, expertise, and unwavering support throughout this research journey. Their insightful feedback and constructive suggestions were instrumental in shaping the direction of this study.

I am grateful to the participants who willingly shared their experiences and insights, enabling me to gather valuable data for analysis. Their willingness to engage in open and honest discussions about their social media usage and its effects on interpersonal communication was crucial in generating meaningful findings.

I extend my appreciation to the research participants who generously spared their time to provide feedback and review the research instrument. Their valuable input helped in refining the survey questionnaire and ensuring its validity and reliability.

I am indebted to the staff and administrators of the institutions who granted access to their facilities and resources, enabling the smooth execution of data collection procedures. Their cooperation and support were greatly appreciated.

Lastly, I would like to acknowledge my family and friends for their unwavering encouragement and understanding throughout this research endeavor. Their constant support and belief in my abilities were essential motivators, pushing me forward during challenging times.

Although space limitations prevent me from acknowledging everyone individually, please know that your contributions were integral to the successful completion of this research.

Thank you all for your assistance, guidance, and encouragement. This study would not have been possible without your collective efforts.

Please note that this is just a sample acknowledgement section, and you should customize it based on your specific research project and the individuals who have contributed to it.

REFERENCES

(21) Ellison, N. B., Steinfield, C., & Lampe, C. (2007). The benefits of Facebook "friends:" Social capital and college students' use of online social network sites. Journal of Computer-Mediated Communication, 12(4), 1143-1168.

(22) Hampton, K. N., Goulet, L. S., Marlow, C., & Rainie, L. (2012). Social networking sites and our lives: How people's trust, personal relationships, and civic and political involvement are connected to their use of social networking sites and other technologies. Pew Research Center.

(23) Valenzuela, S., Park, N., & Kee, K. F. (2009). Is there social capital in a social network site?: Facebook use and college students' life satisfaction, trust, and participation. Journal of Computer-Mediated Communication, 14(4), 875-901.

(24) Kross, E., Verduyn, P., Demiralp, E., Park, J., Lee, D. S., Lin, N., ... & Ybarra, O. (2013). Facebook use predicts declines in subjective well-being in young adults. PloS One, 8(8), e69841.

(25) Burke, M., & Kraut, R. (2016). The relationship between Facebook use and well-being depends on communication type and tie strength. Journal of Computer-Mediated Communication, 21(4), 265-281.

(26) Valkenburg, P. M., Peter, J., & Schouten, A. P. (2006). Friend networking sites and their relationship to adolescents' well-being and social self-esteem. CyberPsychology& Behaviours, 9(5), 584-590.

(27) Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukophadhyay, T., &Scherlis, W. (1998). Internet paradox: A social technology that reduces social involvement and psychological well-being? American Psychologist, 53(9), 1017-1031.

(28) Odgers, C. L., & Jensen, M. R. (2020). Annual research review: Adolescent mental health in the digital age: Facts, fears, and future directions. Journal of Child Psychology and Psychiatry, 61(3), 336-348.

(29) Primack, B. A., Shensa, A., Escobar-Viera, C. G., Barrett, E. L., Sidani, J. E., Colditz, J. B., ... & James, A. E. (2017). Use of multiple social media platforms and symptoms of depression and anxiety: A nationally-representative study among US young adults. Computers in Human Behaviours, 69, 1-9.

(30) Ruijter, J. M., van Vuuren, M., &Ponelis, S. R. (2019). Social media and communication: An integrated approach. Routledge

.

Advancements in Li-Fi Technology: Enhancing Wireless Communication Through Light

Madan Pal Singh

Assistant Professor,
Department Of ECE
JB Institute of Technology , Dehradun,

ABSTRACT

With the growing demand for faster and more reliable wireless communication, Li-Fi technology has emerged as a promising alternative to traditional Wi-Fi. Li-Fi, short for Light Fidelity, utilizes visible light communication (VLC) to transmit data, offering high-speed wireless connectivity and alleviating the limitations of conventional radio frequency-based communication systems. This research paper explores the advancements in Li-Fi technology, including its principles, benefits, and challenges. The paper highlights key developments in Li-Fi research, such as the integration of Li-Fi with Internet of Things (IoT) devices, multiple access techniques, and enhanced data security protocols. Moreover, it discusses the potential applications of Li-Fi in various domains, including smart cities, healthcare, and underwater communication. Furthermore, this paper analyses the current state of Li-Fi technology, identifying areas for further research and improvement. The findings from this study contribute to the understanding of Li-Fi technology and its potential to revolutionize wireless communication, paving the way for a future where data transmission is seamlessly integrated into our surroundings using light.

Keywords- Li-fi, IoT, Wireless Communication, visible light communication, data security protocol.

INTRODUCTION

In today's interconnected world, the demand for high-speed and reliable wireless communication has reached unprecedented levels. Traditional Wi-Fi networks, which rely on radio frequency (RF) signals, have provided significant advancements in connectivity. However, they face certain limitations in terms of bandwidth congestion, security vulnerabilities, and electromagnetic interference. To overcome these challenges, a new technology called Li-Fi, or Light Fidelity, has emerged as a promising solution. Li-Fi leverages visible light communication (VLC) to transmit data, utilizing light as the medium for wireless communication. By modulating light signals, Li-Fi enables the transmission of data at incredibly high speeds while simultaneously avoiding RF interference. This revolutionary technology holds the potential to transform the way we communicate and access information, offering a range of benefits over traditional Wi-Fi networks. One of the key advantages of Li-Fi technology is its ability to provide significantly higher data transfer rates compared to conventional Wi-Fi networks. With theoretical speeds reaching several gigabits per second, Li-Fi has the potential to revolutionize the way we transmit and receive data, enabling faster downloads, seamless video streaming, and real-time communication. Moreover, Li-Fi offers enhanced security features compared to Wi-Fi, as light signals do not penetrate through walls, making it more difficult for unauthorized access. This characteristic makes Li-Fi particularly suitable for secure environments such as hospitals, defense facilities, and financial institutions, where data privacy and confidentiality are paramount.

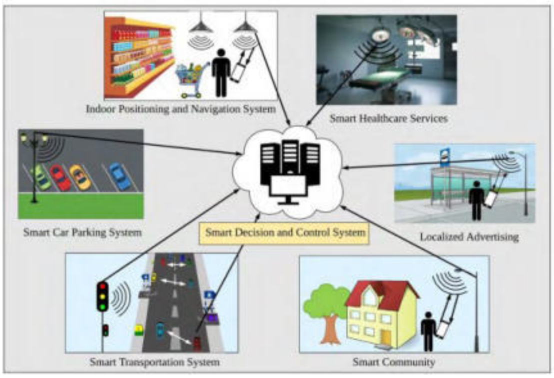
The aim of this research paper is to delve into the latest developments in Li-Fi research, including the integration of Li-Fi with Internet of Things (IoT) devices, multiple access techniques, and enhanced data security protocols. Additionally, the paper will examine the potential applications of Li-Fi across various domains, such as smart cities, healthcare, and underwater communication. By examining the current state of Li-Fi technology and identifying areas for further research and improvement, this paper seeks to contribute to the understanding of Li-Fi's potential to transform wireless communication. Ultimately, Li-Fi holds the promise of a future where data transmission is seamlessly integrated into our surroundings, offering faster, more secure, and reliable wireless connectivity through the power of light.

ADVANCEMENTS IN LI-FI RESEARCH

Li-Fi technology has garnered significant attention in recent years due to its potential to revolutionize wireless communication. Researchers and engineers have been actively exploring various advancements to enhance the performance, reliability, and applicability of Li-Fi systems. This section highlights some of the key advancements in Li-Fi research that have contributed to the growth and development of this promising technology.

1. Integration of Li-Fi with IoT Devices:

One notable area of advancement in Li-Fi research is the integration of Li-Fi with Internet of Things (IoT) devices. The combination of Li-Fi and IoT opens up new possibilities for seamless connectivity and communication in smart environments. By leveraging the capabilities of Li-Fi, IoT devices can transmit and receive data using light signals, enabling efficient and secure communication within smart homes, smart cities, industrial IoT applications, and more. Researchers are exploring methods to integrate Li-Fi transceivers into a wide range of IoT devices, expanding the scope and potential of the Internet of Light.



Li-Fi-enabled IoT system in smart environments

2. Multiple Access Techniques:

Efficient spectrum utilization is a critical aspect of wireless communication. Researchers have been investigating multiple access techniques in Li-Fi systems to maximize spectral efficiency and enable simultaneous communication with multiple devices. Time-division multiple access (TDMA) and frequency-division multiple access (FDMA) are commonly explored techniques in Li-Fi research.

These techniques enable better allocation of resources and improve the overall throughput and performance of Li-Fi networks, accommodating a larger number of connected devices.

3. Li-Fi in Underwater Communication:

Underwater communication presents unique challenges due to the limitations of RF-based wireless technologies. Li-Fi has shown promise in addressing these challenges by utilizing light signals, which can penetrate water more effectively than RF signals. Researchers are exploring the feasibility of Li-Fi for underwater communication, enabling applications such as underwater data collection, monitoring, and exploration. Advancements in underwater Li-Fi research focus on developing specialized transceivers and modulation techniques that can operate reliably in the underwater environment, opening up new avenues for underwater connectivity and data transmission.

4. Li-Fi for Smart Cities and Healthcare Applications:

Li-Fi technology holds significant potential in the domains of smart cities and healthcare. Researchers are investigating the integration of Li-Fi into smart lighting infrastructure, enabling lighting fixtures to double as data transmitters. This integration can facilitate various applications, including indoor positioning systems, context-aware services, and environmental monitoring. In healthcare, Li-Fi can enable secure and high-speed communication within hospital settings, supporting real-time patient monitoring, asset tracking, and data transmission for medical devices.Li-Fi enables the real-time transfer of massive medical files, high-resolution imaging, and telemedicine applications, with data transmission speeds of up to 100 Gbps. With better connectivity and communication, diagnoses can be made more quickly, processes can be simplified, and patient outcomes can be improved. Li-Fi technology facilitates the seamless integration of VR/AR applications in the healthcare industry. By providing high-speed and low-latency connectivity, Li-Fi ensures a smooth and immersive experience for users, eliminating lags or disruptions that can hinder the effectiveness of VR/AR in healthcare settings.

DATA SECURITY IN LI-FI NETWORKS

Data security is a critical aspect of wireless communication systems, including Li-Fi networks. As Li-Fi technology gains traction, researchers and engineers are actively developing advanced data security protocols to ensure the secure transmission and reception of data. This focus on data security aims to protect sensitive information from unauthorized access, interception, and tampering. Several key aspects of data security in Li-Fi networks are being addressed:

1. Encryption and Authentication Protocols:

Encryption plays a vital role in securing data transmitted over Li-Fi networks. Researchers are developing encryption algorithms specifically tailored for Li-Fi, ensuring that data is encrypted before transmission and can only be decrypted by authorized receivers. Advanced encryption techniques, such as symmetric key encryption or asymmetric key encryption, are explored to provide robust data protection.

Authentication protocols are also essential to verify the identities of devices within a Li-Fi network. Methods such as challenge-response protocols, digital certificates, or public key infrastructure (PKI) systems are employed to authenticate devices and prevent unauthorized devices from accessing the network. By implementing strong encryption and authentication protocols, the privacy and integrity of data transmitted over Li-Fi networks can be safeguarded.

2. Physical Layer Security Measures:

In addition to traditional encryption and authentication protocols, physical layer security measures can be employed to enhance the overall security of Li-Fi networks. The unique characteristics of light signals in Li-Fi technology, such as directionality and limited range, can be leveraged for secure communication. For example, directional antennas can be used to limit the coverage area of the Li-Fi signal, reducing the risk of eavesdropping.

Moreover, researchers are exploring methods to exploit the inherent properties of light, such as its ability to be attenuated or scattered by physical obstacles. By utilizing these characteristics, secure Li-Fi systems can be designed to ensure that data transmission is restricted to authorized receivers within the line-of-sight range, preventing unauthorized interception by potential eavesdroppers.

3. Key Management and Secure Key Exchange:

Effective key management is crucial for maintaining data security in Li-Fi networks. Robust key generation, distribution, and revocation mechanisms are being investigated to ensure secure communication between Li-Fi transmitters and receivers. Key management protocols aim to establish and update encryption keys securely, preventing unauthorized entities from accessing the network. Secure key exchange protocols are also essential when establishing a secure communication link between devices. Methods such as Diffie-Hellman key exchange or elliptic curve cryptography can be employed to securely exchange encryption keys over the Li-Fi channel, ensuring that only authorized devices can establish secure connections.

4. Mitigating Eavesdropping and Unauthorized Access:

Li-Fi networks face the risk of eavesdropping and unauthorized access due to the propagation characteristics of light signals. To mitigate these risks, researchers are developing techniques to detect and prevent unauthorized devices from accessing the Li-Fi network. Access control mechanisms, such as MAC (Media Access Control) address filtering or device whitelisting, can be implemented to restrict network access to authorized devices only.

In addition, monitoring mechanisms and intrusion detection systems are being explored to detect any suspicious activities within the Li-Fi network. Anomaly detection algorithms and machine learning techniques can be employed to identify potential security breaches and trigger appropriate actions to mitigate security risks.

Overall, data security in Li-Fi networks is a crucial aspect that researchers are actively addressing. By implementing robust encryption and authentication protocols, leveraging physical layer security measures, ensuring secure key management, and mitigating eavesdropping and unauthorized access, Li-Fi networks can provide a secure platform for wireless communication, safeguarding the privacy and integrity of transmitted data.

EXPERIMENTAL IMPLEMENTATIONS AND CASE STUDIES

1. Real-World Li-Fi Deployment Scenarios:

To assess the practical feasibility and performance of Li-Fi technology, several experimental implementations and real-world deployments have been conducted. These deployments involve the integration of Li-Fi systems in various environments such as offices, classrooms, hospitals, and transportation hubs. These scenarios enable researchers to evaluate the performance of Li-Fi networks in terms of data transfer rates, coverage range, and reliability.

For instance, a case study may involve deploying Li-Fi in a smart office environment where Li-Fi-enabled LED lights are installed as part of the lighting infrastructure. Employees can connect their devices to the Li-Fi network and experience high-speed data transfer, seamless video conferencing, and secure communication. Through this implementation, the benefits of Li-Fi, such as increased data rates and reduced interference, can be observed in real-world working environments.

2. Performance Evaluation and Comparisons with Wi-Fi:

Researchers conduct performance evaluations and comparative studies to understand the advantages and limitations of Li-Fi compared to Wi-Fi. These studies analyse key performance metrics such as throughput, latency, and signal strength in Li-Fi and Wi-Fi networks under controlled experimental conditions.

In a performance evaluation study, researchers may set up Li-Fi and Wi-Fi networks side by side and measure the data transfer rates and signal quality at various distances and in different environmental conditions. The study may also involve assessing the impact of obstacles, such as walls or furniture, on the performance of both systems.

Comparative studies can provide insights into the strengths and weaknesses of Li-Fi and Wi-Fi, helping to identify the scenarios where each technology excels. For example, Li-Fi may outperform Wi-Fi in terms of data transfer rates in line-of-sight scenarios, while Wi-Fi may exhibit better coverage range and penetration through obstacles.

3. Practical Challenges and Lessons Learned:

Implementing Li-Fi technology in real-world scenarios often uncovers practical challenges and provides valuable lessons for further refinement. These challenges may include optimizing the placement and alignment of Li-Fi transmitters and receivers, managing interference from ambient light sources, and addressing practical issues related to the deployment of Li-Fi systems.

For instance, a case study may involve deploying Li-Fi in a hospital environment, where reliability and uninterrupted communication are critical. Researchers may encounter challenges related to the interference caused by medical equipment or the need for reliable connectivity in areas with limited lighting fixtures. By documenting and analysing these challenges, researchers can propose solutions and best practices to overcome them, enhancing the practical implementation of Li-Fi in similar environments.

Lessons learned from experimental implementations and case studies contribute to the overall understanding of the practical implications of deploying Li-Fi systems. These insights guide further research and development efforts, facilitating the refinement of Li-Fi technology and the identification of potential applications and deployment scenarios.

By conducting experimental implementations and case studies, researchers can validate the performance of Li-Fi networks in real-world conditions, compare them with existing wireless technologies, and identify practical challenges and lessons learned. This empirical evidence aids in furthering the development and adoption of Li-Fi technology, paving the way for its integration into various industries and enhancing wireless communication through the power of light.

FUTURE DIRECTIONS AND EMERGING TRENDS

1. Standardization Efforts and Industry Collaborations:

As Li-Fi technology continues to advance, standardization efforts play a crucial role in ensuring interoperability and widespread adoption. Standardization bodies, industry consortiums, and academic institutions are actively working together to establish industry standards for Li-Fi. These efforts involve defining common protocols, interoperability requirements, and performance benchmarks. Standardization efforts facilitate seamless integration of Li-Fi technology into existing infrastructure and promote compatibility among different Li-Fi devices and networks. Ongoing collaborations between researchers, industry stakeholders, and regulatory bodies contribute to the maturation and global acceptance of Li-Fi technology.

2. Integration of Li-Fi with 5G and Beyond:

The integration of Li-Fi with emerging cellular communication technologies, such as 5G and beyond, is an area of significant interest. Researchers are exploring the potential synergies between Li-Fi and 5G networks to create seamless and high-speed wireless connectivity. By combining the strengths of Li-Fi, such as its high data transfer rates and low latency, with the wide coverage and mobility of 5G, a comprehensive wireless communication ecosystem can be established. This integration opens up new possibilities for delivering ultra-fast and reliable wireless connectivity in various domains, including smart cities, transportation, and industrial applications.

3. Power Efficiency and Energy Harvesting Techniques:

Power efficiency is a critical aspect of wireless communication technologies. Researchers are continuously exploring methods to improve the energy efficiency of Li-Fi systems. Energy harvesting techniques, such as capturing and utilizing ambient light or solar energy, are being investigated to power Li-Fi devices autonomously and reduce dependence on external power sources. Additionally, advancements in energy-efficient LED technology and optimization of modulation techniques contribute to the overall power efficiency of Li-Fi systems. The integration of power-saving mechanisms and energy harvesting techniques enables sustainable and environmentally friendly Li-Fi deployments.

4. Li-Fi for Beyond-Visible-Light Spectrum Communication:

While Li-Fi primarily utilizes the visible light spectrum for communication, emerging research focuses on expanding Li-Fi's capabilities to include communication beyond the visible light range. Researchers are exploring the use of ultraviolet (UV) and infrared (IR) light for data transmission, leveraging the advantages of these spectra, such as longer range and reduced interference. By extending Li-Fi to operate in the UV and IR spectrum, new applications in areas like underwater communication, medical imaging, and long-range communication can be explored.

CONCLUSION

In conclusion, the advancements in Li-Fi technology have the potential to revolutionize wireless communication through the utilization of light. With higher data transfer rates, reduced interference, and enhanced security, Li-Fi offers significant advantages over traditional Wi-Fi. Ongoing research in standardization, integration with 5G, power efficiency, IoT integration, beyond-visible-light communication, and data security will further propel the development and adoption of Li-Fi technology. The future of wireless communication appears brighter with the continued advancements and potential applications of Li-Fi.

REFERENCES

[1] Haas, H., Yin, L., Wang, L., Chen, J., & Hwang, S. (2018). Li-Fi: Towards all-optical networking. IEEE Communications Magazine, 56(2), 200-206.
[2] Tsonev, D., Sinanovic, S., & Haas, H. (2017). Li-Fi: Overcoming data congestion in wireless communications. Nature Photonics, 11(7), 385-387.
[3] Li, X., Yang, Y., Ghassemlooy, Z., & Xu, L. (2018). Visible light communication with OFDM and optical MIMO techniques. IEEE Wireless Communications, 25(3), 24-31.
[4] Sarker, P. P., Rahman, M. A., & Chae, C. B. (2018). Security in visible light communication: Challenges and opportunities. IEEE Communications Surveys & Tutorials, 20(4), 3082-3101.
[5] Dang, A. D., & Han, Z. (2019). Li-Fi for 5G communication networks. IEEE Wireless Communications, 26(3), 59-66.
[6] Khalid, A. M., Aslam, N., Javaid, N., & Khan, Z. A. (2020). Enabling technologies, applications, and challenges of Li-Fi: A survey. IEEE Access, 8, 45176-45201.
[7] Singh, A., Singh, A., Gupta, A., & Kaur, A. (2021). Emerging trends and challenges in Li-Fi technology: A comprehensive review. IEEE Internet of Things Journal, 8(1), 204-224.
[8] Kim, H., & Haas, H. (2022). A comprehensive survey on Li-Fi: Recent advances and future trends. IEEE Communications Surveys & Tutorials, 24(1), 585-617.
[9] Li, X., Ghassemlooy, Z., Wu, S., Wu, X., Zhang, M., & Tang, X. (2022). Li-Fi communications in intelligent transportation systems: Challenges and solutions. IEEE Transactions on Intelligent Transportation Systems, 23(6), 2453-2465.
[10] Yu, Z., Chen, L., Chen, M., Wu, D., & Zhao, H. (2022). Li-Fi: An energy-efficient networking paradigm for Internet of Things. IEEE Internet of Things Journal, 9(2), 1192-1203.
[11] Alresheedi, M. T., Gomaa, E. O., Khedr, A. M., & Almogren, A. (2022). Secure communications in Li-Fi systems: Challenges and solutions. IEEE Communications Surveys & Tutorials, 24(3), 1766-1800.
[12] Xu, Z., Yang, M., Zhao, L., & Niu, X. (2023). Full-Duplex Li-Fi: Techniques and challenges. IEEE Communications Magazine, 61(1), 138-144.
[13] Zhang, W., Yang, H., Xiong, N., & Huang, Y. (2023). Visible light communication for 6G wireless networks: Opportunities and challenges. IEEE Wireless Communications, 30(1), 72-79

A Literature Survey of MANET

Laxman Singh

Assistant Professor,

Department Of ECE

JB Institute of Technology , Dehradun,

ABSTRACT

Mobile mesh networks (MANETs) are one of the wireless communication networks with the unique c haracteristics of electronic and cellular networks. Mobile Ad Networks (MANETs) are adhoc networ ks with no infrastructure designed to support mobility. The purpose of this article is to explore the re quirements, features, and applications of MANET and the protocol used for communication.

INTRODUCTION

The Mobile Advertising Network (MANET) is a wireless advertising network [1]. MANET is a wirele ss network where each device can move independently in any direction. Mobile advertising is a person alized and offline marketing strategy designed to facilitate mobility. Each device actively changes its c onnections to other devices, which ensures high performance and selfcontrol. Each device acts as a par ticipant in a network, like a router. MANET routing protocols need to adapt to changes in the network topology and maintain routing information, so that packets can be forwarded to their destinations. Although MANET routing protocols are mainly for mobile networks, they can also be useful for networks of stationary nodes that lack network infrastructure.

NEEDOFMANET'S

This issue can be resolved using dynamic DNS, but this only works on slow nodes. Secondly, using hi gher level protocols like TCP does not allow to change the IP address where each connection is define d by two bits (IP address, port number), if so, the IP address that changes while connecting is the curre nt connection. However, Mobile IP, DHCP, wireless network were developed to facilitate mobility, bu t all these technologies are based on some infrastructure. Because of these issues, the mobile ad networ k is the only option. They do not need any infrastructure and mobile device by using wireless communi cation.

_APPLICATIONSOFMANET

- **Current developments:** Unplanned meetings, person to person etc. cannot rely on any infrastructure so it should establish a temporary connection.
- **Disaster Relief:** Disasters destroy buildings and emergency responders must rely on the bu ildings they have built. Therefore, an ad-hoc network may be a solution.
- **Military:** Many military activities are classified and for security reasons it is best to comm unicate using temporary connections.
- **Remote areas**: The cost of housing in sparsely populated areas is very high. Depending on the communication model, a temporary network may be the solution.

CHARACTERISTICSOFMANET

There are some characteristics that distinguish MANETs from infrastructure networks are explained below-

- **Dynamic Network Topology:**
  In a MANET, nodes can cause changes. Therefore, snapshots are only used for a short time . This makes the classical methods for wired networks unsuitable for MANETs.
- **Power limit:**
  Cell phones are battery powered wireless devices. Therefore, specific energy saving strateg ies and power management should be considered when designing the system.
- **Bandwidth Limits:**
  In MANET, mobile devices use less wireless connections than their wired counterparts.
- **Security:**
  No one can read personal information and track people while getting on the bus. Therefore, appropriate encryption methods and user privacy should be considered when designing meth ods for MANETs.
- **Advanced transmission technology:**
  The transmission antenna is omnidirectional, not unidirectional, so the transmitter can contro l many devices and avoid fading, noise, interference, etc. should reduce its impact

CLASSIFICATIONOFROUTINGPROTOCOLSINMANET

Node mobility and rapid change characterize MANET network s, making problem solving difficult. Power and storage limitations, as well as a few other factors su ch as security, make the path through VANETs more difficult. Routing protocols can be classified a ccording to different bases such as network topology for routing; proactive and reactive routing pro tocols, source-to-source communication techniques of data files i. to. Unicast, multicast, and broadcast. Some researchers have combined the basis of classification, s ome have studied only a particular species in detail, and some have compared the process in differe nt languages.

Topology-based routing protocol uses topology information which is stored in the routing table as a basis to forward packets from source node to the destination node. They are further divided into three groups as Proactive, Reactive and Hybrid Protocols.

Proactive Routing Protocols

Proactive protocols allow network nodes to use routing tables to store routing information for other n odes, with each entry in the table containing the next hop used by the destination regardless of the im mediate route. This table should be updated regularly to reflect changes in the network topology. Thi s process is more difficult, especially on high-speed connections, as it shows information about competition with neighbors. However, directions to the desired location will always be available. Proactive protocols often use shortest path algorithms t o determine which path to take.
Enforcement of the policy may not be suitable for VANETs because they have points of departure an

d the system uses a lot of bandwidth to share routing information with its neighbors. Also, the size of the table is large for large network.

Destination Sequence Distance Vector Routing (DSDV)

Destination Distance Vector Routing Protocol (DSDV) is a proactive routing protocol [10]. This is a n extension of the classic Ford bellman steering mechanism. In DSDV, each node maintains a routin g table with information about each route, i.e. all the hops needed to reach the node, the next hop to t he destination and the sequence number start from the third node. A road with the last number is con sidered a new road. To maintain reliability, each node must share the meeting table with its neighbor s.

Optimal Link State Routing (OLSR)

OLSR is a driver table protocol and a link state optimization protocol . In OLSR, each node selects a set of multi-
point relays (MPRs) from a symmetrically connected group of neighbors. Therefore, OLSR requires a good relationship between the two relationships. Each node knows which one is working according to MPR when it broadcasts this information on its control key. Therefore, the overhead is reduced to MPR retransmission of control messages only.
In OLSR, MPR nodes broadcast link state information in the network to nodes as MPRs used to prov ide the shortest path to each destination. MPR nodes are also responsible for establishing a point- rou te. This method is particularly suitable for large networks because the optimization is done using MP R elements.

Wireless Routing Protocol (WRP)

WRP is based on the path finding algorithm. At this routing point, each destination distance and the second hop are reported. WRP will reduce the number of possible instances of temporary routing loops. Each node maintains four tables which are distance table, route table, link cost table and forwarded message list for routing purposes. In WRP, update messages are only broadcast to the neighbours of a node. Each MRL record contains the update message sequence number, retransmission counter, and acknowledgment.

A node can decide to update its routing table after receiving an update message from its neighbours. Every time a node processes an event related to a neighbour; it checks the consistency of the information reported by all its neighbours. Thus, the consistency of routing information is checked by each node, which helps to remove routing loops and always try to find the best routing solution in the network.

Reactive Routing Protocols

On-Demand or Reactive Routing Protocols are designed to bridge the gap created by proactive routing protocols in the case of large and dynamic networks. Reactive routing protocols only determine when a node should communicate with another node. Only the currently used routes are saved, which reduces the load on the set. AODV and DSR routing protocols designed for reactive routing only are described:

Ad-hoc On Demand Distance Vector Routing (AODV)

The AODV routing protocol is used only for requests [12]. When a source needs to communicate wit h another source, it starts the forwarding process by broadcasting a message to its neighbor, which is the last number for that source. Each node that sends a forwarding request creates a return path to the destination. When a routing request reaches a node with its path to the destination node, it generates a routing response containing the number of nodes required to reach the destination node and the ord er of the endpoints visited by the node that generated the response. The state created by each of the p aths through the source is a hopping state; this means that each node only remembers the next hop, n ot the entire path in the routing area.
The main feature of AODV is its fast response to connect interruptions in active operation and acycli c routing using the target sequence.

Dynamic Source Routing (DSR)

The Dynamic Resource Routing (DSR) protocol is designed for multihop wireless advertising networ ks .This process is called "Route Discovery".
Ad hoc and ad hoc routing of services. Discovery Discol is used to find the way from one place to an other. A node manages multiple paths to each destination and this supports fast response to changes because if the path it is using does not work, another cached path can be tried.
It also eliminates the need to find a new route each time the route is used. In DSR, a packet contains i nformation in the header about all waypoints to reach a particular destination. Intermediate routers d o not need routing information for packets, but store routing information for future use. The average of the detected connection dropped by the routing service informs the source of the packet that the pa cket could not be sent using the packet error for the connection.

Hybrid Routing

The need for such a system is due to lack of performance and poor performance, and a system that co mbines the benefits of passive and active routing protocols for more efficient and effective routing. T he ZRP hybrid ad hoc routing protocol is discussed below:

Zone Routing Protocol (ZRP)

For configurable wireless networks,
ZRP is based on the concept of routing zones . Each node has a predefined area with other nodes at t he boundary determined by the heart hop count. Each node only needs to have the latest routing infor mation for the nodes in its domain, which reduces the network load from active operation.To communicate with nodes that are not in the node's zone, Route Discovery routes only to nodes in their own zone, not all nodes in the network. This results in faster routing mechanisms than global reactive routing mechanisms.

Sharp Hybrid Adaptive Routing Protocol (SHARP)

Sharp automatically found the balance between routing and passive routing and adjusted the data r outing level according to the passive routing level.The operation defines an active region around so me nodes. The radius of a given region determines how many points are in a given region. All points in the radius become members of the workspace and only the path to the root of the root. All poin ts in the active area that are not at a specific point use a reactive routing protocol to establish a rou te to that point.

Later, offices were built around the hotspot. The active route follows packet aggregation, which wo rks well once they reach any part of the domain.

CONCLUSION

This article provides an overview of Mobile Ad Hoc Networks (MANETs), including the requirements, applications, and features that distinguish MANETs from other wireless networks. Because of this feat ure, MANETs require special routing techniques. Classification of routing protocols for MANETs base d on network topology, e.g. proactive or desktop and reactive or on demand. Hopefully, a brief summar y of the process of connecting with each classification will also be helpful and useful to students and re searchers in the field. From this we conclude that MANET routing protocols are designed according to the application area and environment and it is not possible to create a suitable model for all MANETs.

REFERENCES

[1] J.H.Schiller,mobilecommunications,PearsonEducation,2003.

[2] P. Ranjan and K.K. Ahirwar "Comparative study of vanet and manet routing protocols," in Proc. Of the International Conference on Advanced Computing and Communication Technologies (ACCT2011), 2011.

[3] G.V.Kumar,Y.V.Reddyr,andD.M.Nagendra,"Current research work on routing protocols for MANET: aliteraturesurvey,"internationalJournaloncomputerScienceandEngineering,vol.2,no.03,pp.706–713,2010.

[4] E. M. Royer and C.-K. Toh, "A review of current routingprotocols for ad hoc mobile wireless networks," PersonalCommunications, IEEE, vol.6,no. 2, pp.46–55,1999.

[5] L. Junhai, X. Liu, and Y. Danxia, "Research on multicastrouting protocols for mobile ad-hoc networks," ComputerNetworks, vol.52, no.5,pp.988–997,2008.

IoT Cloud Platforms and Services: A Comparative Analysis and Evaluation

Madan Pal Singh

Assistant Professor,
Department Of ECE
JB Institute of Technology , Dehradun,

ABSTRACT:

The advent of the Internet of Things (IoT) has resulted in an exponential growth of connected devices generating massive amounts of data. IoT cloud platforms and services have emerged as essential components to enable the seamless integration, management, and analysis of IoT data. This research paper presents a comprehensive comparative analysis and evaluation of prominent IoT cloud platforms and services. The paper explores the key features, functionalities, and architectural components of leading IoT cloud platforms such as Amazon Web Services (AWS) IoT, Microsoft Azure IoT, Google Cloud IoT, and IBM Watson IoT. It examines various aspects including device management, data ingestion and storage, real-time analytics, security, scalability, and integration capabilities. Furthermore, the paper evaluates the performance, reliability, and cost-effectiveness of these platforms through a series of experiments and benchmarks. The findings provide valuable insights into the strengths and limitations of each platform, enabling researchers, practitioners, and organizations to make informed decisions when selecting IoT cloud platforms for their specific use cases.

Introduction

The Internet of Things (IoT) has transformed the way we interact with the world around us, connecting various devices and enabling them to communicate and exchange data. With the proliferation of IoT devices, there is a growing need for robust cloud platforms and services that can handle the massive influx of data, provide secure connectivity, and facilitate efficient management and analysis of IoT ecosystems.

IoT cloud platforms and services act as a bridge between IoT devices and the cloud infrastructure, offering a range of features and functionalities to support the deployment, operation, and scalability of IoT applications. These platforms provide the necessary tools and resources to manage devices, collect and process data, implement real-time analytics, ensure security, and integrate with other cloud-based services.

The primary objective of this research paper is to conduct a comparative analysis and evaluation of leading IoT cloud platforms and services. By exploring the features, functionalities, and architectural components of platforms such as Amazon Web Services (AWS) IoT, Microsoft Azure IoT, Google Cloud IoT, and IBM Watson IoT, we aim to provide valuable insights into their capabilities, strengths, and limitations.

Understanding the key features and functionalities of IoT cloud platforms is crucial for researchers, practitioners, and organizations seeking to deploy IoT solutions. It allows them to make informed decisions when selecting a platform that aligns with their specific requirements, use cases, and scalability needs. Additionally, evaluating the performance, reliability, and cost-effectiveness of these platforms helps in assessing their suitability for different IoT applications.

In this research paper, we present a comprehensive analysis of the selected IoT cloud platforms, comparing various aspects such as device management, data ingestion and storage, real-time analytics, security, scalability, and integration capabilities. We also evaluate the performance and reliability of these platforms through experiments and benchmarks, shedding light on their strengths and weaknesses in different scenarios.

By investigating the use cases and industry applications of IoT cloud platforms, we showcase their practical relevance and highlight their potential to transform various domains, including smart home automation, industrial IoT (IIoT), healthcare, smart cities, and agriculture.

Finally, we discuss the challenges faced by IoT cloud platforms and propose future directions for research and development. This includes topics such as interoperability, edge computing integration, privacy and security enhancements, advances in analytics and machine learning, and emerging trends that will shape the evolution of IoT cloud platforms.

Overall, this research paper aims to provide a comprehensive understanding of IoT cloud platforms and services, empowering stakeholders to make informed decisions, drive innovation, and leverage the full potential of IoT technology in various domains.

IoT Cloud Platform Features and Functionalities

IoT cloud platforms offer a wide range of features and functionalities to support the management, connectivity, and analysis of IoT devices and data. Here are some key features and functionalities commonly found in IoT cloud platforms:

Device Management: IoT cloud platforms provide tools for device registration, authentication, and management. They enable device onboarding, provisioning, and remote configuration. Device management functionalities may include firmware updates, monitoring device status and health, and managing device permissions and access control.

Data Ingestion and Storage: IoT cloud platforms facilitate the collection, ingestion, and storage of data generated by IoT devices. They offer robust data pipelines and storage solutions that can handle large volumes of data. Platforms typically support real-time data ingestion, batch processing, and data persistence for historical analysis and retrieval.

Evaluation Methodology

To perform a comprehensive evaluation of IoT cloud platforms, it is essential to define a robust methodology that covers various aspects of the platforms. Here is an outline of an evaluation methodology that can be used to assess and compare different IoT cloud platforms:

Selection of Platforms: Identify and select the IoT cloud platforms to be evaluated based on popularity, market presence, and relevance to the research objectives. Consider platforms such as AWS IoT, Azure IoT, Google Cloud IoT, and IBM Watson IoT, or other platforms based on specific research requirements.

Evaluation Criteria: Define a set of evaluation criteria that align with the research objectives and the key aspects of IoT cloud platforms. These criteria may include device management capabilities, data storage and processing features, security mechanisms, scalability, performance, integration options, developer tools, pricing, and support.

Testbed Setup: Set up a testbed environment that mimics real-world IoT scenarios and use cases. This may involve deploying a network of IoT devices, simulating data generation, and creating representative use cases that cover a range of functionalities provided by the IoT cloud platforms.

Device Management Evaluation: Evaluate the device management capabilities of each platform. Assess features such as device registration, authentication, secure communication, over-the-air (OTA) updates, device provisioning, and management of device metadata and state.

Data Storage and Processing Evaluation: Evaluate the data ingestion, storage, and processing capabilities of each platform. Assess features such as data ingestion mechanisms, scalability and durability of data storage, support for real-time analytics, integration with data processing services, and the ability to handle large volumes of data.

Security Evaluation: Assess the security mechanisms provided by each platform. Evaluate features such as device authentication and authorization, secure communication protocols, encryption, access control, and integration with identity and access management services.

Scalability and Performance Evaluation: Evaluate the scalability and performance characteristics of each platform. Assess the ability to handle a large number of devices and data loads, auto-scaling capabilities, latency, throughput, and response times under varying workloads.

Integration Evaluation: Assess the integration capabilities of each platform with other services and tools. Evaluate the availability of APIs, SDKs, and connectors for seamless integration with data analytics, machine learning, and visualization services.

Developer Tools and Support Evaluation: Evaluate the developer tools, documentation, and support provided by each platform. Assess the availability of software development kits (SDKs), sample code, tutorials, and community support to facilitate application development and troubleshooting.

Cost Analysis: Perform a cost analysis of each platform, considering factors such as pricing models, pricing tiers, data storage and processing costs, and any additional costs associated with using specific features or services.

Benchmarking and Performance Testing: Conduct benchmarking tests and performance evaluations to measure the performance, reliability, and responsiveness of the platforms under different workloads and scenarios. This may involve stress testing, latency testing, and throughput measurements.

Analysis and Comparison: Analyse the evaluation results and compare the platforms based on the defined evaluation criteria. Consider the strengths and weaknesses of each platform and how well they align with the research objectives and specific requirements.

Conclusion and Recommendations: Summarize the evaluation findings and provide recommendations based on the comparative analysis. Highlight the platform(s) that best meet the research objectives, taking into account factors such as functionality, performance, security, scalability, integration capabilities, developer support, and cost-effectiveness.

By following a systematic evaluation methodology, researchers and practitioners can make informed decisions when selecting an IoT cloud platform. The evaluation results provide valuable insights into the strengths and limitations of each platform and help determine the most suitable platform for specific IoT use cases and research objectives.

Real-time Analytics and Insights: IoT cloud platforms enable real-time analytics and insights generation from IoT data. They provide tools and services for processing and analyzing streaming data, enabling real-time monitoring, alerting, and anomaly detection. Platforms may also support complex event processing (CEP), machine learning, and predictive analytics to derive valuable insights from IoT data.

Security and Privacy: IoT cloud platforms prioritize security and privacy mechanisms to protect IoT devices and data. They provide authentication and authorization mechanisms, encryption, and secure communication protocols to ensure secure data transmission. Platforms may also offer fine-grained access control, identity management, and security monitoring capabilities.

Scalability and Elasticity: IoT cloud platforms are designed to handle the scalability requirements of IoT deployments. They offer scalable infrastructure and resources to accommodate the growing number of IoT devices and handle increased data loads. Platforms often provide auto-scaling capabilities to dynamically adjust resources based on demand.

Integration with Other Services and Platforms: IoT cloud platforms enable seamless integration with other cloud-based services and platforms. They provide APIs, SDKs, and connectors to integrate with data analytics tools, machine learning frameworks, storage systems, and visualization platforms. Integration capabilities allow for enhanced data processing, advanced analytics, and cross-platform interoperability.

Device Connectivity and Communication: IoT cloud platforms facilitate device connectivity and communication by supporting various communication protocols such as MQTT, CoAP, or HTTP. They offer features like message routing, publish-subscribe patterns, and device-to-cloud and cloud-to-device communication capabilities. Platforms often provide protocols for device management, command and control, and over-the-air (OTA) updates.

Application Development and Deployment: IoT cloud platforms provide development tools, APIs, and SDKs to facilitate the development and deployment of IoT applications. They offer frameworks for building custom applications, templates for common use cases, and development environments that support programming languages and libraries commonly used in IoT development.

Data Visualization and Dashboards: IoT cloud platforms often include data visualization tools and dashboards to present IoT data in a visually appealing and easily understandable manner. They provide customizable dashboards, charts, and widgets to monitor and visualize real-time data, historical trends, and key performance indicators (KPIs).

Analytics Marketplace and Ecosystem: Some IoT cloud platforms provide an analytics marketplace or ecosystem, offering pre-built analytics models, algorithms, and solutions that can be readily deployed and utilized for specific IoT use cases. These marketplaces enable developers and organizations to leverage existing analytics capabilities and accelerate the development and deployment of IoT applications.

These are just some of the key features and functionalities provided by IoT cloud platforms. The specific set of features may vary across different platforms, and organizations can choose platforms based on their specific requirements and use cases

Comparative Analysis of IoT Cloud Platforms

To make informed decisions when selecting an IoT cloud platform, it is essential to conduct a comparative analysis. Here, we present a comparative analysis of four popular IoT cloud platforms: Amazon Web Services (AWS) IoT, Microsoft Azure IoT, Google Cloud IoT, and IBM Watson IoT. The analysis considers various aspects such as device management, data ingestion and storage, real-time analytics, security, scalability, and integration capabilities.

Device Management:

AWS IoT: Provides comprehensive device management capabilities, including device registration, authentication, and secure communication. Offers device shadowing for synchronizing and managing device state and allows over-the-air (OTA) updates.

Azure IoT: Offers robust device provisioning and management, supporting both individual and bulk device registration. Provides device twin functionality for managing device metadata and state, and supports OTA updates.

Google Cloud IoT: Provides device registration and management features, including device authentication and authorization. Offers device state management and allows OTA updates through the use of Google Cloud Functions.

IBM Watson IoT: Offers device registration, authentication, and device management functionalities. Provides device shadowing for synchronizing device state and supports OTA firmware updates.

Data Ingestion and Storage:

AWS IoT: Offers IoT Core for data ingestion and Amazon S3 for scalable and durable storage of IoT data. Supports integration with AWS services like Amazon Kinesis, DynamoDB, and Redshift for advanced data processing and analytics.

Azure IoT: Provides Azure IoT Hub for data ingestion and Azure Blob Storage for storing IoT data. Offers integration with Azure Stream Analytics, Azure Event Hubs, and Azure Cosmos DB for advanced data processing and analytics.

Google Cloud IoT: Offers data ingestion through Cloud IoT Core and provides scalable storage using Google Cloud Storage. Integrates with Google Cloud Dataflow, Big Query, and Pub/Sub for real-time analytics and processing.

IBM Watson IoT: Provides data ingestion through the IBM Watson IoT Platform and supports data storage in various cloud databases such as IBM Db2 and IBM Cloudant. Offers integration with IBM Watson Studio and Watson Machine Learning for advanced analytics.

Real-time Analytics:

AWS IoT: Integrates with AWS IoT Analytics and Amazon Kinesis for real-time analytics and processing of IoT data. Offers integration with AWS Lambda for serverless computing and AWS Sage Maker for machine learning capabilities.

Azure IoT: Offers Azure Stream Analytics for real-time data processing and analytics. Provides integration with Azure Functions and Azure Machine Learning for advanced analytics and machine learning capabilities.

Google Cloud IoT: Integrates with Google Cloud Dataflow for real-time data processing and analysis. Offers integration with Google Cloud Pub/Sub, Big Query, and TensorFlow for advanced analytics and machine learning.

IBM Watson IoT: Offers integration with IBM Watson Studio, Watson Machine Learning, and IBM Streams for real-time analytics and advanced machine learning capabilities.

Security:

AWS IoT: Provides robust security features, including device authentication, authorization, and secure communication using Transport Layer Security (TLS). Offers integration with AWS Identity and Access Management (IAM) for access control.

Azure IoT: Offers secure device provisioning and authentication using X.509 certificates or symmetric keys. Provides integration with Azure Key Vault for secure key storage and supports role-based access control.

Google Cloud IoT: Provides device authentication and secure communication using X.509 certificates and TLS. Offers integration with Google Cloud IAM for access control and identity management.

IBM Watson IoT: Offers device authentication and authorization using X.509 certificates. Provides secure communication using TLS and supports integration with external identity providers.

Scalability and Integration:

AWS IoT: Provides auto-scaling capabilities to handle varying workloads. Offers seamless integration with other AWS services, such as Lambda, S3, DynamoDB, and Redshift, for scalable data processing and storage.

Azure IoT: Offers scalable infrastructure and supports horizontal scaling of IoT solutions. Provides integration with other Azure services like Azure Functions, Event Hubs, and Cosmos DB for seamless data processing and storage.

Google Cloud IoT: Provides auto-scaling capabilities and leverages Google's global infrastructure for scalability. Integrates with Google Cloud Pub/Sub, Dataflow, Big Query, and Storage for seamless data processing and storage.

IBM Watson IoT: Offers scalability through the IBM Cloud infrastructure. Provides integration with other IBM Cloud services like Watson Studio, Watson Machine Learning, and Db2 for seamless data processing and storage.

This comparative analysis provides an overview of the features and capabilities of popular IoT cloud platforms. Organizations can use this information to evaluate which platform aligns best with their specific requirements, use cases, and scalability needs. It is important to conduct a detailed analysis and consider additional factors such as pricing, ecosystem support, developer tools, and customer support before making a final decision.

When conducting a comparative analysis of IoT cloud platforms, it is essential to evaluate key aspects such as device management, data storage and processing, security, scalability, and integration capabilities. Here is a comparative analysis of four popular IoT cloud platforms: Amazon Web Services (AWS) IoT, Microsoft Azure IoT, Google Cloud IoT, and IBM Watson IoT.

Device Management:

AWS IoT: Provides comprehensive device management capabilities, including device registration, authentication, and secure communication. Offers device shadowing for synchronizing and managing device state and allows over-the-air (OTA) updates.

Azure IoT: Offers robust device provisioning and management, supporting both individual and bulk device registration. Provides device twin functionality for managing device metadata and state, and supports OTA updates.

Google Cloud IoT: Provides device registration and management features, including device authentication and authorization. Offers device state management and allows OTA updates through the use of Google Cloud Functions.

IBM Watson IoT: Offers device registration, authentication, and device management functionalities. Provides device shadowing for synchronizing device state and supports OTA firmware updates.

Data Storage and Processing:

AWS IoT: Offers IoT Core for data ingestion and Amazon S3 for scalable and durable storage of IoT data. Supports integration with AWS services like Amazon Kinesis, DynamoDB, and Redshift for advanced data processing and analytics.

Azure IoT: Provides Azure IoT Hub for data ingestion and Azure Blob Storage for storing IoT data. Offers integration with Azure Stream Analytics, Azure Event Hubs, and Azure Cosmos DB for advanced data processing and analytics.

Google Cloud IoT: Offers data ingestion through Cloud IoT Core and provides scalable storage using Google Cloud Storage. Integrates with Google Cloud Dataflow, Big Query, and Pub/Sub for real-time analytics and processing.

IBM Watson IoT: Provides data ingestion through the IBM Watson IoT Platform and supports data storage in various cloud databases such as IBM Db2 and IBM Cloudant. Offers integration with IBM Watson Studio and Watson Machine Learning for advanced analytics.

Security:

AWS IoT: Provides robust security features, including device authentication, authorization, and secure communication using Transport Layer Security (TLS). Offers integration with AWS Identity and Access Management (IAM) for access control.

Azure IoT: Offers secure device provisioning and authentication using X.509 certificates or symmetric keys. Provides integration with Azure Key Vault for secure key storage and supports role-based access control.

Google Cloud IoT: Provides device authentication and secure communication using X.509 certificates and TLS. Offers integration with Google Cloud IAM for access control and identity management.

IBM Watson IoT: Offers device authentication and authorization using X.509 certificates. Provides secure communication using TLS and supports integration with external identity providers.

Scalability and Performance:

AWS IoT: Provides auto-scaling capabilities to handle varying workloads. Offers seamless integration with other AWS services, such as Lambda, S3, DynamoDB, and Redshift, for scalable data processing and storage.

Azure IoT: Offers scalable infrastructure and supports horizontal scaling of IoT solutions. Provides integration with other Azure services like Azure Functions, Event Hubs, and Cosmos DB for seamless data processing and storage.

Google Cloud IoT: Provides auto-scaling capabilities and leverages Google's global infrastructure for scalability. Integrates with Google Cloud Pub/Sub, Dataflow, Big Query, and Storage for seamless data processing and storage.

IBM Watson IoT: Offers scalability through the IBM Cloud infrastructure. Provides integration with other IBM Cloud services like Watson Studio, Watson Machine Learning, and Db2 for seamless data processing and storage.

Integration and Ecosystem:

AWS IoT: Offers a rich ecosystem of services, tools, and integrations with other AWS offerings. Provides extensive support for popular development languages and frameworks.

Azure IoT: Integrates well with the wider Microsoft Azure ecosystem, including services like Azure Functions, Machine Learning, and Power BI. Provides robust developer tools and support for multiple programming languages.

Google Cloud IoT: Offers seamless integration with the Google Cloud ecosystem, including services like Pub/Sub, Big Query, and Dataflow. Provides comprehensive development tools and APIs.

IBM Watson IoT: Integrates with other IBM Cloud services and solutions, such as Watson Studio, Watson Machine Learning, and Db2. Offers extensive support for analytics and cognitive capabilities.

It is crucial to conduct a thorough analysis and consider factors such as pricing, customer support, developer community, and specific requirements of the IoT project before selecting an IoT cloud platform. This comparative analysis provides a starting point to evaluate the strengths and weaknesses of each platform, helping organizations make informed decisions based on their unique needs.

Performance and Reliability Analysis

To assess the performance and reliability of IoT cloud platforms, it is crucial to conduct rigorous testing and analysis. Here are some key aspects to consider when performing a performance and reliability analysis:

Performance Metrics: Define relevant performance metrics based on the specific use cases and requirements of the IoT application. Metrics may include latency, throughput, response time, data processing speed, and scalability.

Workload Testing: Design and execute workload tests to evaluate how the IoT cloud platforms handle varying data loads and concurrent device connections. Generate synthetic workloads or use real-world data to simulate realistic scenarios and measure platform performance under different conditions.

Latency Analysis: Measure the end-to-end latency between IoT devices and the cloud platform. Assess the time it takes for devices to send data, the platform to receive and process it, and the resulting actions or responses. Analyse latency variations under different workloads and network conditions.

Throughput Analysis: Evaluate the throughput of the IoT cloud platforms, which refers to the volume of data that can be processed and transmitted within a given time frame. Measure the rate at which data is ingested, processed, and transmitted between devices and the cloud platform.

Scalability Evaluation: Assess the ability of the IoT cloud platforms to scale resources to handle increased workloads. Test how well the platforms can accommodate a growing number of devices, data volume, and concurrent connections without experiencing significant performance degradation.

Reliability and Availability: Evaluate the reliability and availability of the IoT cloud platforms. Monitor uptime and measure the platform's ability to handle failures or disruptions gracefully. Analyse data backup and recovery mechanisms, as well as disaster recovery capabilities.

Fault Tolerance and Redundancy: Assess the fault tolerance and redundancy features of the IoT cloud platforms. Test how the platforms handle device or component failures, network interruptions, and data loss scenarios. Evaluate the platform's ability to recover from failures and maintain data integrity.

Real-time Analytics Performance: If real-time analytics is a critical component of the IoT application, evaluate the performance of the platforms in processing and analyzing data in real-time. Measure the time it takes for the platforms to perform analytics tasks, generate insights, and trigger appropriate actions.

Performance Under Load: Stress test the IoT cloud platforms to determine their performance limits. Increase the data load and device connections to assess the platform's behaviours and identify any bottlenecks or performance limitations.

Comparative Analysis: Compare the performance and reliability results across different IoT cloud platforms. Identify the platforms that exhibit superior performance, reliability, and scalability based on the defined metrics and evaluation criteria.

Optimization Opportunities: Identify potential areas for optimization and performance improvement. Explore strategies such as data partitioning, load balancing, caching, and query optimization to enhance platform performance and reliability.

Real-world Use Cases: Validate the performance and reliability of the IoT cloud platforms in real-world use cases. Deploy the platforms in practical IoT applications and monitor their performance over an extended period. Gather feedback from users and stakeholders to assess the platforms' reliability in real-world scenarios.

By conducting a comprehensive performance and reliability analysis, researchers and practitioners can gain insights into the capabilities of IoT cloud platforms. The analysis helps identify platforms that can handle the desired workloads, provide high availability, and deliver the required performance for specific IoT applications.

Cost Analysis and Optimization

When evaluating IoT cloud platforms, conducting a cost analysis is essential to understand the financial implications of using each platform. Here are steps to perform a cost analysis and identify optimization opportunities:

Cost Components: Identify the different cost components associated with each IoT cloud platform. These may include device connectivity fees, data storage costs, data transfer charges, compute resources, and additional services or features that incur costs.

Usage Scenarios: Define representative usage scenarios for your IoT application. Consider factors such as the number of devices, data volume, frequency of data transmission, and the desired level of data retention.

Pricing Models: Understand the pricing models of each IoT cloud platform. Analyse pricing structures such as pay-as-you-go, tiered pricing, and reserved instances. Take note of any minimum commitments, discounts for long-term usage, and pricing variances across different regions.

Cost Estimation: Estimate the costs associated with each platform based on your defined usage scenarios. Consider factors such as data ingestion, data storage, data processing, device connectivity, and any additional services utilized in your IoT application.

Optimization Opportunities: Identify potential optimization opportunities to reduce costs while maintaining the required functionality and performance. Some optimization strategies may include:

a. Data Storage Optimization: Evaluate the data storage requirements of your application and consider compression techniques, data lifecycle management, and tiered storage options to optimize costs.

b. Data Processing Optimization: Analyse the data processing needs of your IoT application and consider optimizing the use of compute resources. Explore serverless computing options, resource allocation strategies, and efficient use of data processing services.

c. Device Connectivity Optimization: Assess the connectivity requirements of your devices and explore options for optimizing device connectivity costs. Consider batching or aggregating data transmissions, optimizing data payloads, and choosing the appropriate connectivity plans.

d. Service Tier Optimization: Evaluate the service tiers offered by each IoT cloud platform and assess whether the desired level of service matches your application requirements. Consider adjusting service tiers to balance functionality and cost.

Cost Comparison: Compare the estimated costs of using each IoT cloud platform based on the defined usage scenarios. Identify the platform that offers the best balance between cost and required functionality for your specific application needs.

Total Cost of Ownership (TCO): Consider the long-term implications of using each platform. Evaluate factors such as vendor lock-in, future scalability requirements, potential price reductions or increases, and the availability of cost management tools.

Cost Optimization Monitoring: Continuously monitor and review the costs incurred by your IoT application on the selected platform. Utilize cost management tools and services provided by the platform to identify cost-saving opportunities and adjust usage patterns accordingly.

Cost Optimization Strategies: Implement cost optimization strategies based on the findings of your cost analysis. Regularly review and refine these strategies as your IoT application evolves and as new cost-saving opportunities emerge.

Evaluation of Cost-Effectiveness: Consider the cost-effectiveness of each IoT cloud platform, taking into account factors such as the quality of service, scalability, reliability, support, and the overall value proposition provided by the platform.

By conducting a thorough cost analysis and implementing optimization strategies, you can effectively manage and optimize the costs associated with your IoT cloud platform. This allows you to make informed decisions that align with your budgetary constraints while maximizing the value and performance of your IoT application.

Use Cases and Industry Applications

IoT cloud platforms find application in various industries, enabling innovative solutions and transforming processes across different sectors. Here are some prominent use cases and industry applications where IoT cloud platforms play a crucial role:

Smart Home Automation: IoT cloud platforms enable the integration and management of smart devices in homes, allowing users to control and automate various functions such as lighting, temperature, security systems, and entertainment systems. These platforms provide centralized control, data analytics, and remote access to smart home devices, enhancing convenience, energy efficiency, and security.

Industrial IoT (IIoT): IoT cloud platforms have a significant impact on industries, enabling the digital transformation of manufacturing, supply chain management, and asset monitoring. IIoT applications include predictive maintenance of machinery, real-time monitoring of production lines, inventory optimization, and remote asset management. IoT cloud platforms provide connectivity, data storage, analytics, and integration with other industrial systems.

Healthcare and Remote Patient Monitoring: IoT cloud platforms are used to monitor and manage the health of patients remotely. Connected medical devices, wearable sensors, and health monitoring systems transmit real-time data to the cloud platform, allowing healthcare providers to monitor patient vitals, detect anomalies, and provide timely interventions. These platforms offer secure data storage, analytics, and integration with healthcare systems for comprehensive patient care.

Smart Cities and Infrastructure: IoT cloud platforms are instrumental in building smart cities and optimizing urban infrastructure. They enable the collection and analysis of data from various IoT devices and sensors deployed throughout the city, supporting functions such as traffic management, waste management, environmental monitoring, energy management, and public safety. These platforms provide real-time insights, analytics, and integration with city management systems.

Agriculture and Environmental Monitoring: IoT cloud platforms are utilized in agriculture for precision farming, monitoring soil conditions, crop health, and irrigation systems. They enable the collection of data from IoT sensors deployed in fields and provide analytics and actionable insights to optimize crop yields, reduce water usage, and minimize environmental impact. These platforms facilitate remote monitoring, data visualization, and integration with agricultural management systems.

Energy Management and Smart Grids: IoT cloud platforms are employed in energy management to monitor, control, and optimize energy consumption. They enable the integration of IoT devices, sensors, and smart meters, allowing real-time monitoring of energy usage, load balancing, demand response, and integration of renewable energy sources. These platforms offer analytics, predictive modelling, and integration with utility management systems.

Retail and Inventory Management: IoT cloud platforms are used in the retail sector for inventory management and supply chain optimization. Connected sensors and RFID tags provide real-time visibility into inventory levels, stock movement, and shelf availability. These platforms enable accurate demand forecasting, inventory optimization, and integration with retail management systems for efficient stock management and order fulfilment.

Transportation and Fleet Management: IoT cloud platforms are employed in transportation and logistics for fleet management, vehicle tracking, and route optimization. Connected vehicles and sensors transmit real-time data on location, vehicle health, fuel consumption, and driver behaviours to the cloud platform. These platforms provide fleet analytics, predictive maintenance, driver performance monitoring, and integration with transportation management systems.

Environmental Monitoring and Conservation: IoT cloud platforms play a crucial role in monitoring and conserving the environment. They enable the deployment of IoT sensors and devices for tracking air quality, water quality, biodiversity, and weather conditions. These platforms provide data analysis, early warning systems, and integration with environmental management systems to support conservation efforts.

Hospitality and Smart Buildings: IoT cloud platforms are utilized in the hospitality industry for smart building management and guest experience enhancement. They integrate IoT devices such as smart thermostats, occupancy sensors, and smart locks to optimize energy usage, automate room controls, and personalize guest experiences. These platforms provide centralized management, analytics, and integration with hotel management systems.

These are just a few examples of the wide-ranging applications of IoT cloud platforms across different industries. The versatility and scalability of these platforms make them a vital enabler of digital transformation, offering connectivity, data management, analytics, and integration capabilities for innovative IoT solutions.

Challenges and Future Directions

While IoT cloud platforms have made significant advancements, several challenges and opportunities for future development exist. Here are some key challenges and future directions in the field:

Interoperability and Standardization: Interoperability remains a challenge in the IoT ecosystem. The lack of standardized protocols and data formats hinders seamless integration and communication between different devices and platforms. Future directions include promoting industry-wide collaboration, developing common standards, and establishing interoperability frameworks to ensure compatibility and facilitate seamless data exchange.

Edge Computing and Fog Computing Integration: As the number of IoT devices and the volume of data they generate continue to increase, there is a growing need to process data closer to the edge of the network. Integrating edge computing and fog computing capabilities into IoT cloud platforms can enable real-time decision-making, reduce latency, enhance data privacy, and alleviate network congestion. Future directions involve optimizing edge-to-cloud data flows, developing efficient edge analytics algorithms, and enabling distributed processing across edge, fog, and cloud resources.

Privacy and Security Enhancements: The proliferation of IoT devices increases concerns about data privacy and security. Future directions include implementing robust security mechanisms, encryption techniques, and access control measures to protect IoT data and devices. Enhancements in identity management, secure device provisioning, and secure communication protocols will be crucial to address the evolving cybersecurity threats associated with IoT deployments.

Advances in Analytics and Machine Learning: IoT cloud platforms can leverage advanced analytics and machine learning techniques to extract meaningful insights from the vast amount of IoT data generated. Future directions include developing more sophisticated analytics algorithms, integrating AI and machine learning capabilities into IoT platforms, and enabling real-time and predictive analytics for faster and more accurate decision-making.

Edge AI and Distributed Intelligence: With the growth of edge computing, there is a trend towards moving AI and machine learning capabilities closer to the edge devices. Future directions involve integrating edge AI capabilities into IoT cloud platforms, enabling distributed intelligence, and allowing devices to perform local processing, decision-making, and data filtering. This approach reduces reliance on the cloud, enhances privacy, and enables faster response times in latency-sensitive applications.

Energy Efficiency and Sustainability: IoT deployments consume significant amounts of energy, which can strain power resources and have environmental impacts. Future directions involve optimizing power consumption in IoT devices, adopting energy-efficient communication protocols, and developing energy harvesting techniques to prolong device battery life. Additionally, exploring the use of renewable energy sources to power IoT infrastructure can contribute to sustainability goals.

Edge-to-Cloud Orchestration and Management: Managing a large-scale IoT deployment across edge devices, gateways, and the cloud requires efficient orchestration and management. Future directions include developing comprehensive tools and frameworks for provisioning, monitoring, and managing IoT resources, ensuring efficient utilization, fault tolerance, and scalability.

Cost Optimization and Business Models: While the costs associated with IoT cloud platforms continue to decrease, optimizing costs remains a challenge. Future directions involve developing cost optimization strategies, exploring flexible pricing models, and considering alternative business models to make IoT deployments financially viable for organizations of all sizes.

Ethical and Social Implications: As IoT deployments become more pervasive, addressing ethical and social implications becomes crucial. Future directions include defining and implementing ethical guidelines for IoT data collection, usage, and privacy. Ensuring transparency, consent, and accountability in IoT deployments will be essential to build trust among users and stakeholders.

Integration with Emerging Technologies: IoT cloud platforms can benefit from integration with other emerging technologies such as blockchain, 5G, and augmented reality (AR)/virtual reality (VR). Exploring synergies between IoT and these technologies can enhance security, connectivity, and immersive experiences, opening up new possibilities and use cases.

Addressing these challenges and exploring future directions will contribute to the evolution and maturation of IoT cloud platforms, enabling them to better support diverse IoT applications, enhance interoperability, strengthen security and privacy, optimize resource utilization, and leverage emerging technologies for maximum impact. Continued research, industry collaboration, and innovation will be key to unlocking the full potential of IoT cloud platforms in the coming years.

CONCLUSION

In conclusion, conducting a comparative analysis and evaluation of IoT cloud platforms and services provides valuable insights into their features, capabilities, and suitability for different use cases. By assessing factors such as device management, data ingestion and storage, real-time analytics, security, scalability, and integration, organizations can make informed decisions when selecting an IoT cloud platform.

The comparative analysis highlights the strengths and weaknesses of popular IoT cloud platforms such as Amazon Web Services (AWS) IoT, Microsoft Azure IoT, Google Cloud IoT, and IBM Watson IoT. Each platform offers unique features and functionalities, and their performance varies across different criteria. It is important to consider specific requirements, use cases, and scalability needs when making a final decision.

Challenges such as interoperability, security, and cost optimization exist in the IoT cloud platform landscape. Future directions involve addressing these challenges and exploring opportunities for edge computing integration, enhancing analytics and machine learning capabilities, improving energy efficiency, and considering ethical and social implications.

By considering the findings of the comparative analysis, organizations can select the most suitable IoT cloud platform that aligns with their requirements, ensuring seamless connectivity, efficient data management, and effective utilization of IoT devices. This choice will enable organizations to unlock the full potential of IoT, drive digital transformation, and achieve enhanced operational efficiency, improved decision-making, and innovative business opportunities

REFERENCES

[5] "Internet of Things (IoT) A Literature Review" by Vimal Kumar and Ashish Kr. Luhach in International Journal of Computer Science and Information Technologies (IJCSIT)

[6] "A Comprehensive Study on Internet of Things (IoT): Applications, Challenges, and Future Directions" by Pethuru Raj and Anupama C. Raman in Journal of Ambient Intelligence and Humanized Computing

[7] "Cloud Computing for IoT: A Systematic Review" by Sahar Hoteit, Fabrice Mourlin, and Robert Laurini in Sensors

[8] "An Internet of Things (IoT)-Based Architecture for Smart Healthcare System Using Cloud Computing" by Syed Muhammad Hassan Zaidi, Muzzammil Hussain, and Sabahat Tariq in Sensors

[9] "A Comparative Analysis of IoT Development Platforms" by Jonathan Mayo, Oscar Postigo, and Miguel Vargas-Martin in Proceedings of the 3rd International Conference on Internet of Things, Big Data and Security (IoTBDS)

[10] These references can serve as a starting point for your research on IoT cloud platforms and services. Additionally, you can explore academic databases, research papers, and conference proceedings related to IoT, cloud computing, and specific IoT cloud platforms such as AWS IoT, Azure IoT, Google Cloud IoT, and IBM Watson IoT.

[11] hniques. A K Peters, Ltd, MA, USA.

PERFORMANCE ANALYSIS OF FUZZY AND PCA-BASED HUMAN EMOTION RECOGNITION MODEL

Laxman Singh

Assistant Professor,
Department Of ECE
JB Institute of Technology , Dehradun,

ABSTRACT

This research paper will analyze the performance of the human emotion recognition model (HERM) based on fuzzy and PCA approaches. Here new database is also prepared and different tests are carried out on this database. In this paper effectiveness of the Fuzzy face detector and segmenter (FFDAS)is also exposed. Further comparison between recognition rates of various emotions is also presented by preparing confusion matrices.

Keywords-Emotion Recognition, Fuzzy, Principal component analysis (PCA), Euclidean Distance, Eigen Range, Recognition Rate

INTRODUCTION

The most crucial element for happier connections between people is emotion. Human-human connection is becoming increasingly rare and is being supplanted by human-computer interaction (HCI) as a result of humans' increasing reliance on highly intelligent technologies. Emotions, however, also play a significant part in human-computer interactions since people can never completely turn off their emotions. Researchers discovered that even though they had created a very intelligent computer, it was still unable to effectively communicate with people because it lacked emotions. This was the beginning of the emotion detection problem.

The purpose of this work is to empirically examine how well the fuzzy and PCA technique for recognizing various emotions described in the paper [8] performs. Three elements make up the suggested approach for recognizing emotions: FFDAS, PCA for dimensionality reduction, and Euclidean Distance for emotion detection. The structure of this essay is as follows: The general methodology for automated facial expression analysis is presented in Section 2. Section 3 presents a neural network as a classifier for emotion recognition. General PCA feature selection and reduction difficulties are covered in Section 4. Experimental assessment is presented in Section 5. The final part discusses the outcomes and makes some final observations.

METHODOLOGY

In this research. Fuzzy logic is used to segment and identify faces. PCA is used to identify emotions, and it is based on an information theory methodology where the pertinent data from a face is retrieved as effectively as feasible. Euclidean Distance also serves as a measure of similarity between training images and the image being tested in emotion classification. The proposed human emotion recognition model (HERM) consists of the following six stages:

1. Database Preparation
2. Pre-Processing
3. Implementation of FFDAS
4. PCA algorithm
5. Euclidean Distance Calculation
6. Emotion Recognition

DATABASE PREPARATION: The most crucial component needed to construct HERM is a database. Two different databases have been prepared for this research. By taking several pictures of a youngster in various states of feeling, a database1 of 52 photographs has been created.The sample of Database 1 is shown in Figure 1. In addition, the database is split into two sets: the training dataset (40 photos) and the testing dataset (12 images). Face photos of a single person with the following emotions are included in the training and testing datasets: neutral, happy, sad, angry, disgusted, and surprised. JPEG format is used for images.

Fig. 1- Sample of Database 1

The FACES Collection database as shown in Figure 2, which is connected to the Max Planck Institute for Human Development, is used for another set of databases [2]. This collection includes several people in a range of moods, representing various age groups and genders. BMP format is used for images.

PREPROCESSING: After the preparation of databases preprocessing is the next step of the suggested model. The following preprocessing processes are applied to both training and test images:

Lightning Compensation: Variable illumination is one of the most difficult issues in face recognition since it is impossible to alter lighting conditions in practical applications. Prior to face identification, illumination compensation must be carried out, which involves compensating for the uneven illumination of human faces and reconstructing face pictures under standard lighting circumstances. The categorization process then employs the rebuilt facial pictures. Lightning Compensation is done by using the Matlab command below:

J = IMADJUST (I,[LOW_IN; HIGH_IN], [LOW_OUT; HIGH_OUT])

Where, [LOW_IN; HIGH_IN] = [0.3; 1] and

[LOW_OUT; HIGH_OUT] = [0; 1]

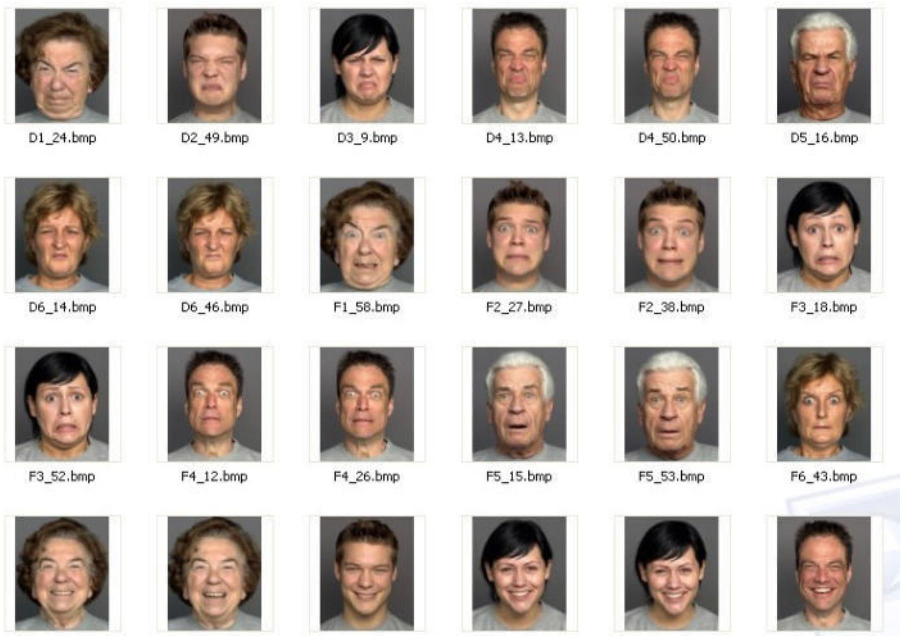


Fig. 2- Sample of Database 2

It maps the values in intensity image I to new values in J such that values between LOW_IN and HIGH_IN map to values between LOW_OUT and HIGH_OUT. Values below LOW_IN and above HIGH_IN are clipped; that is, values below LOW_IN map to LOW_OUT, and those above HIGH_IN map to HIGH_OUT.

Image Sharpening: To combat the effects of interpolation and anti-aliasing filters, digital pictures must be sharpened. The following command is used to perform image sharpening:

```
cn=rgb2ntsc(RGB);
 a=fspecial('unsharp');
 cn(:,:,1)=filter2(a,cn(:,:,1));
 cu=ntsc2rgb(cn);
```

RGB2NTSC RGB values should be converted to NTSC color space. The grayscale signal used to display images on monochrome (black and white) televisions in the NTSC color scheme is called brightness. The information about hue and saturation is contained in the other components. The NTSC components are defined by the function 'rgb2ntsc' using

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.274 & -0.322 \\ 0.211 & -0.523 & 0.312 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

A 3-by-3 unsharp contrast enhancement filter is produced by H = FSPECIAL ('unsharp', ALPHA). From the negative of the Laplacian filter with parameter ALPHA, FSPECIAL produces the unsharp filter. The value of ALPHA, which determines the Laplacian's shape, must be between 0.0 and 1.0. ALPHA is set by default at 0.2.The formula Y = filter2 (h, X) applies a two-dimensional FIR filter on the data in X. It uses two-dimensional correlation to calculate the outcome, Y, and then returns the portion of the correlation's center that is the same size as X.

Histogram Equalization: Sometimes images look washed out because they do not have sufficient contrast. In some images, the light and dark areas blend together creating a flatter image that lacks highlights and shadows. Histogram equalization can overcome this problem. The MATLAB function 'histeq(image)' can be used to perform histogram equalization. By changing the values in an intensity image so that the histogram of the output image roughly resembles a specified histogram, the function "histeq" improves the contrast of images.

Noise Removal: Because image analysis is necessary, noise reduction is a crucial task in image processing. When eliminating noise, it's crucial to maintain image features so that the edges and corners of the objects are still clearly visible. There are numerous methods for eliminating both linear and nonlinear noise from images. In this research, the RGB image's noise is removed using the "medfilt2." Median filtering is implemented by this function. To lessen "salt and pepper" noise, median filtering is a nonlinear procedure that is frequently employed in image processing.

IMPLEMENTATION OF FFDAS: Images are input to FFDAS after preprocessing in order to minimize workspace by precisely finding and cropping the facial region from the image. Initially, YCbCr color space is used to transform RGB images. Following that, a Sugano-type fuzzy inference system (FIS) is designed, and Cb and Cr values are used to differentiate the skin tone of the face from the rest of the image.

Membership function Editor: For face region selection, as shown in Figure 3. Cb and Cr are the inputs that is defined by three membership functions: Light, Medium and Dark. Each membership function is of trapezoidal shape (trapmf):

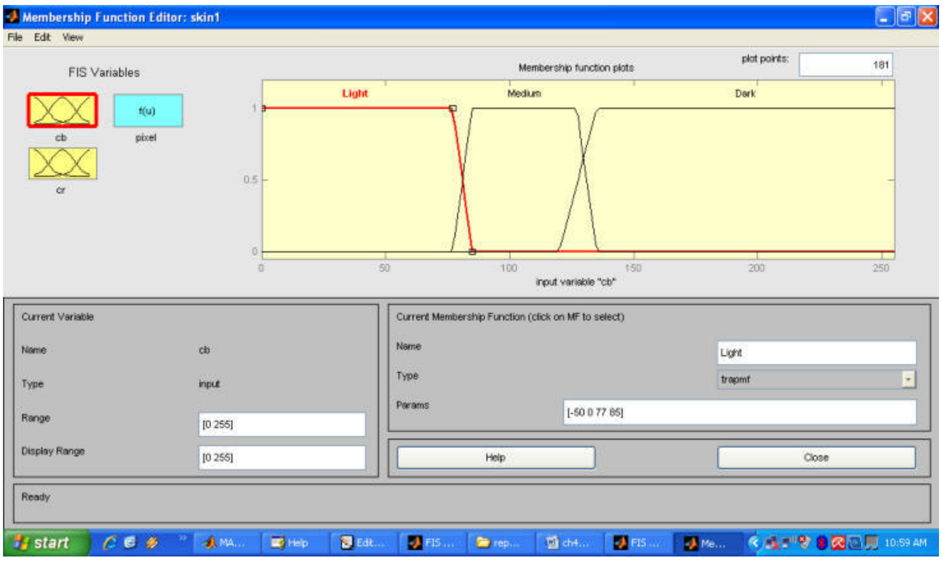


Fig. 3- Membership Function Editor for Input Cb

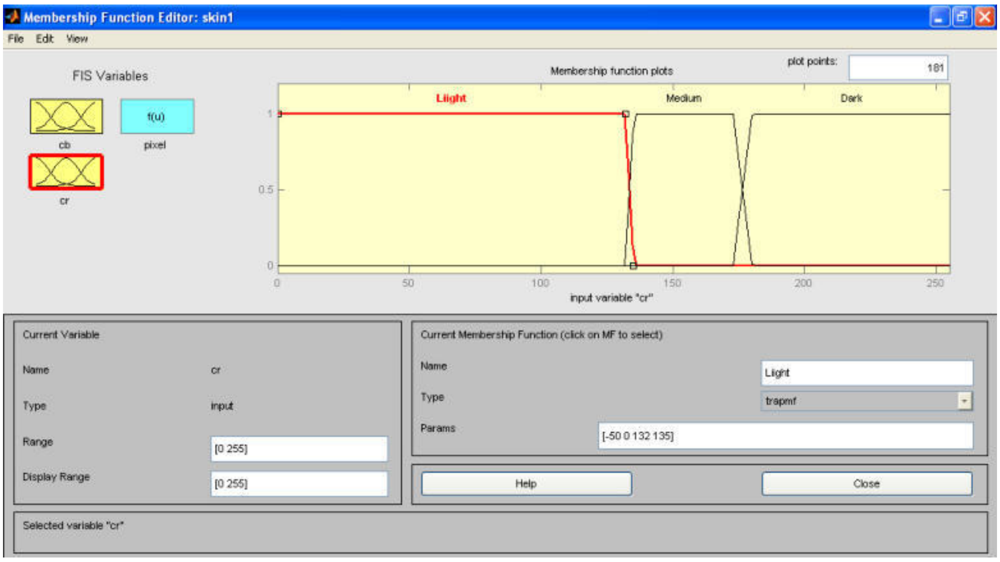


Fig. 4- Membership Function Editor for Input Cr

Output of FIS is denoted by skin and is defined by two membership functions: 'skin' and 'notskin' of constant type with value '0' (for 'notskin') and '1' (for 'skin').

Rule Editor: As there are two inputs each with three membership functions then set of 9 rules are formed. These rules are defined on the basis of some prior knowledge about skin region, such as

"IF Cb is Light and Cr is Light THEN the skin_pixel =0".

Skin pixels are further selected using thresholds of HSV model. These selected skin pixels are separated out from rest of the image for further operations.

PCA FOR FEATURE EXTRACTION: PCA is used to extract distinctive facial features vital to differentiating between various human emotions. This is the applied PCA algorithm:

1. Create the data set of M human facial imagesi.e., I= {I1, I2, I3 ….IM} (each with NxN pixels) necessary for feature extraction.
2. Create vector versionsN^2X1 of each NXN image matrix.
3. Build database matrix I (N^2XM) that combines all of the images into a single matrix.
4. Calculate mean for each image dimension (each column of matrix I). Resulting matrix I_{MEAN} will be a row vector of dimension MX1.
5. Subtract the mean of each image dimension from image vector. Resultant matrix is known as mean adjusted matrix (say Y).
6. Calculate the covariance matrix C of mean adjusted matrix Y obtained in step 5.
7. Calculate the eigen vector matrix λ_k and eigen values u_k of covariance matrix such that C= $\lambda_k u_k$
8. Feature vector is prepared by collecting all eigenvectors in one matrix.
9. Multiply feature vector by mean adjusted data to calculate image feature.
10. Face space F is created by collecting image features of all images.
11. Feature spaces F are used for classification of different emotions.

COMPUTING EUCLIDEANDISTANCES: This fundamental principle, "dimensionality reduction followed by distance calculation in a subspace," is one of the key strategies for dealing with complexity and seeing patterns in vast volumes of real-world data. The distance between two face pictures in the original eigenface is not the distance in the original MXN dimensional image space, but rather the Euclidean distance between their projected points in a PCA subspace. We have substituted MXN discrepancies between pixel values with a single value by calculating the distance between face photos. The method used by eigenface to increase the signal-to-noise ratio is computing the distance between faces in this lower dimensional sub-space.

EMOTION RECOGNITION: An indicator of how similar two feature vectors from images i and j are to one another is the Euclidean distance between them. Calculated Euclidean distances exist between test photos and other training images. The final recognized emotion associated with that test image is therefore said to be the expression of the training image that produces the least Euclidean distance.

EXPERIMENTAL RESULTS AND ANALYSIS

An algorithm for facial expression recognition divides the provided image into seven fundamental facial emotion categories: surprise, anger, disgust, neutral, surprise, fear, and terror.

The FACE Collection database, which contains faces of people in various age groups and genders, is used to test the proposed technique. Additionally, our own prepared database is used for testing. For the purpose of evaluating the system's performance, two different training and testing databases have been created. The machine also fed the emotions connected with each image in the training database. The training data set's model subjects are represented in the testing data set's 12 separate test photos. Here, the system is unaware of the emotion connected to each visual. And this is what we anticipate from our system—that it will associate the most appropriate feeling with these visuals.

As a simulation tool, Matlab's Image Processing Toolbox is employed. The following simulation results are also displayed:

1. FFDAS is first used to extract faces from the training and test data sets. The testing dataset's simulation result is displayed in Figure5.

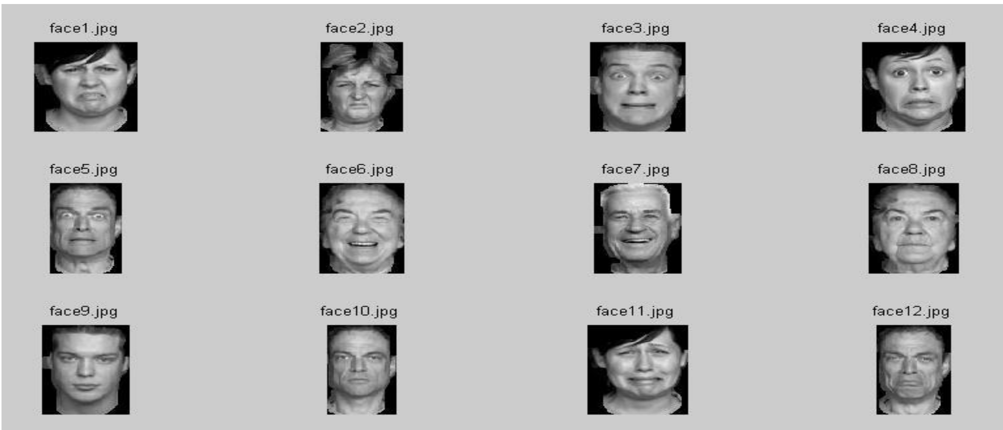


Fig. 5-Cropped face region of testing dataset 2 using FFDAS

2. Then, using lower-order principal components—which contain the "most important" aspects of the data—instead of higher-order ones, PCA is performed on the input data to reduce its dimensionality while maintaining those properties of the data set that contribute most to its variance. Projecting a test image on face space is done using the retrieved feature vectors from the reduced space.
3. Euclidean distance between each test image's eigenface and the training dataset is calculated. The test image with the smallest Euclidean distance between its eigenface and the training dataset is deemed to be the best match, and the expression associated with the corresponding train image is thought to represent the test image's emotion. Figure6 displays the simulation output for this stage. Test photos are shown here along with the resulting emotion.

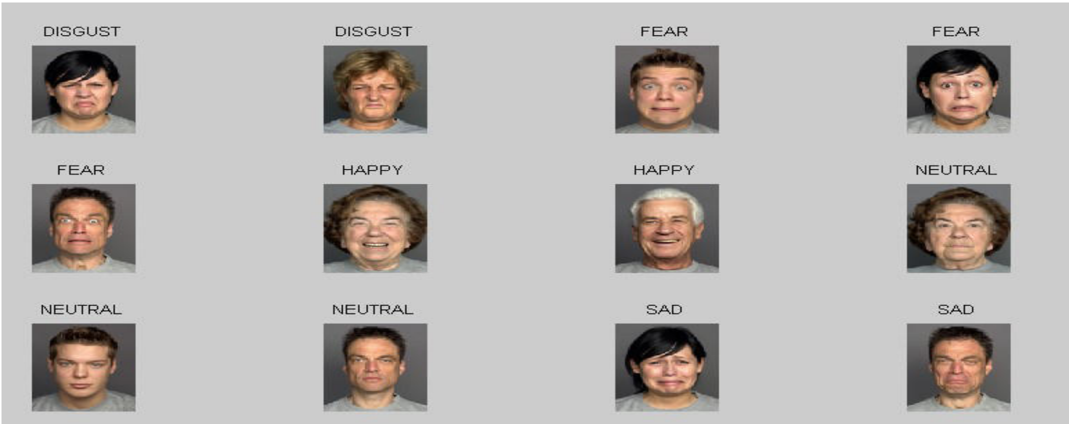


Fig. 6-Recognized emotions for testing dataset 2

4. There are also some non-face photos in Dataset 1. Figure 7's simulation results demonstrate that our suggested system can also distinguish between images of faces and objects without faces.

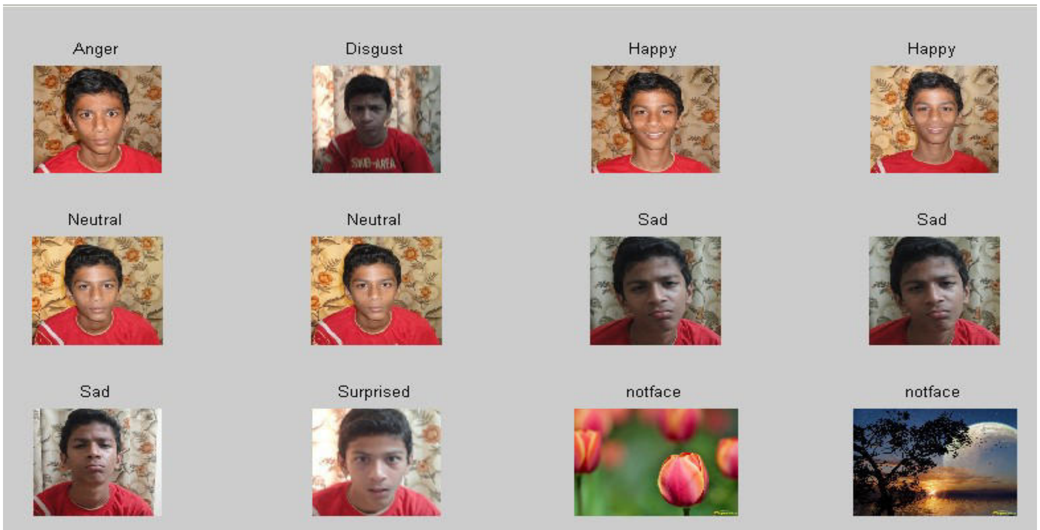


Fig. 7-Recognized emotions and non-face images for testing dataset 1

Variations in the number of eigenfacesutilized for feature extraction are used to analyze the suggested method as well. Figure 8 displays the recognition performance.The experiment is based on:

Number of Train images = 40

Number of Test images = 12

The result of the proposed algorithm is:

Maximum recognition rate = 100% (when approximately half number of Eigen faces used)

Minimum recognition rate = 41.66%

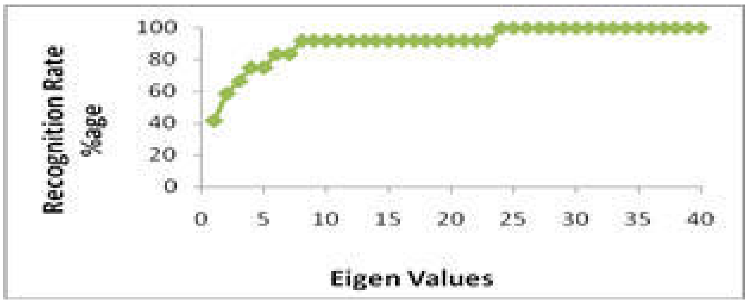


Fig. 8- Graph of Recognition Rate v/s Eigen Values for Database 2

CONCLUSION

This research proposes a fuzzy and PCA-based emotion identification system. The findings of an experiment demonstrating the success of the fuzzy and PCA approaches in identifying emotions through facial expressions had an average detection rate of almost 96.66% when seven emotions were tested. Future studies like the simultaneous analysis of non-static, real-time photos using emotional computing approaches could benefit from the findings of this research. With these likely outcomes, assistants and computer optimizers might assist users in the most varied applications. By performing these analyses, some of the user's emotional states, such as joy, fear, and anger, could be seen.

REFERENCES

(31) Byun, SW., Lee, SP. Human emotion recognition based on the weighted integration method using image sequences and acoustic features. Multimed Tools Appl **80**, 35871–35885 (2021).

(32) https://faces.mpdl.mpg.de/imeji/

(33) Jamshidnezhad Amir. (2011). A Learning Fuzzy Model for Emotion Recognition,European Journal of Scientific Research, Vol.57, No.2, pp.206-211.

(34) Kaur M., Vashisht R., Nirvair N. (2010). Recognition of Facial Expressions with Principal Component Analysis and Singular Value Decomposition,International Journal of Computer Applications, Vol.9, No.12, pp. 36-40.

(35) Kharat G.U., Dudul S.V.(2008). Emotion Recognition from Facial Expression Using Neural Networks, HIS, Krakow, Poland, May 25-27, IEEE.

(36) Kishore K.V.K. and Varma G.P.S. (2011). Efficient Facial Emotion Classification with Wavelet Fusion of Multi Features", IJCSNS International Journal of Computer Science and Network Security, Vol.11, No.8.

(37) Liu M, Li S, Shan S, Wang R, and Chen X (2014) Deeply learning deformable facial action parts model for dynamic expression analysis. 2014 Asian Conference on Computer Vision (ACCV) 143–157.

(38) Tayal S. and Vijay S. (2012). Human Emotion Recognition and Classification from Digital Color Images Using Fuzzy and PCA Approach" Advances in Computer Science, Eng. & Appl., AISC 167, pp. 1033–1040.

FUTURE SCOPE OF ELECTRONICS AND COMMUNICATION ENGINEERING: TRENDS, CHALLENGES, AND OPPORTUNITIES

Jitesh Kumar
Assistant Professor,
Department Of ECE
JB Institute of Technology , Dehradun,

ABSTRACT

A key factor in determining the direction of technology is the fast-developing discipline of electronics and communication engineering (ECE). By examining new trends, noting obstacles, and analysing developing patterns, this research study investigates the future use of ECE. The Internet of Things (IoT), 5G and beyond, artificial intelligence (AI), and nanotechnology are some of the major topics covered in this article. ECE professionals may be ready for the exciting and revolutionary advances that lie ahead by grasping the potential of these technologies and their ramifications.

Keywords-Emotion Recognition, Fuzzy, Principal component analysis (PCA), Euclidean Distance, Eigen Range, Recognition Rate

INTRODUCTION

Over the years, Electronics and Communication Engineering (ECE) has made incredible strides, revolutionizing a number of industries like telecommunications, healthcare, transportation, and manufacturing. With the continued transformation of our world by new technology, the future has even more possibilities. By looking at new trends, emphasizing obstacles, and finding possibilities, this research study hopes to offer insights into the future use of Electronics and Communication Engineering, or ECE. ECE professionals may align their knowledge and abilities to take advantage of upcoming possibilities by comprehending the changing environment.

INTERNET OF THINGS (IOT)

IoT Overview:

The Internet of Things (IoT) is a vast ecosystem of physical devices, vehicles, and appliances connected through sensors, software, and connectivity. It enables remote monitoring, control, and optimization of objects through data-driven insights, revolutionizing various domains like healthcare, transportation, agriculture, manufacturing, and smart homes. IoT devices capture real-time data, such as temperature, humidity, motion, and location, and transmit it to a centralized system or cloud platform for analysis. This data can be used to make informed decisions, automate processes, and improve efficiency. IoT enhances productivity and convenience, enabling remote monitoring of vital signs in healthcare and optimizing irrigation in agriculture. By leveraging IoT, businesses can improve efficiency, reduce waste, and enhance overall user experience.

Applications and Impact:

The applications of the Internet of Things (IoT) span across various industries and have a significant impact on our daily lives. Here are some key applications and their impact:

1. Smart Homes: IoT enables homeowners to control and automate devices within their homes, enhancing convenience, energy efficiency, and security. Users can remotely monitor and

control lighting, appliances, and security systems, leading to optimized energy usage, cost savings, and improved home safety.

2. Healthcare: IoT is transforming healthcare through remote patient monitoring, wearable devices, and connected medical equipment. This enables continuous health monitoring, early detection of health issues, and personalized treatments. It also improves patient care by reducing hospital visits and allowing doctors to provide remote consultations.

3. Industrial Automation: IoT enhances industrial processes by connecting machines, equipment, and systems for real-time monitoring, data analysis, and automation. This leads to improved operational efficiency, predictive maintenance, reduced downtime, and optimized resource utilization in manufacturing plants and industrial settings.

4. Smart Cities: IoT plays a vital role in creating smarter and sustainable cities. Connected devices and sensors enable efficient transportation, smart street lighting, waste management, environmental monitoring, and enhanced public safety. This results in reduced traffic congestion, improved resource management, and better quality of life for citizens.

5. Agriculture: IoT applications in agriculture, known as precision farming or smart farming, enable farmers to monitor and optimize crop growth, irrigation, fertilization, and pest control. This leads to increased crop yield, reduced resource wastage, minimized environmental impact, and improved farming practices.

6. Logistics and Supply Chain Management: IoT enables real-time tracking, monitoring, and optimization of goods throughout the supply chain. It improves inventory management, reduces losses, enhances transparency, and enables efficient delivery routes. This results in streamlined operations, reduced costs, and improved customer satisfaction.

7. Energy Management: IoT facilitates intelligent energy management by monitoring and controlling energy usage in buildings, homes, and power grids. Smart meters, sensors, and energy management systems help optimize energy consumption, promote renewable energy integration, and reduce greenhouse gas emissions.

8. Environmental Monitoring: IoT devices enable real-time monitoring of environmental parameters such as air quality, water quality, and weather conditions. This data helps in identifying pollution sources, managing natural resources, and responding to natural disasters more effectively.

The impact of IoT is far-reaching. It improves efficiency, productivity, and decision-making in various sectors. It enhances safety, convenience, and quality of life for individuals. It drives sustainability, resource optimization, and environmental stewardship. However, it also raises concerns related to data privacy, security, and ethical considerations, which need to be addressed for the responsible and secure deployment of IoT technologies.

Future Directions and Challenges:

The future of the Internet of Things (IoT) holds immense potential, but it also presents certain challenges. Here are some future directions and challenges of IoT:

1. Scalability: As the number of connected devices continues to grow exponentially, IoT systems need to handle massive data volumes and support a larger number of devices. Scalability will be crucial to ensure smooth operations and efficient management of IoT ecosystems.

2. Edge Computing: With the increasing complexity and volume of data generated by IoT devices, there is a growing need for processing data at the edge of the network. Edge computing enables faster response times, reduced latency, and improved privacy by processing data closer to the source. Future IoT systems will heavily rely on edge computing capabilities.

3. 5G and Connectivity: The deployment of 5G networks will significantly impact IoT by offering faster data transfer rates, lower latency, and increased network capacity. This will enable the widespread adoption of IoT applications and support new use cases that require real-time communication and high-bandwidth connections.

4. Artificial Intelligence and Machine Learning: The integration of AI and machine learning algorithms into IoT systems will enable intelligent decision-making, automation, and predictive analytics. AI-driven IoT devices will learn from patterns, adapt to user behaviours, and provide personalized services.

5. Data Security and Privacy: With the proliferation of IoT devices and the vast amount of data they generate, ensuring robust security and privacy measures will be a significant challenge. IoT systems will need advanced encryption, authentication, and access control mechanisms to protect sensitive data from cyber threats.

6. Interoperability and Standards: The lack of interoperability and standardized protocols remains a challenge in the IoT landscape. Future developments should focus on creating open standards that facilitate seamless integration and communication between different IoT devices and platforms.

7. Ethics and Legal Frameworks: As IoT devices become more pervasive in our lives, ethical considerations regarding data privacy, consent, and responsible use become crucial. Clear legal frameworks and regulations need to be established to address these ethical concerns and protect individuals' rights.

8. Energy Efficiency: The growing number of connected devices in IoT raises concerns about energy consumption. Future IoT solutions should prioritize energy-efficient designs, optimized data transmission, and power-saving modes to minimize the environmental impact and ensure sustainability.

Overall, the future of IoT is exciting, with advancements in connectivity, computing, and AI. However, addressing challenges related to scalability, security, privacy, interoperability, ethics, and sustainability will be crucial for the successful and responsible development and deployment of IoT technologies.

5G AND BEYOND

Evolution of Wireless Communication:

The evolution of wireless communication has been a remarkable journey, marked by significant advancements and technological breakthroughs. Here is a brief overview of its evolution:

1. First Generation (1G): Introduced in the 1980s, 1G was based on analogy cellular technology. It provided basic voice services with low capacity and limited coverage. The most notable example of 1G technology is the Advanced Mobile Phone System (AMPS) in North America.

2. Second Generation (2G): 2G brought about the transition from analogy to digital wireless communication. It introduced digital voice encoding and improved capacity and efficiency. The two main 2G standards were Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA).

3. Third Generation (3G): 3G systems emerged in the early 2000s, offering faster data transfer rates, enhanced voice quality, and the introduction of mobile internet services. It enabled advanced features such as video calling, multimedia messaging, and mobile broadband connectivity.

4. Fourth Generation (4G): 4G networks provided significant improvements over 3G in terms of data speeds, latency, and capacity. It introduced Long-Term Evolution (LTE) technology, offering faster data rates, improved multimedia streaming, and better support for high-bandwidth applications.

5. Fifth Generation (5G): 5G represents the latest generation of wireless communication. It brings massive improvements in terms of speed, latency, capacity, and connectivity. 5G networks utilize advanced technologies such as millimetre waves, massive MIMO (Multiple Input Multiple Output), and network slicing to enable ultra-fast speeds, low latency, and support for a massive number of connected devices. 5G has the potential to revolutionize various industries, including IoT, autonomous vehicles, healthcare, and smart cities.

Alongside these generations, various wireless communication standards have emerged, such as Wi-Fi, Bluetooth, and Zigbee, which have enabled wireless connectivity for specific applications and use cases.

Looking ahead, the future of wireless communication is expected to focus on the widespread deployment and evolution of 5G networks, enabling transformative technologies such as the Internet of Things (IoT), artificial intelligence (AI), augmented reality (AR), and virtual reality (VR). Additionally, advancements in satellite communication, low-power wide-area networks (LPWAN), and emerging technologies like 6G are also on the horizon, promising even faster speeds, greater capacity, and more innovative applications.

Features and Benefits of 5G:
5G, the fifth generation of wireless communication technology, offers a range of features and benefits that significantly advance connectivity and enable transformative applications. Here are some key features and benefits of 5G:

1. Higher Data Speeds: 5G provides significantly faster data transfer speeds compared to previous generations. With peak speeds reaching up to 10 Gbps, it enables ultra-fast downloads, seamless streaming of high-definition content, and real-time interactive experiences.

2. Lower Latency: 5G significantly reduces network latency, resulting in near-instantaneous response times. This is crucial for applications requiring real-time interactivity, such as remote surgeries, autonomous vehicles, and augmented reality (AR) gaming.

3. Increased Capacity: 5G networks have a much higher capacity to handle a massive number of connected devices simultaneously. This capacity is essential for supporting the Internet of Things (IoT), where billions of devices will require seamless connectivity.

4. Enhanced Connectivity: 5G offers improved coverage and better connectivity in densely populated areas. It provides consistent and reliable connections even in crowded environments, such as stadiums, airports, and urban areas, where previous generations might have experienced network congestion.

5. Massive IoT Support: 5G is designed to support massive-scale IoT deployments. It enables a vast number of devices to connect and communicate simultaneously, making it ideal for smart city applications, industrial IoT, and smart agriculture.

6. Ultra-Reliable Communications: 5G provides high reliability and availability for critical applications that require uninterrupted connectivity. This is crucial for applications like emergency services, industrial automation, and remote monitoring of critical infrastructure.

7. Network Slicing: 5G introduces the concept of network slicing, allowing the network to be divided into multiple virtual networks tailored for specific applications or industries. This ensures optimized performance, security, and quality of service for diverse use cases.

8. Improved Energy Efficiency: 5G networks are designed to be more energy-efficient compared to previous generations. This is important for reducing the environmental impact and improving the battery life of connected devices.

9. Enablement of New Applications: 5G unlocks the potential for innovative applications and technologies. It enables advancements in augmented reality (AR), virtual reality (VR), autonomous vehicles, smart cities, telemedicine, remote robotics, and more.

Overall, the features and benefits of 5G contribute to enhanced user experiences, increased productivity, and transformative possibilities across various industries. It has the potential to revolutionize the way we live, work, and interact with technology.

Beyond 5G Technologies:

Beyond 5G, there are ongoing research and development efforts towards next-generation wireless communication technologies that aim to further enhance connectivity, and performance, and enable new applications. Here are some of the key technologies that are being explored:

1. 6G: While 5G is still in the early stages of deployment, research into 6G has already begun. 6G is expected to provide even higher data rates, lower latency, and improved reliability compared to 5G. It is envisioned to enable applications such as holographic communication, ubiquitous augmented reality (AR), and advanced AI-driven services.

2. Terahertz (THz) Communication: Terahertz frequencies (above 100 GHz) are being explored for future wireless communication. THz communication offers extremely high data rates and

massive bandwidth, allowing for ultra-fast wireless connections. However, there are technical challenges to overcome, such as signal attenuation and device miniaturization.

3. Visible Light Communication (VLC): VLC, also known as Li-Fi, utilizes visible light spectrum for wireless data transmission. It offers high data rates, interference-free communication, and can be used in environments where radio frequencies are restricted. VLC has potential applications in indoor communication, smart lighting systems, and location-based services.

4. Satellite Communication: Satellite communication is being advanced to provide global coverage and support for remote areas. Low Earth Orbit (LEO) satellite constellations are being deployed to improve connectivity and reduce latency. These advancements aim to bridge the digital divide and enable seamless global communication.

5. Quantum Communication: Quantum communication leverages the principles of quantum mechanics to provide secure and unbreakable communication channels. Quantum key distribution (QKD) allows for secure transmission of encryption keys, ensuring high-level data protection. Quantum communication technologies are still in the early stages of development but hold promise for future secure communication networks.

6. Cognitive Radio: Cognitive radio technology enables intelligent and dynamic spectrum allocation. It allows devices to adaptively utilize available spectrum resources based on real-time conditions, improving spectrum efficiency and reducing interference. Cognitive radio has the potential to optimize spectrum utilization and address the growing demand for wireless connectivity.

7. Heterogeneous Networks (HetNets): HetNets combine multiple wireless technologies and network types, such as 5G, Wi-Fi, and small cells, to create seamless and integrated communication environments. HetNets enable efficient and flexible use of available network resources and enhance connectivity in diverse environments.

These are just a few examples of the technologies being explored beyond 5G. The aim is to address the ever-increasing demands for connectivity, speed, reliability, and support for emerging applications and use cases. The evolution of wireless communication will continue to drive innovation and transform various industries, paving the way for a more connected and advanced future.

Challenges:

1. Infrastructure Requirements: The deployment of 5G and beyond requires a significant investment in infrastructure, including the installation of new base stations, small cells, and fiber-optic networks. Upgrading existing infrastructure and ensuring widespread coverage pose challenges, particularly in rural and remote areas.

2. Spectrum Availability: Acquiring and allocating sufficient spectrum for 5G and beyond is a challenge. Spectrum resources need to be managed effectively to meet the increasing demand for higher bandwidth and support diverse applications while addressing interference concerns.

3. Security and Privacy: With the proliferation of connected devices and increased data exchange, ensuring the security and privacy of users' information becomes critical. 5G networks and beyond need robust security measures to protect against cyber threats, data breaches, and unauthorized access.

4. Interoperability and Standards: Developing global standards and achieving interoperability among different networks, devices, and service providers is crucial. This includes harmonizing frequency bands, ensuring seamless roaming, and defining protocols for consistent user experiences across various networks and technologies.

5. Energy Consumption: 5G and beyond technologies are expected to increase energy consumption due to the densification of networks and the deployment of new infrastructure. Addressing energy efficiency concerns is important to minimize the environmental impact and manage operational costs.

Opportunities of 5G and Beyond:

1. Enhanced Connectivity: 5G and beyond offer significantly faster data speeds, lower latency, and higher capacity. This enables immersive experiences, seamless streaming, real-time communication, and support for emerging technologies like augmented reality (AR), virtual reality (VR), and Internet of Things (IoT) applications.

2. Internet of Things (IoT) Advancements: 5G and beyond facilitate the growth of IoT by providing better connectivity, improved coverage, and low-power communication capabilities. This enables advanced IoT applications in industries such as smart cities, industrial automation, healthcare, and agriculture.

3. Industry Transformation: 5G and beyond technologies drive digital transformation across industries. They enable innovations in autonomous vehicles, remote robotic surgery, smart manufacturing, edge computing, and real-time analytics. These advancements can lead to increased productivity, efficiency, and new business opportunities.

4. Telecommunication Innovation: 5G and beyond technologies encourage innovation in the telecommunications sector. Service providers can deliver new services and business models, including network slicing for tailored services, low-latency applications, and edge computing capabilities.

5. Economic Growth: The deployment of 5G and beyond networks can stimulate economic growth by creating job opportunities, attracting investments, and fostering innovation and entrepreneurship. It can enable new industries and services, contributing to economic development and competitiveness.
6. Bridging the Digital Divide: 5G and beyond have the potential to bridge the digital divide by providing high-speed connectivity to underserved areas. This enables access to education, healthcare, e-commerce, and government services, promoting inclusivity and reducing the digital divide.

7. Big Data Analytics: The massive amount of data generated by 5G and beyond networks presents opportunities for advanced analytics, machine learning, and artificial intelligence applications. Insights derived from this data can drive informed decision-making, predictive analysis, and personalized services.

While challenges exist, the opportunities presented by 5G and beyond technologies are vast, impacting various sectors and transforming the way we live, work, and interact with technology. Addressing the challenges and leveraging the opportunities will shape the future of connectivity and drive innovation in the digital era.

ARTIFICIAL INTELLIGENCE (AI) AND MACHINE LEARNING (ML)

Integration of AI and ECE: The integration of Artificial Intelligence (AI) and Electronics and Communication Engineering (ECE) has the potential to revolutionize various industries and transform the way we interact with technology. Here are some key aspects of the integration:

1. Intelligent Systems: AI can be applied to create intelligent systems that can perceive, reason, and make decisions based on data and patterns. By integrating AI algorithms into ECE systems, such as sensors, actuators, and control systems, intelligent systems can autonomously adapt, optimize performance, and respond to changing conditions in real-time.

2. Machine Learning and Data Analytics: ECE systems generate vast amounts of data that can be utilized by AI algorithms for predictive analysis, anomaly detection, and optimization. Machine learning techniques, such as neural networks and deep learning, can be employed to extract insights from data and make intelligent decisions in real-time.

3. Robotics and Automation: The integration of AI and ECE enables the development of intelligent robots and automation systems. AI algorithms can be utilized to enable autonomous navigation, object recognition, grasping, and decision-making capabilities in robots. This opens up opportunities in industries such as manufacturing, logistics, healthcare, and agriculture.

4. Internet of Things (IoT): AI can enhance the capabilities of IoT systems by enabling intelligent data processing, anomaly detection, and predictive maintenance. ECE systems within IoT networks can leverage AI techniques to analyse sensor data, optimize resource utilization, and enable smart decision-making.

5. Communication Systems: AI can be applied to enhance communication systems in ECE. AI algorithms can optimize network resources, improve spectrum efficiency, and enable intelligent routing and congestion control. AI can also be utilized for intelligent signal processing and noise reduction in wireless communication systems.

6. Biomedical Engineering: The integration of AI and ECE has significant applications in biomedical engineering. AI algorithms can analyse medical data, such as medical images or patient records, for early disease detection, personalized treatment recommendations, and predictive healthcare analytics. ECE systems can enable the collection and processing of medical data for AI-driven applications.

7. Security and Privacy: AI can be integrated into ECE systems to enhance security and privacy measures. AI algorithms can detect and mitigate cyber threats, identify abnormal patterns in network traffic, and enhance data encryption techniques. AI can also be used for facial recognition, voice authentication, and biometric security systems.

The integration of AI and ECE holds immense potential to create intelligent, adaptive, and efficient systems in various domains. It enables advanced automation, improved decision-making, enhanced communication, and increased efficiency. As technology continues to advance, the synergy between AI and ECE will drive innovations and transform industries.

Applications in ECE: Artificial Intelligence (AI) and Machine Learning (ML) have profound applications in the field of Electronics and Communication Engineering (ECE). Here are some key areas where AI and ML are applied in ECE:

1. Signal Processing: AI and ML techniques are employed in signal processing tasks to analyse, interpret, and extract meaningful information from signals. This includes applications such as speech recognition, image and video processing, audio processing, and pattern recognition.

2. Communication Systems: AI and ML algorithms are utilized in communication systems for various purposes. They can optimize network resource allocation, adaptively manage spectrum usage, improve channel estimation and equalization, and enhance interference cancellation techniques in wireless communication systems.

3. Intelligent Networks: AI and ML techniques enable the development of intelligent networks that can self-optimize, self-configure, and self-heal. This includes autonomous network management, dynamic routing and traffic management, and predictive maintenance of network infrastructure.

4. Internet of Things (IoT): AI and ML are employed in IoT applications to analyse sensor data, detect anomalies, and enable predictive maintenance. They can also facilitate intelligent decision-making and optimize resource allocation in IoT networks.

5. Robotics and Automation: AI and ML play a significant role in robotics and automation applications within ECE. They enable autonomous navigation, object recognition, motion planning, and adaptive control in robots. ML algorithms also facilitate machine vision and sensor fusion in robotic systems.

6. Fault Diagnosis and Predictive Maintenance: AI and ML techniques are used to detect and diagnose faults in electronic systems and equipment. ML algorithms can analyse data from sensors and perform predictive maintenance by identifying potential failures or anomalies in advance, enabling proactive maintenance and reducing downtime.

7. VLSI Design and Testing: AI and ML are applied in VLSI design to optimize power consumption, improve circuit performance, and automate design tasks. ML algorithms can be used for chip layout optimization, placement and routing, and automated testing of integrated circuits.

8. Biomedical Engineering: AI and ML find applications in biomedical engineering within ECE. They can be used for medical image analysis, pattern recognition in medical data, diagnosis and prognosis of diseases, and intelligent healthcare monitoring systems.

Overall, the integration of AI and ML in ECE opens up opportunities for intelligent systems, enhanced performance, and advanced applications across various domains within the field. These technologies drive innovation, efficiency, and automation in electronic systems and communication networks.

Challenges:

1. Data Quality and Availability: AI and ML algorithms rely heavily on high-quality and diverse datasets. However, obtaining labelled and representative data can be a challenge, particularly

in niche domains or sensitive applications. Additionally, data biases and privacy concerns need to be addressed to ensure ethical and unbiased AI systems.

2. Explain ability and Transparency: As AI and ML models become more complex, understanding their decision-making processes and explaining their outcomes become challenging. The lack of interpretability and transparency can hinder trust in AI systems, particularly in critical domains like healthcare and finance.

3. Ethical and Legal Considerations: AI and ML raise ethical concerns around issues such as fairness, accountability, transparency, and the impact on employment. Ensuring that AI systems are developed and deployed in an ethical and responsible manner requires robust regulations and guidelines.

4. Lack of Domain Expertise: Developing effective AI and ML solutions requires a deep understanding of the domain in which they are applied. The shortage of domain experts who possess both technical and domain knowledge can be a challenge, leading to potential inaccuracies or misinterpretation of results.

5. Computational Resources: Training and deploying complex AI and ML models often require significant computational resources, including high-performance hardware and storage. The scalability and cost implications of these resource requirements can pose challenges, especially for small organizations or resource-constrained environments.

Future Prospects of AI and ML:

1. Advancements in Deep Learning: Deep learning, a subset of ML, has shown remarkable capabilities in various domains. Future prospects involve advancements in architectures, training techniques, and scalability to handle more complex tasks and larger datasets.

2. Explainable AI (XAI): Researchers are actively working on developing techniques to make AI and ML models more explainable and interpretable. XAI aims to provide insights into the decision-making process of AI systems, increasing trust and understanding.

3. AI in Edge Computing: The integration of AI with edge computing brings intelligence and decision-making capabilities closer to the data source, reducing latency and enhancing privacy. Future prospects involve the development of efficient AI models and algorithms tailored for edge devices and real-time processing.

4. Reinforcement Learning and Autonomous Systems: Reinforcement learning, a form of ML, holds promise for developing autonomous systems that can learn from their environment and make intelligent decisions. This has applications in autonomous vehicles, robotics, and control systems.

5. AI for Personalization and Recommendation: AI and ML techniques will continue to improve personalization and recommendation systems across various domains, including e-commerce, entertainment, and content delivery. AI algorithms can analyse user behaviours and preferences to provide tailored recommendations and personalized experiences.

6. AI in Healthcare: AI and ML have significant potential in healthcare, including medical imaging analysis, drug discovery, personalized medicine, and telemedicine. Future prospects involve leveraging AI to improve diagnosis accuracy, treatment effectiveness, and patient care.

7. AI for Sustainability: AI and ML can contribute to sustainability efforts by optimizing resource usage, energy efficiency, and waste reduction. Applications include smart energy grids, precision agriculture, and environmental monitoring.

The future of AI and ML is promising, but it also requires addressing challenges related to data, ethics, transparency, and expertise. By overcoming these challenges and leveraging the potential of AI and ML responsibly, we can achieve significant advancements and positive impacts across various sectors and society as a whole.

NANOTECHNOLOGY

Nanoelectronics and nanophotonic are two emerging fields in the realm of nanotechnology that focus on manipulating and harnessing the properties of materials and structures at the nanoscale. Here's an overview of each field:

Nanoelectronics: Nanoelectronics deals with the design, fabrication, and application of electronic devices and components at the nanoscale. It involves the exploration of nanoscale materials, such as nanowires, nanotubes, and nanosheets, for creating electronic devices with enhanced performance, reduced power consumption, and increased integration density. Some key aspects of nanoelectronics include:

1. Nanoscale Transistors: Transistors are the fundamental building blocks of electronic devices. Nanoelectronics aims to develop nanoscale transistors with improved performance, such as reduced leakage current, higher switching speeds, and better energy efficiency. Examples include carbon nanotube transistors, nanowire transistors, and single-electron transistors.

2. Quantum Computing: Nanoelectronics is closely associated with the development of quantum computing, which utilizes the principles of quantum mechanics to process and store information. Quantum bits or qubits, the basic units of quantum computing, can be implemented using nanoscale devices such as quantum dots or superconducting circuits.

3. Energy Harvesting and Storage: Nanoelectronics plays a role in the development of energy harvesting and storage technologies. Nanomaterials are employed to enhance the efficiency of solar cells, improve battery performance, and enable new forms of energy storage, such as nanoscale supercapacitors.

Nanophotonic:
Nanophotonic involves the study and manipulation of light at the nanoscale, offering opportunities for controlling and guiding light in ways not possible with conventional optics. It combines the fields of nanotechnology and photonics to develop devices that can manipulate and process light signals with nanoscale precision. Key aspects of nanophotonic include:

1. Plasmonic: Plasmonic explores the interaction of light with metal nanostructures at the nanoscale. It enables the confinement of light to subwavelength dimensions, leading to applications such as nanoscale sensors, enhanced light-matter interactions, and subwavelength imaging.

2. Photonic Crystals: Photonic crystals are periodic nanostructures that can control and manipulate the flow of light. They exhibit unique properties, such as photonic bandgaps, which allow for the creation of devices like optical filters, waveguides, and lasers with improved efficiency and compactness.

3. Nanophotonic Devices: Nanophotonic enables the development of miniaturized optical devices that can operate at the nanoscale. Examples include nanoscale light-emitting diodes (LEDs), nanoantenna's for light manipulation, and nanoscale waveguides for on-chip optical communication.

4. Quantum Photonics: Nanophotonic also plays a role in quantum photonics, where quantum properties of light are harnessed for quantum communication and computation. Nanoscale structures, such as quantum dots and nanowires, can be utilized to generate and manipulate quantum states of light.

Both nanoelectronics and nanophotonic offer immense potential for advancing various fields, including information technology, energy, healthcare, and communications. They enable the development of smaller, faster, and more efficient devices and open up new possibilities for nanoscale exploration and manipulation of materials and light.

Applications and Future Possibilities:

Nanotechnology, the manipulation, and control of matter at the nanoscale, holds tremendous potential for various applications across multiple industries. Here are some notable applications and future possibilities of nanotechnology:

1. Electronics and Computing: Nanotechnology has revolutionized the electronics industry by enabling the development of smaller, faster, and more energy-efficient devices. Nanoscale materials and components, such as nanowires, nanotubes, and graphene, are utilized in transistors, memory devices, sensors, and batteries, pushing the limits of Moore's Law.

2. Healthcare and Medicine: Nanotechnology has transformative applications in healthcare and medicine. Nanoparticles and nanomaterials are used for targeted drug delivery, imaging agents, and diagnostics. Nano sensors can detect and monitor biomarkers for early disease diagnosis. Nanomaterials are also employed in tissue engineering, regenerative medicine, and biosensors for point-of-care testing.

3. Energy and Environment: Nanotechnology plays a crucial role in energy generation, storage, and conservation. Nanomaterials are utilized in solar cells to improve efficiency and reduce costs. Nanocomposites are used in lightweight and high-strength materials for energy-efficient transportation. Nanotechnology also enables the development of advanced batteries, fuel cells, and energy storage devices.

4. Environmental Remediation: Nanotechnology offers potential solutions for environmental challenges. Nanomaterials can be used for water purification, air filtration, and remediation of contaminated sites. Nano sensors can monitor pollutants and enable real-time environmental monitoring.

5. Materials Science: Nanotechnology has expanded the possibilities in materials science. Nanocomposites exhibit unique properties, such as high strength and conductivity, and find applications in aerospace, automotive, and construction industries. Nanocoating's provide enhanced durability, self-cleaning properties, and corrosion resistance.

6. Food and Agriculture: Nanotechnology offers opportunities for improving food safety, quality, and packaging. Nano sensors can detect pathogens and contaminants in food. Nanoencapsulation can enhance the stability and delivery of nutrients and bioactive compounds. Nanomaterials enable the development of smart packaging with improved shelf life and freshness.

7. Water Treatment and Desalination: Nanotechnology plays a role in water treatment and desalination processes. Nanomaterials, such as nano filters and membranes, can remove contaminants and salt ions, improving water quality and addressing water scarcity challenges.

8. Quantum Computing and Communication: Nanotechnology contributes to the development of quantum computing and quantum communication technologies. Nanoscale devices and structures enable the manipulation and control of quantum states, paving the way for powerful quantum computers and secure quantum communication networks.

The future possibilities of nanotechnology are vast. Advancements in nanomaterials, nanofabrication techniques, and characterization methods will lead to more sophisticated applications. Future prospects include nanorobotics for targeted drug delivery, nanoscale 3D printing, nanophotonic for ultrafast computing and communication, and Nano sensors for real-time disease monitoring. However, it is essential to address the ethical, environmental, and safety concerns associated with nanotechnology to ensure responsible and sustainable development.

CHALLENGES AND OPPORTUNITIES IN ECE

1. Energy Efficiency and Sustainability: As technology becomes more pervasive, energy efficiency and sustainability become critical concerns. ECE professionals can contribute by designing energy-efficient circuits, renewable energy systems, and smart grid solutions.

2. Security and Privacy: The increasing interconnectivity and data exchange raise concerns about security and privacy. ECE professionals can develop robust encryption techniques, secure communication protocols, and privacy-enhancing technologies.

3. Skill Development and Education: The rapid evolution of technology demands continuous skill development and education for ECE professionals. Lifelong learning, interdisciplinary collaboration, and adaptability are key to thriving in the future ECE landscape.

CONCLUSION

This research paper explored the future scope of ECE by exa mining emerging trends such as IoT, 5G and beyond, AI, and nanotechnology. The paper identified challenges and opportunities in each area, emphasizing the transformative potential of these technologies. ECE professionals must stay updated with the latest developments, acquire interdisciplinary skills, and embrace emerging technologies to seize opportunities in the future. Collaboration, innovation, and a focus on sustainability and security will be crucial. The future of ECE holds immense potential for technological advancements and societal impact. Continued research and innovation in areas such as quantum computing, biotechnology, and smart materials will shape the future of ECE and pave the way for a smarter and more connected world.

REFERENCES

[1] Chin, WoonHau& Fan, Zhong & Haines, Russell. (2014). Emerging Technologies and Research Challenges for 5G Wireless Networks. IEEE Wireless Communications. 21. 106-112. 10.1109/MWC.2014.6812298.

[2] Cioffi, &Travaglioni, Marta &Piscitelli, & Petrillo, Antonella & Felice, De. (2020). Artificial Intelligence and Machine Learning Applications in Smart Production: Progress, Trends, and Directions. Sustainability. 12. 492. 10.3390/su12020492.

[3] Dwivedi, Abhishek & Dwivedi, Avanish. (2009). Emerging Trends in Nano Technology for Modern Industries. International Journal of Innovative Research and Studies 2319-9725. 2. 4-13.

[4] F. Jindal, S. Mudgal, V. Choudhari and P. P. Churi, "Emerging trends in Internet of Things," 2018 Fifth HCT Information Technology Trends (ITT), Dubai, United Arab Emirates, 2018, pp. 50-60, doi: 10.1109/CTIT.2018.8649535.

[5] Lugani, Yogita &Sooch, Balwinder& Oberoi, Simmi. (2018). Nanotechnology: Current Applications and Future Prospects.

[6] Pujari, Vinayak & Patil, Rajendra &Tambe, Mr& Prof, Asst. (2021). Research Paper on Future of 5G Wireless System. 2021.

[7] Rahman, Habib & Asif, Muhammad & Ahmad, Mudassar. (2017). Future applications and research challenges of IOT. 68-74. 10.1109/ICICT.2017.8320166.

[8] Saha, Himadri& Mandal, Abhilasha& Sinha, Abhirup.(2017). Recent trends in the Internet of Things.1-4. 10.1109/CCWC.2017.7868439.

[9] Sahoo, M., Vishwakarma, S., Panigrahi, C., & Kumar, J. (2021). Nanotechnology: Current applications and future scope in food. Food Frontiers, 2(1), 3-22. https://doi.org/10.1002/fft2.58

A REVIEW OF STATE-OF-THE-ART OPTIMIZATION OF 6G COMMUNICATIONS TECHNOLOGY BEYOND5G ERA OF WEARABLE ANTENNAS DEVICES

Manoj Kumar Bansal

Associate Professor

Department Of ECE

JB Institute of Technology, Dehradun,

ABSTRACT

Next-generation communication systems and wearable technology aim to achieve high data rates, low power consumption and massive connectivity due to the number of Internet of Things (IoT) and mobile devices. These devices will be used for a variety of services such as mobile phones, environmental monitoring, telemedicine, biomedical and intelligent transportation, and more. Therefore, it is difficult for existing communication devices to support such a high number of services. This article summarizs the dynamics and potential of the 6G communication system and discusses its key features. Next, summarize the current state of optimized 5G antenna technology, including existing 5G networks and antennas as well as 5G mobile antennas. The paper also describes useful methods and techniques for antenna design work that can alleviate the challenges and concerns of emerging 5G and 6G applications. The main characteristics and requirements of mobile antennas for next-generation technology are also presented at the end of the document.

Keywords: antenna; array; wearable Devices, internet of things; shared aperture antenna; microwaves; mm-wave; THz;satellite; 5G; 6G

1. Introduction

Global mobile data traffic has increased significantly in recent years due to the high demand for high data transmission rates, fast and secure in many recent and advanced applications including broadcasting, Internet things (IoT), automotive, smart cities, energy, emergency communications, and wearable devices [1]. This has put great pressure on current 3G/4G/WiFi wireless communication systems to improve capacity and performance. Each generation of mobile and wireless communication systems has been created to meet these needs. However, the data-intensive devices used in the above-mentioned applications have greatly increased and require very large data rates [2,3]. One potential way to improve data capacity and speed in current and future mobile and wireless generations is through bandwidth [4,5]. The data rate is proportional to the bandwidth. Higher bandwidth provides higher data rates [6,7]. However, the current frequency bands like the GSM band 1.7 GHz, the 4G/LTE band 1.8 GHz, the 4G/LTE band 2.0 GHz, the 2.1 LTE band and the 2.6 GHz band, providing limited bandwidth. Recent high bands include 24 GHz (n258), 28 GHz (n257 and n261), 37 GHz (n260) and 39 GHz (n260), in addition to some future recommended bands, i.e. 47 and 60 GHz, have been considered for 5G applications [8-17]. These high frequency bands, also known as millimetre wave bands, can provide significantly large bandwidths (above 500 MHz). However, current 5G communications still use the sub-6 GHz band, i.e. 3.3 GHz to 4.2 GHz (n77 and n78) and 4.4 GHz to 5 GHz (n79). The 5G frequency bands are listed in Figure 1. Although some progress has been made, i.e. the use of a more advanced and larger number of antennas with multiple inputs and multiple outputs (MIMO) [18 -19] to improve the wireless network.

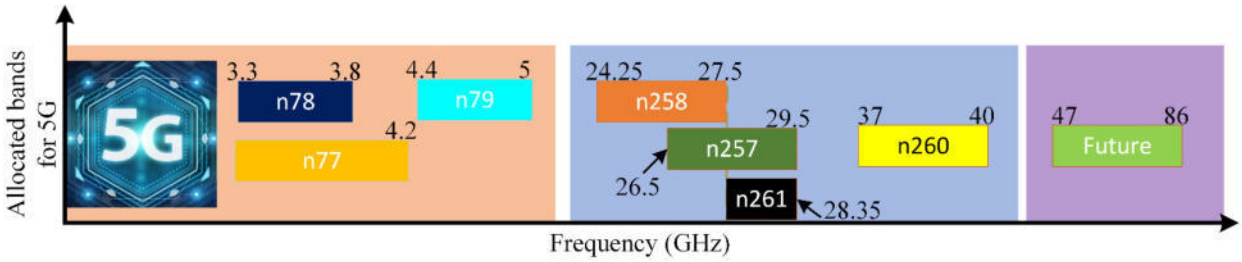


Figure1. Bandsallocatedfor5G,this concept is taken from[1]

In millimetre wave communications, the path loss is remarkably high [20,21]. Therefore, the antenna used must have directional high gain radiation patterns in the direction of the antenna used and must have high directional gain radiation patterns in the direction of propagation to minimize this transmission loss. Another big challenge in multi-wave propagation is to minimize this transmission loss in microwave and millimetre wave mobile communications, is in applications, in microwave and millimetre wave mobile communications, which is the direction inconsistent communication.

In other words, the position and direction of communication are inconsistent. In other words, the position and orientation of the mobile phone relative to the base station cannot be determined. Therefore, the orientation of the mobile phone relative to the base station has not been determined. Therefore, new and unprecedented techniques that provide full-beam coverage are needed as well as previous and new techniques that provide full-beam coverage and radiation patterns. Stable radiation with higher directional gain is required. Therefore, Wave 5G, 3G/4G/WiFi and 5G sub-6 GHz communications still exist. Therefore, integrated antenna modules using a split-aperture antenna structure are also essential.

Since previous cellular transitions, each generation has taken almost a decade (i.e. 1G in the 1980s, 2G in the 1990s, 3G in the 2000s, 4G in the 2010s), 6G is expected to be adopted by 2030, or before, due to the development of transition technologies. Detailed information about the integrated 6G communication system will be presented in the next section. The structure of The 6G communication system is introduced in the next section.

2. In the vicinity of 6G. Communication system

6G communication has been conceptually developed and shaped [1,2,6,21]. Huge demand for data speeds has driven the transition and upgrade of used 5G technology to 6G communication systems, focusing on ultra-low latency, incredible capacity, and coverage on higher and wider poles of television and mobile in academia and industry. Based on the current literature, the communication system envisioned for 6G is shown in Figure 2. It generally targets all possible communication scenarios, including terrestrial wireless communication networks, GEO/LEO satellites, intelligent transportation, and giant IoT. It covers large geographical areas, including urban, rural, remote areas, oceans, and air.

Figure 2. Main features of 6G communication system [1].

3. Main features of 6G

i. Connectivity:

One of the key features of the 5G to 6G transition is massive connectivity. A large number of IoTs are expected to be interconnected, in line-of-sight or line-of-sight scenarios. Uninterrupted connectivity will be achieved using reconfigurable artificial intelligence-powered hypersurfaces. Connectivity in large areas needs to be achieved through integrated 5G and satellite networks.

ii. Mobility:

A very high-speed intelligent transportation system is expected. Extremely low latency in data communication will improve the transportation system [22]. The maximum speed considered in 6G is 1,000 km/h for aeronautical communication scenarios, much higher than 5G.

iii. Data Protection:

Data privacy and security are important aspects of any communication system, especially in the defense and banking sectors, as shown in Figure 3. By applying deep learning and intelligence technology artificial intelligence At the physical and network layers, security will be enhanced in phishing operations, infrastructure, and assets in 6G networks.

iv. Broadcasting:

New media infrastructure and services focused on ultra-high-speed video streaming, live streaming and entertainment will be available on 6G. This excellent quality of service will be achieved through a combination of satellite, cable and cellular technologies.

v. Ubiquity:

The coverage area must be larger than that of the 5G system. The 6G system will include space and maritime communications as well as terrestrial communications to achieve wider coverage and higher data rates. It will be available using a combination of the GEO/LEO satellite network and the terrestrial network. This is very important, especially for communications on planes, ships, and people living/working in remote areas.

vi. Data speed:

According to Shannon's equation, the data rate proportional to capacity can be improved by increasing the bandwidth and the number of antennas. The mm/THz range provides a remarkably high bandwidth from 1 to 10 GHz. Therefore, both techniques, a large number of antennas and the Mm/THz band, are simple methods to meet the higher demand for data rates. It is expected to reach 1 Tbps, faster than 5G in both uplink and downlink [6,22]. Higher data rates matter in almost every industry, including ultra-high definition video streaming, large data files in the office, and more.

4. 5G Wearable Antennas

Demand for wearables has increased dramatically over the past decade. The number of connected handheld electronic devices has increased by more than 100% in the past 4 years, from 325 million in 2016 to approximately 720 million in 2019 [23 - 27]. As technology continues to advance at a high rate, these devices are expected to reach 1.1 billion by 2022 [25]. Mobile antennas are one of the essential parts of portable electronic equipment used for a number of mobile applications ranging from medical, military, entertainment and other daily use mobile devices. [26] as shown in Figure 21. Some examples of wearable antennas include medical and patient monitoring devices, smart watches with built-in small antennas, tracking systems military tracking and positioning, wearable cameras with Wi-Fi and Bluetooth, and handheld sports devices, and more. [28 - 33]. However, the design of cellular antennas is important, especially for 5G millimetre wave and IoT applications, where manufacturing processes and tolerances at higher frequencies have a significant effect on performance. of the antenna. Several aspects also need to be considered when designing cellular antennas for 5G applications intended for use as an integral part of wearable devices [25]. They must be compliant/flexible, robust and operate with minimal performance degradation near the human body. It is well known that the human body has a tendency to degrade antenna performance and gain due to loss of natural body tissue. Therefore, the deployment environment needs to be considered during the design process to achieve a highly stable and powerful 5G mobile antenna [27-30]. Mobile antennas must also work efficiently in different bending conditions, meeting the high demand for such devices. On the other hand, the materials used as substrates and conductive parts for mobile antennas are very important [31-33]. They should be carefully selected to provide the necessary mechanical/physical properties such as folding, packing and sometimes washing while maintaining minimal impact on performance [34 - 36].

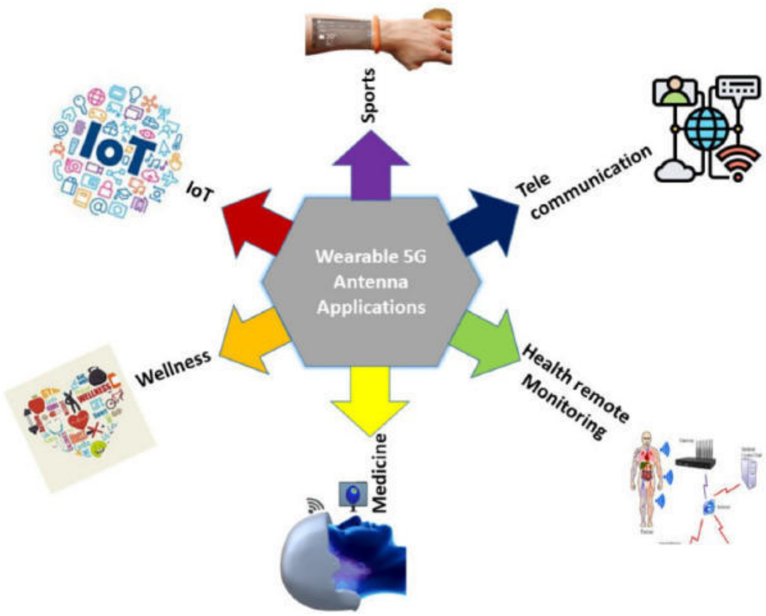


Figure 21. Illustration of Wearable mobile antenna applications.

More recently, a cellular millimetre wave antenna based on textiles has been introduced in [37]. The antenna operates in higher order mode covering the frequency range from 24.9 to 31 GHz. The antenna demonstrated a measured gain of 8.2 dBi. A 13×13 element array was also evaluated to explore energy reception efficiency, and numerical results demonstrated up to six times more energy reception than a conventional array. Overall, the existing cellular antennas for 5G applications described in this review demonstrate the advancements and efforts made by researchers in the field to address most of the challenges. Mobile antenna challenge for emerging technologies in the 5G and 6G era. .

5. Conclusions

In this article, the potential 6G communication system and its main features have been summarized. It has been shown that the next generations (5G/B5G/6G) of communication systems and wearable technology will aim to achieve high data rates, ultra-high security, low power consumption, High-Speed Internet Anywhere and Large-scale IoT Connectivity. Since these systems will be a combination of multiple services using multiple spectrums (below 6 GHz, mm-wave and THz), it will be difficult to arrange more antennas in a single device. Therefore, today's most modern 5G antennas and networks are summarized to indicate new directions for future communication systems. At the end of the article, the main characteristics and requirements of mobile antennas for next-generation technology are also presented.

References

1. Ikram, M.; Sultan, K.; Lateef, M.F.; Alqadami, A.S.M. A Road towards 6G Communication—A Review of 5G Antennas, Arrays, and Wearable Devices. Electronics **2022**, 11, 169. https://doi.org/10.3390/electronics11010169

2. Giordani, M.; Polese, M.; Mezzavilla, M.; Rangan, S.; Zorzi, M. Toward 6G Networks: Use Cases and Technologies. IEEE Commun. Mag. **2020**, 58, 55–61. [**Google Scholar**] [**CrossRef**]

3. Gui, G.; Liu, M.; Tang, F.; Kato, N.; Adachi, F. 6G: Opening new horizons for integration of comfort, security, and intelligence. IEEE Wirel. Commun. **2020**, 27, 126–132. [**Google Scholar**] [**CrossRef**]

4. Ikram, M. Multi-Functional Antenna Structures for 4G/5G Wireless Communication Devices. Ph.D. Thesis, The University of Queensland, Brisbane, Australia, 2021. [**Google Scholar**]

5. Hong, W. Solving the 5G Mobile Antenna Puzzle: Assessing Future Directions for the 5G Mobile Antenna Paradigm Shift. IEEE Microw. Mag. **2017**, 18, 86–102. [**Google Scholar**] [**CrossRef**]

6. Jornet, J.M.; Akyildiz, I.F. Channel Modeling and Capacity Analysis for Electromagnetic Wireless Nanonetworks in the Terahertz Band. IEEE Trans. Wirel. Commun. **2011**, 10, 3211–3221. [**Google Scholar**] [**CrossRef**][**Green Version**]

7. Rajatheva, N.; Atzeni, I.; Bjornson, E.; Bourdoux, A.; Buzzi, S.; Dore, J.B.; Erkucuk, S.; Fuentes, M.; Guan, K.; Hu, Y.; et al. White paper on broadband connectivity in 6G. arXiv **2020**, arXiv:2004.14247. [**Google Scholar**]

8. Bang, J.; Choi, J. A SAR Reduced mm-Wave Beam-Steerable Array Antenna With Dual-Mode Operation for Fully Metal-Covered 5G Cellular Handsets. IEEE Antennas Wirel. Propag. Lett. **2018**, 17, 1118–1122. [**Google Scholar**] [**CrossRef**]

9. Buey, C. Design and Measurement of Multi-Antenna Systems toward Future 5G Technologies. Ph.D. Thesis, Université Côte d'Azur, Nice, France, 2018. [**Google Scholar**]

10. Deckmyn, T.; Cauwe, M.; Ginste, D.V.; Rogier, H.; Agneessens, S. Dual-band (28,38) GHz coupled quarter-mode sub-strate-integrated waveguide antenna array for next-generation wireless systems. IEEE Trans. Antennas Propag. **2019**, 67, 2405–2412. [**Google Scholar**] [**CrossRef**][**Green Version**]

11. Ikram, M.; Hussain, R.; Sharawi, M.S. 4G/5G antenna system with dual function planar connected array. IET Microw. Antennas Propag. **2017**, 11, 1760–1764. [**Google Scholar**] [**CrossRef**]

12. Krishna, S. Design and Development of 5G Spectrum Massive MIMO Array Antennas for Base Station and Access Point Applications. Ph.D. Thesis, San Diego State University, San Diego, CA, USA, 2018. [**Google Scholar**]

13. Løvaas, H.G.D. Multiband UWB Antenna Design for WiFi, LTE and 5G. Master's Thesis, The Norwegian University of Science and Technology, Trondheim, Norway, 2017. [**Google Scholar**]

14. Ojaroudiparchin, N.; Shen, M.; Zhang, S.; Pedersen, G.F. A Switchable 3-D-Coverage-Phased Array Antenna Package for 5G Mobile Terminals. IEEE Antennas Wirel. Propag. Lett. **2016**, 15, 1747–1750. [**Google Scholar**] [**CrossRef**][**Green Version**]

15. Parchin, N.O.; Al-Yasir, Y.; Ali, A.H.; Elfergani, I.; Noras, J.M.; Rodriguez, J.; Abd-Alhameed, R.A. Eight-Element Dual-Polarized MIMO Slot Antenna System for 5G Smartphone Applications. IEEE Access **2019**, 7, 15612–15622. [**Google Scholar**] [**CrossRef**]

16. Salous, S.; Degli Esposti, V.; Fuschini, F.; Thomae, R.S.; Mueller, R.; Dupleich, D.; Haneda, K.; Garcia-Pardo, J.M.M.; Garcia, J.P.; Gaillot, D.P.; et al. Millimetre-wave propagation: Characterization and modeling toward fifth-generation systems. IEEE Antennas Propag. Mag. **2016**, 58, 115–127. [**Google Scholar**] [**CrossRef**][**Green Version**]

17. Zhao, A.; Ren, Z. Size Reduction of Self-Isolated MIMO Antenna System for 5G Mobile Phone Applications. IEEE Antennas Wirel. Propag. Lett. **2018**, 18, 152–156. [**Google Scholar**] [**CrossRef**]

18. Chataut, R.; Akl, R. Massive MIMO systems for 5G and beyond networks—Overview, recent trends, challenges, and future research direction. Sensors **2020**, 20, 2753. [**Google Scholar**] [**CrossRef**] [**PubMed**]

19. You, L.; Li, K.X.; Wang, J.; Gao, X.; Xia, X.G.; Ottersten, B. Massive MIMO transmission for LEO satellite communications. IEEE J. Sel. Areas Commun. **2020**, 38, 1851–1865. [**Google Scholar**] [**CrossRef**]

20 Siddique, U.; Tabassum, H.; Hossain, E.; Kim, D.I. Wireless backhauling of 5G small cells: Challenges and solution approaches. IEEE Wirel. Commun. 2015, 22, 22–31. [Google Scholar] [CrossRef]

21 Bariah, L.; Mohjazi, L.; Muhaidat, S.; Sofotasios, P.C.; Kurt, G.K.; Yanikomeroglu, H.; Dobre, O.A. A Prospective Look: Key Enabling Technologies, Applications and Open Research Topics in 6G Networks. IEEE Access 2020, 8, 174792–174820. [Google Scholar] [CrossRef]

22 Jiang, W.; Han, B.; Habibi, M.A.; Schotten, H.D. The Road Towards 6G: A Comprehensive Survey. IEEE Open J. Commun. Soc. 2021, 2, 334–366. [Google Scholar] [CrossRef]

23 Wearable Technology Market Size Analysis Report 2028. Available online: https://www.grandviewresearch.com/industryanalysis/wearable-technology-market (accessed on 3 December 2021).

24. Gartner Forecasts Global Spending onWearable Devices to Total $81.5 Billion in 2021. Available online: https://www.gartner.com/en/newsroom/press-releases/2021-01-11-gartner-forecasts-global-spending-on-wearable-devices-to-total-81-5-billionin-2021 (accessed on 3 December 2021).

25. Global ConnectedWearable Devices 2016–2022|Statista. Available online: https://www.statista.com/statistics/487291/globalconnected-wearable-devices/ (accessed on 2 December 2021).

26. Aun, N.F.M.; Soh, P.J.; Al-Hadi, A.A.; Jamlos, M.F.; Vandenbosch, G.A.; Schreurs, D. Revolutionizing Wearables for 5G: 5GTechnologies: Recent Developments and Future Perspectives forWearable Devices and Antennas. IEEE Microw. Mag. 2017, 18,108–124. [CrossRef]

27. Wang, G.; Hou, C.;Wang, H. Flexible and Wearable Electronics for Smart Clothing; Wiley: Hoboken, NJ, USA, 2020.

28. Soh, P.J.; Vandenbosch, G.A.; Mercuri, M.; Schreurs, D.M.P. Wearable Wireless Health Monitoring: Current Develop-ments,Challenges, and Future Trends. IEEE Microw. Mag. 2015, 16, 55–70. [CrossRef]

29. Sultan, K.; Mahmoud, A.; Abbosh, A.M. Textile Electromagnetic Brace for Knee Imaging. IEEE Trans. Biomed. Circuits Syst. 2021,15, 522–536. [CrossRef]

30. Alqadami, A.S.M.; Zamani, A.; Trakic, A.; Abbosh, A. Flexible Electromagnetic Cap for Three-Dimensional Electromagnetic HeadImaging. IEEE Trans. Biomed. Eng. 2021, 68, 2880–2891. [CrossRef]

31. Alqadami, A.S.M.; Stancombe, A.E.; Bialkowski, K.S.; Abbosh, A. Flexible Meander-Line Antenna Array forWearable ElectromagneticHead Imaging. IEEE Trans. Antennas Propag. 2020, 69, 4206–4211. [CrossRef]

32. Alqadami, A.S.M.; Nguyen-Trong, N.; Stancombe, A.E.; Bialkowski, K.; Abbosh, A. Compact FlexibleWideband Antenna forOn-Body Electromagnetic Medical Diagnostic Systems. IEEE Trans. Antennas Propag. 2020, 68, 8180–8185. [CrossRef]

33. Alqadami, A.S.; Nguyen-Trong, N.; Mohammed, B.; Stancombe, A.E.; Heitzmann, M.T.; Abbosh, A. Compact UnidirectionalConformal Antenna Based on Flexible High-Permittivity Custom-Made Substrate for Wearable Wideband Electromagnetic HeadImaging System. IEEE Trans. Antennas Propag. 2020, 68, 183–194. [CrossRef]

34. Mahmood, S.N.; Ishak, A.J.; Saeidi, T.; Alsariera, H.; Alani, S.; Ismail, A.; Soh, A.C. Recent Advances in Wearable AntennaTechnologies: A Review. Prog. Electromagn. Res. B 2020, 89, 1–27. [CrossRef]

35. Karim, R.; Iftikhar, A.; Ijaz, B.; Mabrouk, I.B. The Potentials, Challenges, and Future Directions of On-Chip-Antennas for EmergingWireless Applications—A Comprehensive Survey. IEEE Access 2019, 7, 173897–173934. [CrossRef]

36. Tsolis, A.; Whittow,W.G.; Alexandridis, A.A.; Vardaxoglou, J.C. Embroidery and Related Manufacturing Techniques forWearableAntennas: Challenges and Opportunities. Electronics 2014, 3, 314–338. [CrossRef]

Review on Progress of Accelerating VLSI Placement Optimization for Physical Design

Laxman Singh

Assistant Professor,

Department Of ECE

JB Institute of Technology, Dehradun,

ABSTRACT

Placement plays a very important role in very large-scale integration (VLSI) physical design, as it directly affects the design cycle. Existing research allows for quick and efficient placement, but challenges remain due to the increasing complexity of the design. In this review, we looked at the optimization process from the perspective of accelerating the physical design of VLSI and systematically understood the problem of VLSI placement and the means of the process. Corresponding optimizations, thereby advancing modern research on Placement optimization to overcome the problems that have arisen due to the complexity of the VLSI physical design.

We focused on the latest trends in modern placement-centric VLSI physical design flows, including placement optimizers and learning-based analyses. At the beginning define the placement problems and review the classical placement algorithms, then discuss the application bottleneck of the classical placement algorithms in advanced technology nodes and give corresponding solutions.

After that, the development of placement optimizers, including algorithm improvement and computational speed increase, emphasizes that these two aspects will together drive the acceleration of VLSI physical design. Finally, we discuss the general and individual challenges faced by placement optimization tools and learning process-based predictors.

Keywords: VLSI placement; large-scale optimization; physical design; machine learning; prediction; placement challenges.

1. Introduction

Moore's law [1] has long guided the development of the semiconductor industry as a universal law to guide the semiconductor industry. However, in the post-Moore era, the semiconductor industry faced serious challenges due to the increasing scale and complexity of design [2]. These challenges make it difficult or even worse, to automate the physical design (PD) of very large-scale integration (VLSI) or, even worse, lead to longer design cycles. When starting the VLSI PD, the position of the circuit cells must be determined. At the beginning of VLSI PD, the circuit cells' location needs to be determined. There are two critical stages called macro (e.g., RAMs and ROMs) placement and standard cell (logic gates, such as NOR and NAND) placement [3-5]. As shown in Figure 1, various algorithms are used to solve the placement problem, including partitioning-based methods, heuristic algorithms, analytical solvers, and learning-based algorithms [6].

Inspired by [7,8], we find that recent developments in placement optimization have the ultimate goal of accelerating PD VLSI. For example, some have worked on improving the algorithm to achieve better position quality (e.g. profit and time), which can lead to significant costs but ultimately time savings. due to a reduction in the number of process repetitions. Some researchers have directly accelerated the computation of a placer (e.g., applying a GPU-accelerated platform). Some have added predictions of the quality of candidate placement results to avoid unnecessary flow iterations. From this perspective, we group the placement studies into two categories: placement optimizers and learning-based predictors.

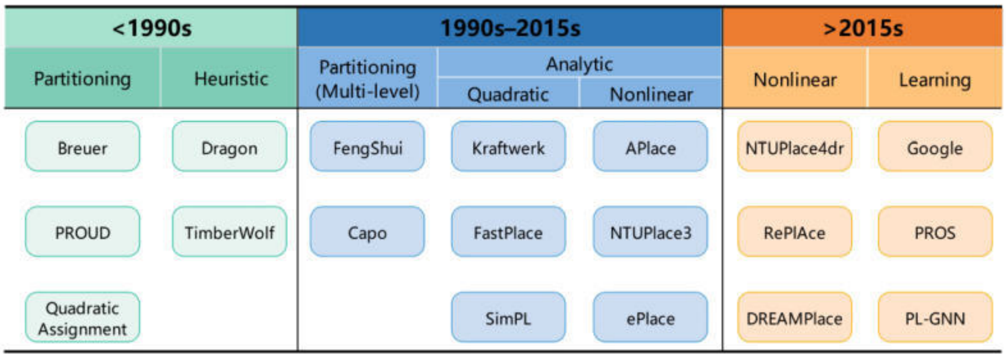
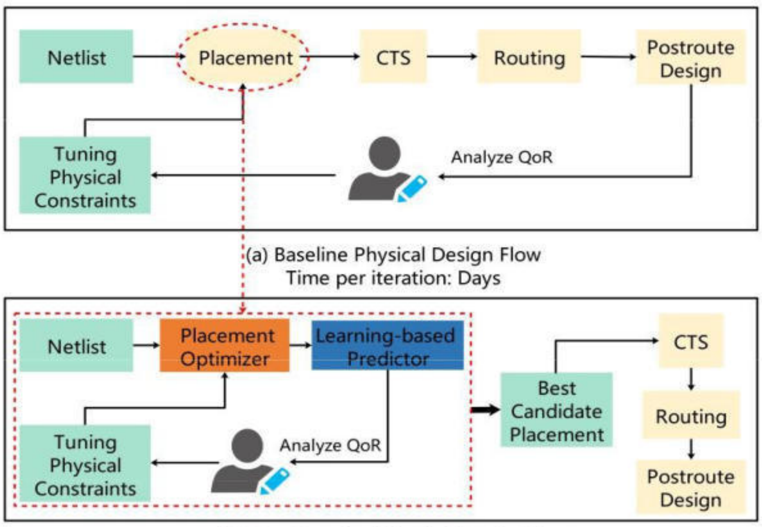


Fig 1. Describe the corresponding placers and placement algorithms in academia. As the design size increased, the dominant placement algorithms shifted from the early partitioning-based method to heuristic algorithms [6]. Furthermore, learning-based algorithms are gaining more attention, and a well-known example is Google's automatic macro placer [7].

Figure 2 depicts the new trends of VLSI PD flow. Figure 3 further classifies the optimizers and predictors, the details of which will be presented in the subsequent section. The optimizers perform online placement optimization, emphasizing algorithmic optimization and accelerated computation to get good placement quickly. The predictor performs offline placement optimization, highlighting the use of placement results to make predictions about next metrics, and back to better placement guidance. To narrow our discussion, we focus on the ASIC position and exclude FPGA, analog circuits, and more. The reason for this is that the placement studies for these different types of circuits are similar, with ASICs being the most studied.



(b) New Trends of Physical Design Flow
Time per iteration: Minutes

Figure 2. Latest trends of placement-centric VLSI physical design flow. This flow comprises two key technologies: (i) a placement optimizer, which contains algorithm improvement and computational acceleration, and (ii) a learning-based predictor, which is used to classify postplacement results [6].

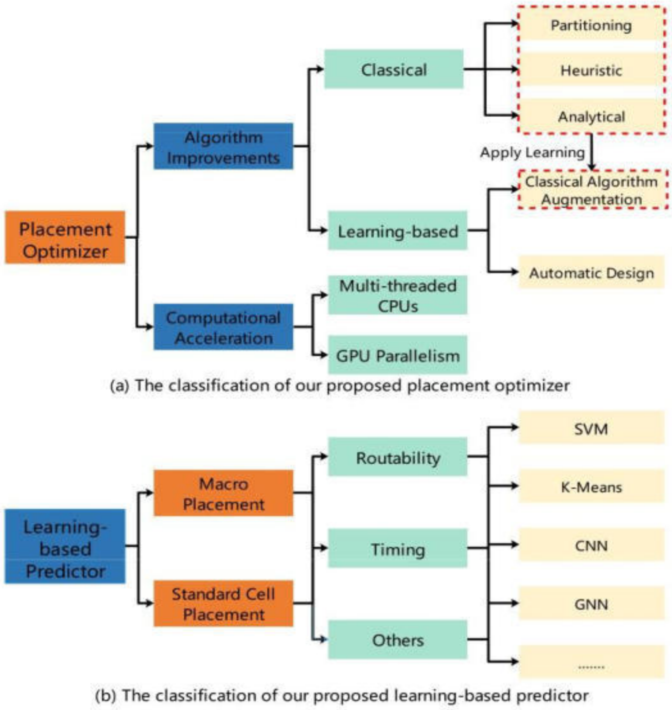


Figure 3. The classification of the placement optimizers and learning-based predictors. The optimizers perform online placement optimization and the predictors perform offline placement optimization. The details will be introduced in the subsequent section [6].

2. Problem Definition

Placement is a multi-objective optimization problem that requires a rational determination of the locations of macros or standard cells. The problem can be described as follows [15]: Given the placement region P, the input netlist G = (V, E) (V denotes the macros or standard cells to be placed; E denotes the connections between circuit cells), and the objective function F = (V, E), find the location (x_i, y_i) of each v_i 2 V such that (1) the objective function F = (V, E) is minimized and (2) the design constraints are satisfied.

The objectives are usually one or more of these: wirelength [3], routability [8], timing [10], power [16], thermal [17], and manufacturability [18]. The design constraints typically include cells not overlapping, cells being placed within the placement region, placement density being less than a threshold, fence region constraints [7], and so on. The visualization of the placement process is given in Figure 4.

Previous placement studies focused on optimizing the algorithm itself and less on both accelerated computation and ML-aided to accelerate VLSI PD. We attribute these studies to classical placement algorithms. As they are essential for understanding the development of placement and advancing research, classical placement algorithms are presented in Section 3.

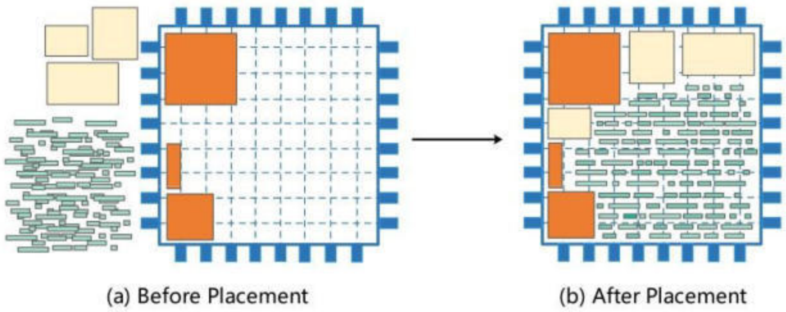


Figure 4. Elaboration of the placement process. The placement region is usually rectangular and can be divided into several bins. The blue rectangles form the placement region. The orange, milk-white, and green rectangles represent fixed-position macros, movable macros, and movable standard cells, respectively [6].

3. Classical Placement Algorithms

This section reviews classical placement algorithms, including partition-based algorithms, heuristic algorithms, and analytic methods. Table 1 summarizes the main ideas, strengths and weaknesses of the three types of algorithms and their correlation with typical placers [6].

Table 1. The core ideas (*), strengths (+), and weaknesses ( ) of the three types of algorithms and the corresponding typical placers ($) [6].

Type	Description
Partitioning-based Algorithms	(*) Divide and conquer (+) Efficient and scalable, can be used to solve large-scale circuits (−) Poor placement quality due to lack of global or local information (−) Harder to handle multiple objectives simultaneously ($) Capo [19] and FengShui [20]
Heuristic Algorithms	(*) Stochastic/hill-climbing methods (+) Simple to implement, high quality for small designs (+) Easier to handle multiple objectives simultaneously (−) Slower and less scalable for large-scale circuits ($) Dragon [21] and TimberWolf [22]
Analytical Methods	(*) Mathematical programming (+) More efficient and scalable (+) Better quality for even large-scale designs (+) Easier to consider multiple objectives simultaneously (−) Harder to optimize macro orientations ($) Quadratic: FastPlace [23], Polar [24], SimPL [25] ($) Nonlinear: NTUplace [26], ePlace [27], RePlAce [28]

In advanced technology nodes, VLSI PD [25] faces large design scale and complex optimization goals and constraints (such as area, power consumption and time). In this case, classical placement algorithms encounter application-level bottlenecks, mainly the following:

1. Classical placement algorithms have unsatisfactory solution quality. Limited by the huge solution space due to the large design scale, classical placement algorithms often have to compromise between runtime and solution quality, which brings subopti-mal solutions [1].

2. Classical placement algorithms such as heuristics and nonlinear methods are very time-consuming when solving large-scale netlists. The vast time overhead does not help to complete VLSI PD quickly 23-25.
3. Classical placement algorithms lack foresight. Classical algorithms become complex or powerless when more optimization objectives and constraints are considered. Most classical algorithms in academic research only use wavelength as a metric for placement quality, which is far from predictive for downstream metrics. A poorly foresighted placement can lead to routing failures, costing time for design-flow iterations [1].

Through research on placement-related work over the past few years, we believe that the future of placement in cutting-edge technology nodes looking at advancing VLSI development can be summarized in the following directions: after:

1. Algorithm improvements, including the improvement of classical placement algorithms and the newly proposed learning-based algorithms [25].
2. Computational acceleration, including the application of multi-threaded CPUs and GPUs to accelerate the placement-solution finding [1].
3. Learning-based predictors: application of ML or deep learning (DL) methods for predicting downstream metrics [29].

The new trend of placement-centric VLSI PD flow is shown in Figure 2. As depicted in Figure 3, we attribute directions 1 and 2 to the placement optimizer.

4. Challenges

As technological nodes have advanced, many new challenges have arisen when it comes to placement optimization. We provide an overview of placement challenges from the perspective of PD VLSI acceleration [25]. Specifically, we discuss the common challenge faced by placement optimizers and activity-based predictors and then present the respective challenges.

A common challenge is the application of learning algorithms [27]. These challenges include lack of data sets, difficulty in integrating schedulers, poor generalizability of trained models, and expensive training. As data-driven algorithms, learning algorithms most critically require a large amount of data, which is usually lacking in VLSI designs. Some work on data generation [15-17] was mainly based on existing several datasets and then modified the parameter settings with the help of EDA tools to get more datasets with different qualities. However, this is insufficient to achieve true design-level or netlist-level generalization. These two works [18-20] are worth mentioning for better generalization.

In addition to the common challenge mentioned above, placement optimizers also require attention on the following:

1. Classical placement algorithms do not require large amounts of data for training compared to learning algorithms [29-32]. However, the solution time may be too long to apply to increasingly complex designs. Keeping the classical placement algorithms feasible is a crucial challenge. It may be necessary to revisit the process of classical placement algorithms, rebalance solution time and algorithm quality, use learning algorithms to circumvent drawbacks [26], and so on.

2. Advanced challenges of GPU acceleration [32]. These challenges include a lack of parallelism and irregular computation patterns, high expectations for quality and inevitable

quality degradation, a lack of available baseline implementations, and high development cost. Future efforts on GPU acceleration include algorithmic innovation, pushing the speed limit on very hard kernels, and generating universal frameworks or programming models [21].

5. CONCLUSIONS

In this article, we took an in-depth look at advances in placement optimization to accelerate VLSI's physical design. After providing the foundation for location optimization research, we highlighted emerging trends in the modern location-focused VLSI physical design process, including location optimizers and predictive tools based on learning activity. .

Efficient and fast placement is still a problem. Although learning algorithms are becoming mainstream research, we should continue to study classical placement algorithms. There is still considerable research space for learning-based placement algorithms. Building infrastructure, especially datasets, will become increasingly important for driving placement research that supports learning. RL and GNN deserve further study, which promises to further automate VLSI placement problem-solving and accelerate the physical design of VLSI.

REFERENCES

1. Waldrop, M.M. The chips are down for Moore's law. Nature **2016**, 530, 144–147.

2. Garey, M.R.; Johnson, D.S.; Stockmeyer, L. Some simplified NP-complete problems. In Proceedings of the STOC '74, Sixth Annual ACM Symposium on Theory of Computing, Seattle, WA, USA, 30 April–2 May 1974; pp. 47–63.

3. Nam, G.J.; Alpert, C.J.; Villarrubia, P.;Winter, B.; Yildiz, M. The ISPD2005 placement contest and benchmark suite. In Proceedings of the ISPD '05, 2005 International Symposium on Physical Design, San Francisco, CA, USA, 3–6 April 2005; pp. 216–220.

4. Nam, G.J. ISPD 2006 Placement Contest: Benchmark Suite and Results. In Proceedings of the ISPD '06, 2006 International Symposium on Physical Design, San Jose, CA, USA, 9–12 April 2006; p. 167. [

5. Viswanathan, N.; Alpert, C.J.; Sze, C.; Li, Z.; Nam, G.J.; Roy, J.A. The ISPD-2011routability - driven placement contest and benchmark suite. In Proceedings of the ISPD '11, 2011 International Symposium on Physical Design, Santa Barbara, CA, USA, 27–30 March 2011; pp. 141–146.

6. Qiu, Y., Xing, Y., Zheng, X., Gao, P., Cai, S., & Xiong, X. (2023). Progress of Placement Optimization for Accelerating VLSI Physical Design. Electronics, 12(2), 337.

7. Mirhoseini, A.; Goldie, A.; Yazgan, M.; Jiang, J.W.; Songhori, E.; Wang, S.; Lee, Y.J.; Johnson, E.; Pathak, O.; Nazi, A.; et al. A graph placement methodology for fast chip design. Nature **2021**, 594, 207–212.

8. Huang, G.; Hu, J.; He, Y.; Liu, J.; Ma, M.; Shen, Z.; Wu, J.; Xu, Y.; Zhang, H.; Zhong, K.; et al. Machine Learning for Electronic Design Automation: A Survey. ACM Trans. Des. Autom. Electron. Syst. **2021**, 26, 1–46. Electronics **2023**, 12, 337 19 of 23

9. Hao, R.; Cai, Y.; Zhou, Q. Intelligent and kernelized placement: A survey. Integration **2022**, 86, 44–50.

10. Alpert, C.J.; Mehta, D.P.; Sapatnekar, S.S. (Eds.) Handbook of Algorithms for Physical Design Automation; OCLC: Ocn214935396; CRC

Press: Boca Raton, FL, USA, 2009;

11. Cheon, Y.; Ho, P.H.; Kahng, A.B.; Reda, S.; Wang, Q. Power-aware placement. In Proceedings of the DAC ’05, 42nd Annual Design Automation Conference, Anaheim, CA, USA, 13–17 June 2005; pp. 795–800.

12. Kahng, A.B.; Kang, S.M.; Li, W.; Liu, B. Analytical thermal placement for VLSI lifetime improvement and minimum performance variation. In Proceedings of the 2007 25th International Conference on Computer Design, Lake Tahoe, CA, USA, 7–10 October 2007; pp. 71–77, ISSN 1063-6404.

13 Huang, Y.C.; Chang, Y.W. Fogging Effect Aware Placement in Electron Beam Lithography. In Proceedings of the 54th Annual Design Automation Conference 2017, Austin, TX, USA, 18–22 June 2017; pp. 1–6.

14. Roy, J.A.; Papa, D.A.; Adya, S.N.; Chan, H.H.; Ng, A.N.; Lu, J.F.; Markov, I.L. Capo: Robust and scalable open-source min-cut floorplacer. In Proceedings of the ISPD ’05, 2005 International Symposium on Physical Design, San Francisco, CA, USA, 3–6 April

2005; pp. 224–226.

15. Can Yildiz, M.; Madden, P.H. Improved cut sequences for partitioning based placement. In Proceedings of the 38th Conference

on Design Automation—DAC ’01, Las Vegas, NV, USA, 18–22 June 2001; pp. 776–779.

16 Wang, M.; Yang, X.; Sarrafzadeh, M. Dragon2000: Standard-cell placement tool for large industry circuits. In Proceedings of the

IEEE/ACM International Conference on Computer Aided Design, San Jose, CA, USA, 5–9 November 2000; pp. 260–263, ISSN

1092-3152.

17. Sechen, C.; Sangiovanni-Vincentelli, A. The TimberWolf placement and routing package. IEEE J. Solid-State Circuits **1985**, 20, 510–522.

18. Viswanathan, N.; Chu, C.N. FastPlace: Efficient analytical placement using cell shifting, iterative local refinement,and a hybrid net model. IEEE Trans. Comput.-Aided Des. Integr. Circuits Syst. **2005**, 24, 722–733.

19. Lin, T.; Chu, C.; Wu, G. POLAR 3.0: An ultrafast global placement engine. In Proceedings of the 2015 IEEE/ACM International Conference on Computer-Aided Design (ICCAD), Austin, TX, USA, 2–6 November 2015; pp. 520–527.

21. Kim, M.C.; Lee, D.J.; Markov, I.L. SimPL: An effective placement algorithm. In Proceedings of the 2010 IEEE/ACM International Conference on Computer-Aided Design (ICCAD), San Jose, CA, USA, 7–11 November 2010; pp. 649–656.

22. Hsu, M.K.; Chen, Y.F.; Huang, C.C.; Chou, S.; Lin, T.H.; Chen, T.C.; Chang, Y.W. NTUplace4h: A Novel Routability-Driven Placement Algorithm for Hierarchical Mixed-Size Circuit Designs. IEEE Trans. Comput.-Aided Des. Integr. Circuits Syst. **2014**,

23. Liang, R.; Xie, Z.; Jung, J.; Chauha, V.; Chen, Y.; Hu, J.; Xiang, H.; Nam, G.J. Routing-Free Crosstalk Prediction. In Proceedings of the 2020 IEEE/ACM International Conference On Computer Aided Design (ICCAD), Virtual, 2–5 November 2020; pp. 1–9,

ISSN 1558-2434.

24. Lee, Y.Y.; Ruan, S.J.; Chen, P.C. Predictable Coupling Effect Model for Global Placement Using Generative Adversarial Networks with an Ordinary Differential Equation Solver. IEEE Trans. Circuits Syst. II **2021**, 69, 2261–2265.

25. Wang, B.; Shen, G.; Li, D.; Hao, J.; Liu,W.; Huang, Y.;Wu, H.; Lin, Y.; Chen, G.; Heng, P.A. LHNN: Lattice hypergraph neural network for VLSI congestion prediction. In Proceedings of the DAC '22, 59th ACM/IEEE Design Automation Conference,

San Francisco, CA, USA, 10–14 July 2022; pp. 1297–1302.

26. Xie, Z.; Pan, J.; Chang, C.C.; Liang, R.; Barboza, E.C.; Chen, Y. Deep Learning for Routability. In Machine Learning Applications in Electronic Design Automation; Ren, H., Hu, J., Eds.; Springer International Publishing: Cham, Switzerland, 2022; pp. 35–61, ISBN 978-3-031-13074-8.

27. Chen, G.; Pui, C.W.; Li, H.; Chen, J.; Jiang, B.; Young, E.F.Y. Detailed routing by sparse grid graph and minimum-area-captured path search. In Proceedings of the ASPDAC '19, 24th Asia and South Pacific Design Automation Conference, Tokyo, Japan, 21–24 January 2019; pp. 754–760.

28. Chai, Z.; Zhao, Y.; Lin, Y.; Liu, W.; Wang, R.; Huang, R. CircuitNet: An Open-Source Dataset for Machine Learning Applications in Electronic Design Automation (EDA). arXiv **2022**, arXiv:2208.01040.

Environmental Pollution: Its Causes and Effects

Dr. Dinesh Kumar Rao

Professor, Mechanical Engineering Department, JBIT, Dehradun,

ABSTRACT

Man is harming all aspects of the environment, including the ecosystem itself, the atmosphere, water, and land. The future's nightmare of man-made pollution and environmental devastation is enough to make us all nervous.

A few tendencies are present when we take a synoptic perspective of the overall situation. Both globally and locally, our atmosphere is extremely contaminated. In the densely inhabited regions of the northern hemisphere, the protective ozone barrier is decreasing twice as quickly as scientists previously believed.

Global warming will soon result from significant changes in weather patterns brought on by the accumulation of greenhouse gases

The destruction of the ozone layer and further warming of the earth's surface pose a threat of catastrophic consequences, including the emergence of cancerous and tropical diseases, the disruption of the ocean food chain, the rise in sea levels, the submergence of many islands, the melting of small land-based glaciers, flooding in many low-lying coastal areas, loss of harvest, etc.

INTRODUCTION

As old as the idea of nature itself is the idea of the environment. It is a collective phrase used to describe the environments in which organisms flourish and turn into living sources of life for all living and non-living things, including plants. The phrase also refers to the wind's velocity, temperature, and direction.

ECOLOGICAL POLLUTANCE

It is equally important to grasp what "pollution" is before comprehending what "environmental pollution" is.

POLLUTION DEFINITION

The term "Pollution" was defined as follows by the Royal Commission on Environmental Pollution in the UK in its third report: introduction of energy or substances into the environment by man that could endanger human health, damage ecosystems and living things, destroy buildings or other structures, or interfere with the environment's ability to be used for its intended purposes.

The definition of "pollution" in Section 1(3) of the U.K. Environment Protection Act, 1990, is as follows:

the discharge of compounds from any process (into any environmental medium) that have the potential to be harmful to humans or any other living things dependent on the environment.

When there is a risk of injury, pollution occurs. Damage to man's health is not limited to physical harm; it also includes offenses to his senses and damage to his property, therefore even smells and sounds that don't physically hurt me can still be considered pollution. Health harm or interference with the ecological processes they depend on are two examples of harm to living things.

KINDS OF POLLUTION

Natural and man-made pollution can both be generically categorized as environmental contamination.

1. Natural Pollution: Natural occurrences like earthquakes, floods, droughts, cyclones, etc. frequently cause environmental pollution.
2. Pollution caused by humans: human activities.

The various types of environmental pollution include air pollution, water pollution, land contamination, food pollution, radioactive pollution, and more.

ENVIRONMENTAL PROBLEM CAUSING ELEMENTS

The "environmental crisis" is a result of environmental and ecological changes brought on by the current century's "economic and technological man's" growth process. In actuality, while the twenty-first century is characterized by socioeconomic, scientific, and technical advancement on the one hand, it is also beset by grave environmental issues on the other.

The environmental crisis resulting from the degradation of the environment brought on by various types of pollution, the rapid exploitation of natural resources, the growing reliance on energy-intensive and environmentally harmful technologies, the loss of habitats brought on by the expansion of industry, cities, and agriculture, the reduction and loss of ecological populations brought on by the excessive use of toxic pesticides and herbicides, and the extinction of many species Since environmental degradation brought on by hum activity is having such a rapid negative impact on everyday life, there has been a noticeable increase in interest in environmental quality, the disruption of the environment, and related topics over the past ten years. The fact that there is a deteriorating interaction between man and the environment as a result of the high rate of resource exploitation, technical advancement, and industrial expansion is the most striking cause of environmental degradation and the ensuing worldwide environmental disaster. Because of human activity, the rate of environmental change and the resulting environmental deterioration has been so rapid and extensive.

Because the transformation or modification of the natural condition and process results in a succession of changes in the biotic and abiotic components of the environment, man's economic activities have a wide range of diverse and extremely complicated effects on the environment. The two types of affects that humans have on the environment are direct (i.e., purposeful) and indirect (i.e., unintentional), Because man is aware of the results, both positive and negative, of each program which is initiated to change or modify the natural environment for the economic development of the region concerned, direct or intentional impacts of human actions are preplanned and premeditated. The impacts of anthropogenic changes in the environment become apparent quickly and can be reversed. On the other hand, human activities that are intended to hasten the rate of economic growth, particularly industrial development, have an indirect impact on the environment that is not premeditated or planned. After a considerable amount of time, when they have accumulated, the indirect effects are felt. The total natural environmental system may change as a result of these indirect human economic activity effects, and the subsequent chain reactions can sometimes deteriorate the environment to the point that it becomes life-threatening for people.Principal Environmental Pollution Causes Today's environmental pollution issue is a complicated result of pressures linked to numerous interrelated elements. There are undoubtedly many different and opposing opinions regarding what might be the fundamental causes of the environmental disaster.

The root cause of environmental deterioration cannot be attributed to one particular factor. Though each of these may be active simultaneously and their balance may change from place to location and over time, the following causes can be identified as the typically underlying factors.

1. **Population growth**

Many contemporary scholars believe that population expansion is the primary source of many human issues. Environmental deterioration is also affected by this observation. The multiplier effect of population growth will necessitate a commensurate increase in all requirements for human existence. To meet the daily necessities of life, population increase necessitates abnormal resource exploitation. It leads to population increase in metropolitan areas and migration of people, which opens the door to new issues with human health, ecology, and sustenance.

2. **Greater Economic Growth and General Wealth**

Affluence, or the material characteristics of per capita consumption of goods and resources, is a significant factor in the link between people, resources, and the environment. Because their wealth is out of proportion to the necessary resource consumption and is not driven by human needs, the wealthy have an increased propensity to waste matter and energy, which is stifling growth in the output of goods and services in both developed and developing countries. Surprisingly, despite having a significant impact on the environment, the affluent component is rarely discussed. On the other hand, the poor and poverty are frequently held responsible for environmental degradation. The idea that the environment is most severely harmed by poverty or the poor is only partially accurate.

3. **Nature of Modern Technology**

The present environmental crisis is intimately tied to the nature of productive technologies. According to Commoner, since World War II, there have been significant changes in productive technology. Productive technologies with significant environmental effects have superseded less harmful ones. This element has played a significant role in the production of synthetic and non-biodegradable materials including plastics, chemical nitrogen fertilizers, synthetic detergents, synthetic fibres, giant automobiles, petrochemical and other businesses that harm the environment, as well as "disposable culture." As a result of a counter ecological pattern of productive expansion, environmental crises is unavoidable. Environmentally friendly technologies were and still exist, but they are not used because they are seen as being incompatible with the short-term goals of maximizing private profit.

4. **Deforestation**

Because they supply raw materials for contemporary businesses, lumber for construction, and habitat for a wide variety of animals and microorganisms, forests are priceless national assets. By tying the soil together through the network of its roots and shielding it from the direct impact of raindrops, good fertile, nutrient-rich soils with a high amount of organic matter provide protection to soils.

They promote and enhance precipitation infiltration, allowing groundwater resources to be fully recharged, and they limit surface runoff, which lessens flood frequency, intensity, and size. They aid in boosting precipitation and act as a natural carbon dioxide sink since they use carbon dioxide during the process of photosynthesis to manufacture their food. They give food and shelter to countless numbers of people and animals, as well as firewood to millions of people worldwide. In actuality, woods are a country's "life line" since they directly affect the wealth and welfare of the society in question. The stability of the environment and ecological balance greatly depend on the condition of the forests in the region in question because they constitute the primary biotic component of the natural environmental system.

The fact that the current economic man has forgotten the environment and ecological significance of natural vegetation, primarily forests and grasslands, and has destroyed forests so quickly and alarmingly that forest areas at global, regional, and local levels have been so noticeably reduced that several serious environmental problems, such as an accelerated rate of soil loss through rain splash, sheet wash, rill and gully erosion, increase in the frequency of wildfires, At both the global and regional levels, shifting cultivation, conversion of forests into pastures, overgrazing, forest fires, lumbering, multipurpose river projects, etc. are the main drivers of deforestation. Deforestation causes a number of issues, including environmental degradation through accelerated soil erosion, increased river sediment loads, reservoir siltation, increased frequency and severity of hoods and droughts, altered patterns of precipitation distribution, intensified greenhouse effect intensity, increased destructive power of atmospheric storms, etc. Economic loss from crop damage brought on by more frequent floods and draughts, a decline in agricultural output due to the loss of fertile top soils, a reduction in the availability of raw materials to the construction industry, etc. As a result, deforestation has a number of negative side effects on the environment.

5. Agricultural Development

Increasing agricultural productivity and net agricultural production are two terms used to describe agricultural growth. It is a result of the advancement of contemporary scientific methodologies, cutting-edge technology, increased production and application of chemical fertilizers, expansion of irrigational infrastructure, creation of high-yielding seed types, etc. On the one hand, this has resolved the issue of the rising food demand caused by the continuously growing global population; nevertheless, on the other hand, it has generated or is now developing harmful environmental issues that are of grave concern. Since there are threats in every direction, modern economic and technical man is at a crossroads.

Agricultural development harms the environment in a number of ways, including (i) the use of chemical fertilizers, herbicides, and insecticides, (ii) the expansion of irrigation systems and irrigation volume, (iii) the alteration of biological communities, etc.

The pace of soil erosion is accelerated when forested land is turned into agricultural farms on muddy terrain. increased use of machines and contemporary scientific techniques, increased application of chemical fertilizers, pesticides, insecticides, and herbicides, increased frequency and area of irrigation of agricultural fields, etc. all result in an increase in agricultural land at the expense of forest destruction and subsequent soil erosion. All of these methods and procedures for accelerating agricultural development contribute to a number of significant environmental issues.

The alarming rate of human population growth seems to be the fundamental cause of all these environmental issues resulting from agricultural development. Therefore, the first action that needs to be performed is to curb population increase because if it continues, agricultural development will need to be supported.

6. **Industrial Development**

"Human society now enjoys economic affluence thanks to rapid industrial development. It has also given the socioeconomic system a new dimension and given the citizens of industrialized nations material comfort, but it has also exacerbated environmental issues on a massive scale. In fact, the glittering results of industrialization have so altered public perception that it is now viewed as the standard of modernity and a fundamental component of a country's socioeconomic growth.quick rates of modernization led to quick rates of resource extraction and higher industrial output. Both the exploitation of natural resources and other aspects of industrial development.

Industrial production has produced a number of dangerous environmental issues as well as widespread environmental issues and ecological imbalance on a local, regional, and global scale.

In order to meet the industrial demand for raw materials, natural resources have been exploited. This has led to (i) the loss of forest cover due to careless tree cutting, (ii) the excavation of land for mining, (iii) the reduction of arable land due to industrial expansion, (iv) the lowering of groundwater levels due to excessive groundwater withdrawal, (v) the collapsing of ground surfaces due to the extraction of mineral oil and groundwater, etc.

Along with desired production, factories also produce a variety of undesirable byproducts that harm the environment by polluting the air, water, land, soils, toxic gases, chemical precipitates, aerosol ashes and smokes, among other things.

The industrialized nations have raised the amount of pollutants that manufacturers emit into the air, water, and land to such a level that they have deteriorated the environment to the point of no return and have put human society in danger of disintegrating.

The negative effects of industrialization may alter the overall nature of the natural world, with sometimes lethal consequences for human civilisation. The majority of industrialization's negative effects are connected to pollution and the damage of the environment. Chemical fertilizers, herbicides, and insecticides (outputs of the chemical industries) affect the physical and chemical properties of soils as well as the food chains and food webs by releasing hazardous substances into the environment through application. Similar to this, the discharge of industrial wastes into ponds, tanks, lakes, rivers, and oceans contaminates the water, leads to a number of diseases and animal fatalities, and upsets the biological balance of the aquatic ecosystem.

Large amounts of contaminants, such as ions of chlorine, sulphate, bicarbonate, nitrate, sodium, magnesium, and phosphate, are released into rivers and lakes through sewage effluents as a result of increasing industrial expansion, poisoning the water. The environment is negatively impacted in a number of ways by the emissions of various gases, smokes, ashes, and other particles from factory chimneys. The atmosphere's natural gaseous composition has changed as a result of an increase in CO_2 concentration brought on by the burning of hydrocarbon fuels (coal and petroleum). Because C02 intensifies the greenhouse effects of the atmosphere by allowing solar radiation to pass through the atmosphere and reach the earth's surface while blocking outgoing long-wave terrestrial radiation from escaping to space, an increase in the atmosphere's carbon dioxide content could change the global radiation and heat balance by increasing the amount of sensible heat in the atmosphere. Ozone layer loss results in reduced absorption of UV sun rays, which significantly increases the earth's surface temperature. Thus, changes in weather and climatic conditions at the global and regional levels may cause severe harm to plant and animal lives and thus may cause ecological imbalance. These changes are caused by an increase in the concentration of carbon dioxide in the atmosphere and the thinning of the ozone layer. It could result in harmful illnesses like skin cancer, etc.

Environmental risks brought on by the intentional or unintentional release of harmful gases by humans kill all kinds of local life forms. A tragic result of contemporary industrialisation is the Bhopal Gas Tragedy, which occurred in India on December 3–4, 1984. Other environmental risks brought on by development include acid rain, urban pollution, nuclear holocaust, etc.

7. Urbanization

The migration of people from rural to urban areas, as well as the birth and growth of new urban centers brought on by industrial development, are to blame for the rapid exploitation of natural resources and various forms of environmental degradation and pollution in both developed and developing nations. The developed nations of the globe have already reached their maximum level of urbanization. Large slum regions have developed and grown as a result of the concentration of people in crowded metropolitan areas brought on by the accumulation of wealth and the expansion of economic and employment opportunities in urban centres.

In actuality, increasing urbanization entails a greater concentration of people in a finite amount of space, which increases the need for more infrastructure such as factories, roads, buildings, sewage systems, storm drains, and vehicles (such as cars, trucks, buses, and motorcycles). All of these factors contribute to a variety of environmental issues. For instance, the growing urban population utilizes a tremendous amount of water for a variety of applications. Because urban effluents are permitted to be discharged into streams and lakes, utilized waste water, such as sewage water, pollutes them if left untreated. Urban areas grow riskier from the perspective of pollution and environmental issues when integrated with industrial sectors. Huge amounts of aerosols and gases are released from factory and vehicle chimneys, creating "Dust Domes" over the cities. 'Pollution Domes' are created by these dust domes over the cities. Due to high air pollution from gases and aerosols released by vehicles, companies, and home appliances, the quality of the air has been rapidly declining as a result of urban and industrial growth. Vehicles are responsible for over 60% of the pollution in Delhi, the capital of India. Calcutta and Bombay have also experienced significant levels of air pollution. The National Environmental Research Institute in Nagpur, India, conducted a survey to determine the amount of air pollution in Delhi, Calcutta, and Cities like Mumbai, Madras, Ahmedabad, Cochin, Hyderabad, Kanpur, and Nagpur have increased. Large quantities of municipal solid trash contribute to environmental issues in addition to industrial wastes from industrial cities. With urban growth and a rise in urban population, the amount of solid urban garbage is fast rising.

8. **Unplanned Urbanization**
Both in urban and rural areas, the environment has significantly and visibly worsened as a result of the imbalanced urban development. The urban areas are in poor condition due to squatter settlements, a lack of water and sanitation, overpopulation, traffic, and pollution. India's cities are struggling with environmental issues like poor sanitation, a persistent lack of resources, and traffic congestion, among others. In addition, disposing of household and industrial garbage in metropolitan areas is a severe problem. Sewer systems are generally insufficient in cities. For instance, research by the Central Board for the Prevention and Control of Water contamination have demonstrated that the main cause of water contamination is the discharge of municipal waste and industrial effluents.

Currently, 87% of Class II towns and 56% of Class I cities lack sewerage systems. Therefore, in order to stop rural-urban migration and other related issues, we need an urbanization process that is carefully controlled and managed.

9. **Coal burnt Thermal Power Plants**

Coal is the primary fuel for the generation of energy in power plants, whether they are public or private. About 62% of the coal mined in our nation is used to generate electricity, which makes up 65% of the total amount of power generated. As a result of this process, numerous byproducts such bottom ash, boiler slag, and fly ash build up. Over 70% of the total is made up of just fly ash. It is a difficult and delicate task to dispose of this much tty ash. Although this material can be used to make cement, bricks, and to condition soil, these operations have not been particularly well-liked for economic and societal reasons. Even if the fly ash is used for the aforementioned operations, only 30% to 40% of the ash produced will be usable. Therefore, it is necessary to store the created ash in a manner that causes the least amount of harm to land, water, and air resources. Typically, a super thermal power station with an 800-acre footprint needs 1200 acres for ash disposal. According to the trends in ash production, approximately 40000 hectares of land are needed for ash disposal. Power plants are often built on waste ground, far from populated areas, but over time, some cultivable land has also been covered with ash mound sites. The residents who live close to the plant site are quite concerned about the presence of ash, especially in the atmosphere. Because to the frequently high wind speeds, this is particularly bad in the summer. The finer fly ash fractions have the potential to be detrimental because when inhaled, they deposit in the lungs and pulmonary tissues of the respiratory system.

10. **Poverty**

Poor people do indeed harm the environment. Due to their extreme poverty, the populace overuses the nation's natural resources to meet their fundamental necessities (food, fuel, shelter, employment, and fodder for their cattle). According to the late Mrs. Indira Gandhi's remarks at the Stockholm Conference, poverty and need are in fact the worst polluters. Therefore, the required efforts must be made to lift the underprivileged out of poverty.

CONCLUSION

There are numerous root causes of environmental issues. It is challenging to accurately define the causes and effects of environmental deterioration in terms of a straightforward one to one relationship due to the diversity of causes. In intricate webs of social, technological, environmental, and political elements, the causes and effects frequently interact. However, the population increase, the economic expansion brought on by the affluence factor, and changes in technology are some of the extremely prevalent reasons of environmental degradation that can be pointed out with clarity. Although population is a valuable resource for development, when it exceeds the support systems' threshold limits, it significantly contributes to environmental degradation. Negative demographic pressure ultimately has a significant negative influence on our ecosystems and resources. When poverty and underdevelopment are present in addition to one another, it forces individuals to live in squalor, further degrading their surroundings. If not adequately managed, the development process itself can harm the environment. The lavish prosperity, which is linked to the rapid economic progress, uses far more resources and puts much more strain on natural resources. The planned obsolescence that results from technology change leads to an increase in waste production, which is thus detrimental to the environment. Additionally, the process of replacing outdated technologies with environmentally friendly ones is hampered by short-term private profit maximization goals**.**

REFERENCES

1. Khan, I.A., Environmental Law, Allahabad: Central Law Agency, 2002.

2. Deep and Deep Publications, New Delhi, Kailash Thakur, Environment Protection Law and Policy in India.

3. Mapping environmental education by Sterling, S. In Key Issues in Environmental Education, University of Bradford: UNESCO, 1992, edited by W. D. S. Leal Filho and J. A. Palmer.

4. Environmental Law and Policy in India - Cases, Material, and Statutes, by Armin Rosencranz, Shyam Divan, and Martha L. Noble, 1991.

5. The Politics of Sustainable Development: Theory, Policy and Practice within the European Union, London: Routledge, 1997; Baker, Susan; Kousis, Maria; Richrdson, Dick; and Young, Stephen.

6.Blackstone's Statutes on Environmental Law, edited by R.M.C. Duxbury and S.G.C. Morton. Blackstone Press Limited, 2000, Third Edition.

7.Pollution Control in the South and North: A Comparative Assessment of Environmental Policy Approaches in India and the Netherlands, by O.J. Kuik et al. Sage Publications, 1997, New Delhi.

8. Salve, H., "Justice Between Generations: Environment and Social Justice," Supreme But Not Infallible, New Delhi: Oxford University Press, 2001, edited by A.N. Kripal, A. Desai, G. Subramanium, R. Dhavan, and R. Ramachandran.

9. Alan Watson, Legal Transplants: An Approach to Comparative Law, Scottish Academic Press, Edinburgh, 1974.

10. G. Grossman and A. Krueger, "Economic Growth and the Environment," Quarterly Journal of Ecosnomics, May 1995, Vol. CX, Issue 2, p. 353.

11. "Integrated Pollution Control and its Impact: Perspectives from Industry," Mehta and Hawkins, Journal of Environmental Law, 10(1), 1998, p. 65.

Indoor Human Activity Recognition System Using RSSI

Amit Kumar
Assistant Professor, Mechanical Engineering Department, JBIT, Dehradun,

ABSTRACT

Because the human body is a good reflector, variations in radio signal can be used to identify it. We would demonstrate how this is achievable through a series of ways in this paper. First, we build a wireless sensor network (WSN) in a confined surface area, and then we analyse the signal variation on that surface in the presence of humans. Furthermore, we monitor the radio signal for gesture movement. The received signal strength indicator (RSSI) records the variances. Then, using radar, we create another human activity identification system and compare the accuracy of the two systems. The paper contains some intriguing findings.

Keywords: RSSI, WSN, human body, gesture activity recognition

1. Introduction:

We know that the human body is an excellent radio signal reflector. As a result, human activity can be detected via radio signals. When a radio wave (ranging from 3 KHz to 300 GHz) propagates across the earth's surface, it is impacted by many items. These effects include reflection, refraction, diffraction, and scattering, among others. The wave's power or magnitude varies depending on these events. If there are no obstacles in the way, the wave can sometimes reach its goal immediately. This is referred to as line of sight (LOS) communication. Our research is based on the monitoring of radio wave fluctuation in the presence of any object, such as a human body. A system can be created to follow a human person with his various gesture positions when he is standing at a certain spot as well as traveling through the area. In this instance, he does not need to carry any wireless device, such as a cell phone or pager. This is accomplished by evaluating the radio signal in that area, which varies depending to the Person's presence. Device-free radio-based identification can expand wireless-enabled devices' awareness beyond device limits.

It could be used for mobile phones, laptop computers, or consumer items that include a wireless channel interface. Multiple wireless devices, such as sensor nodes or Wi-Fi routers, are often deployed across the region. The nodes interact via a single common radio channel, and the strength of signals received from other nodes is constantly monitored. This is referred to as the received signal strength indicator (RSSI). The amplitude of the received signal changes as a result of radio wave interactions with the human body (such as diffraction, reflection, and scattering). Multiple wireless devices that actively broadcast, receive, and analyse radio signals are required in current systems. These devices are often limited to only one or a few frequency channels in a narrow band frequency spectrum due to radio spectrum recognition. In this case, frequency modulation is applied.

2. Background

WSN, as a distributed system, can be used to monitor and track any physical system. Aside from sensing and monitoring, another key feature of WSN is the definition of location and tracking of static or moving objects. Typically, a location determination system necessitates the presence of a physical gadget close to the person being tracked. Furthermore, they typically require the tracked device to actively engage as an activity recognition system. To identify changes in the environment, the system monitors and processes changes in the received physical signals at one or more monitoring stations. The employment of global positioning systems (GPSs) among classic localization techniques is not always the best choice due to the high prices. Furthermore, due to interference, GPS cannot be used properly for interior applications. The capacity of radio waves to penetrate smoke, nonmetallic barriers, and walls is a significant benefit. The standard devices used for tracking and monitoring an object may encounter numerous challenges, such as not working well in low light or on a clumsy closed surface. They may also be harmed by unavoidable conditions. These reduce the effectiveness of a tracking system. From this perspective, the concept of device-free activity localization has been developed. Such systems, which are effective for solving location and tracking problems, are based on the analysis of fluctuations in some physical qualities available at WSN nodes. The measurement of RF signals has been extensively used since the values of their descriptive properties (for example, the RSS) are available at the physical layer of each node without the need for any additional apparatus. In fact, the ability of radio waves to permeate nonmetallic walls can be extremely valuable for building surveillance, monitoring, and tracking [1]. Despite being a pioneering area of research, certain investigations have previously been conducted. Activity recognition systems are a huge subject of research and development for hardware architecture innovation. The goal of activity recognition is to recognize one or more agents' actions and goals based on a sequence of observations on the actors' behaviourss and the ambient conditions. Since the 1980s, this research field has piqued the interest of several computer science communities due to its ability to provide personalized support for a wide range of applications and its connections to a wide range of fields of study such as medicine, human-computer interaction, and sociology. Sensor-based activity detection combines the growing field of sensor networks with cutting-edge data mining and machine learning approaches to model a wide range of human activities [2]. The goal of activity recognition research is to map a particularly complex landscape of cognition objects. When a new sensor is introduced, it is designed to represent a particular aspect of the environment at a high level of detail. Because activity and context recognition are extremely inventive, new sensors are constantly being presented as inputs for activity classification. The physical phenomena detected, data output format, size, precision, dependability, and resource consumption of the sensors themselves vary widely. Recognizing an activity correctly in a given situation would thus imply that a) the recognized activity is actually present in the physical environment at the time, b) the sensor is capable of creating and relaying a useful and reliable representation of physical parameters of the environment that are affected by the activity, and c) the classification algorithm is capable of deciphering these complexities, yielding a correct activity classification. Human activity recognition (HAR) is a dynamic and difficult research issue. It seeks to determine a person's or a group of people's actions based on sensor and/or video observation data, as well as knowledge about the context in which the observed activities occur. In general, the HAR process consists of multiple steps, beginning with the collection of information about human behaviours from raw sensor data and ending with a conclusion on the currently performed activity [4]. These are the actions to take: (1) Raw data from sensor streams are pre-processed to handle incompleteness, eliminate noise and redundancy, and conduct data aggregation and standardization. (2) segmentation - determining the most significant data segments; (3) feature extraction - extracting the main characteristics of features (e.g., temporal and spatial information) from the segmented data using, for example, statistical moments; (4) dimensionality reduction - reducing the number of features to improve their quality and reduce the computational effort required for classification; (5) classification, the core machine learning and reasoning - determining the most significant data segments; The primary goals of HAR systems are to watch and analyse human activities as well as successfully understand ongoing events. HAR systems retrieve and interpret contextual (environmental, geographical, temporal, etc.) data using visual and non-visual sensory data to comprehend human behaviours [5].

3. WIRELESS SENSOR NETWORK

A wireless sensor network (WSN) is a wireless system made up of scattered autonomous devices that use sensors to monitor physical or environmental factors. A WSN system has a gateway that connects wirelessly to the wired world and dispersed nodes [6].

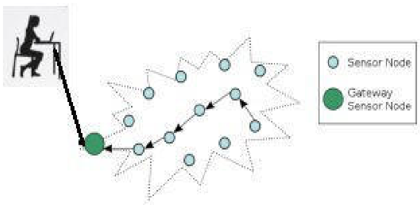


Fig.1. Sensor and gateway sensor nodes

An activity recognition system simply monitors and categorizes various human actions such as "walking," "crawling," "sitting," "lying," and "standing." The RSSI indicator recognizes these human motions based on the fluctuation of the radio signal.

ACTIVITY RECOGNITION SYSTEMS

There are four types of existing activity recognition systems: RSSI-based, specialized hardware-based, radar-based, and CSI-based [19]

A. RSSI Based

The strength or amplitude of the received signal changes as a result of human actions in received signal strength Indicator (RSSI)-based human activity identification systems. The precision of these systems is restricted. Software implementation may increase accuracy. As a result, the collected data's resolution improves. Although the RSSI-based system is significantly simpler than CARM, the accuracy and coverage of the CSI-based human Activity Recognition and Monitoring system (CARM) are much larger. As a result, it is easily deployable in any setting [7].

B. Specialized Hardware Based

Fine-grained signal measurements can be reported by software defined radios or specifically developed hardware. WiSee, for example, uses USRP to measure Doppler shift in wireless signals and achieves a 95% accuracy in activity recognition. Allsee presents a short-range (less than 2.5 feet) solution for gesture detection by extracting the envelope of the received signal using a dedicated low-power circuit [7]. Wisee investigates the feasibility of reconstructing a target image using wireless signals received by several antennas. WiSee is a unique interaction interface that takes advantage of ongoing wireless transmissions in the environment (e.g., WiFi) to enable whole-home sensing and gesture detection. WiSee can enable whole-home gesture detection utilizing a few wireless sources (e.g., a Wi-Fi router and a few mobile devices in the living room) because wireless signals do not require line-of-sight and can pass through walls. Using WiSee, different home allowances such as light switch on/off, TV control without a remote, and many more are available thanks to human gesture detection. WiSee can identify and classify a set of nine gestures with an average accuracy of 94%, according to the results.

Existing gesture-recognition systems take a lot of power and computational resources, which limits their application in low-end devices. AllSee is the first gesture-recognition system that can run on a variety of computing devices, including those that do not have batteries [8]. AllSee consumes three to four orders of magnitude less power than current systems and can enable always-on gesture detection for smart phones and tablets. It collects gesture information from current wireless signals (for example, TV transmissions), but without the power and computational overheads associated with previous wireless techniques. RFID tags and power-harvesting sensors can be recognized by AllSee prototypes. The device can be linked to a smartphone [9]. This allows for gesture control, such as volume changes, while the phone is in your pocket.

C. Radar Based

Radar can also be used to recognize human activity. This type of technology requires much more bandwidth; for example, Frequency Modulated Carrier Wave (FMCW) radar can utilize up to 1.79 GHz bandwidth, whereas WiFi typically uses only 20 MHz bandwidth. Radar-based devices may extract micro-Doppler information and achieve roughly 20 cm higher distance resolution [10]. However, particular hardware is required for both the radar-based and specialized hardware-based systems, whereas CARM operates on COTS WiFi devices.

D. CSI Based

The wireless network (wifi) has recently introduced another system for recognizing human activities. It is an activity recognition system based on channel state information (CSI). In this procedure, CSI values are extracted from the wifi network interface card to monitor various human movement activities such as the presence of a person in a specific location, movement of daily living and other home appliances, counting of human numbers in a congested place, and so on. CSI can also detect and monitor minor changes in human movement and gesture position, such as leap movement, heartbeat, and so on. The system is quite expensive and complex, but it can achieve a higher level of precision.

V. EXPERIMENTAL PROCESSES

We have suggested a non-adhoc active device free recognition method in this paper. We chose a closed office room surface and placed four sensor nodes in four corners at a height towards the ceiling of the space. These sensors specialize on representing a specific aspect of the environment at a high level of detail. Our experiment is carried out in both RSSI and SDR-based device-free RF systems [10, 11]. The configured WSN has an operating frequency of 2.36 GHz. It adheres to the IEEE 802.15.4 WSN standard. The average distance between two nodes is 6m. So that if a human enters the room, the sensor can identify some human activity. The sensor nodes identified four different gestures: walking, crawling, standing, and sitting. All sensors are transceivers capable of sending 100 data packets per second. The sampling frequency is 40 hertz. We investigated radio signal fluctuation in both RSSI and SDR-based systems. The fluctuation of the signal is received by the sensor in RSSI, and the total power of the signal is observed by an indicator called receive signal strength indicator (RSSI) [11]. The user's location can be deduced directly from node placements and RSSI levels. Reduced signal power, node distance, and transmit power all have a relationship.

We emphasize activities rather than positions here. As a result, the receiver classifies and detects four activities. The RSSI recognizes a person's position when he enters the room [12, 13]. Our experiment consisted of four alternative sequences of activities performed by the person.

Fig.2. Recognition of human activation in presenceof wifi network

Situation 1: In the first sequence, the person enters the room and walks to the center of the room, then returns to the entrance location and exits the room.

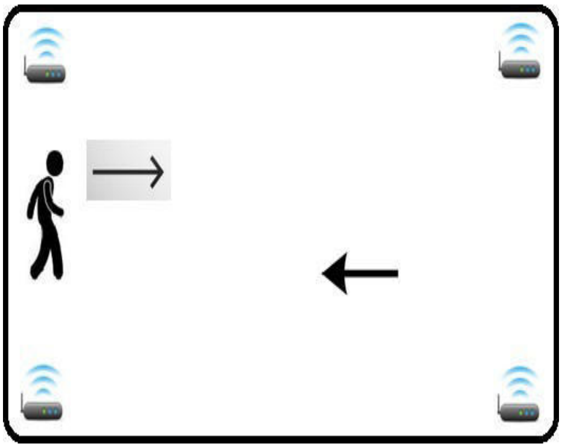


Fig.3. Person entering into the room and walkingtowards the centre

Situation 2: In the second case the after entering into the room walking up to certain distance then stood for awhile and come back. Finally he leaves the room.

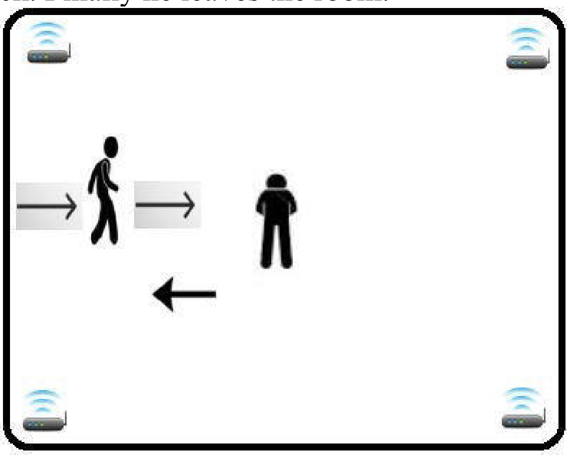


Fig.4. Person entering into the room walking up tocenter, stood and come back

Situation 3: In the third case, the person walked to the centre after entering. A chair is kept in the centre. He sat on the chair for a while, then stood in front of it, and ultimately returned to his entry position.

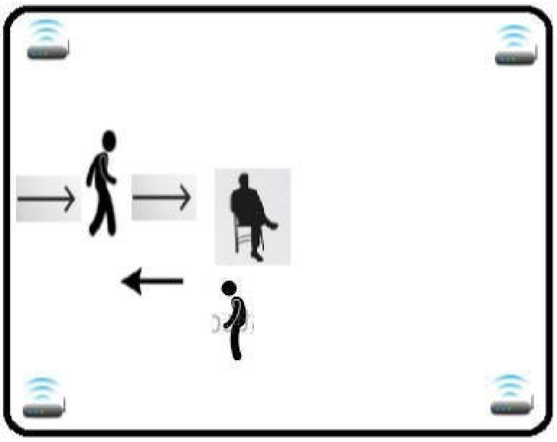


Fig.5. The person after entering walked to thecenter, sit and come back

Situation 4: In the fourth sequence, the man walks towards the centre of the room and stops just before the centre. He crawled the remaining distance and arrived in the centre. He took a seat in the chair. Standing up again, crawling back to the original position, and exiting the room. RSSI records and displays the variance of signal in each place where the subject moved or adjusted his posture. Because the antenna was Omni-directional, the signal flowed in all directions throughout the room.

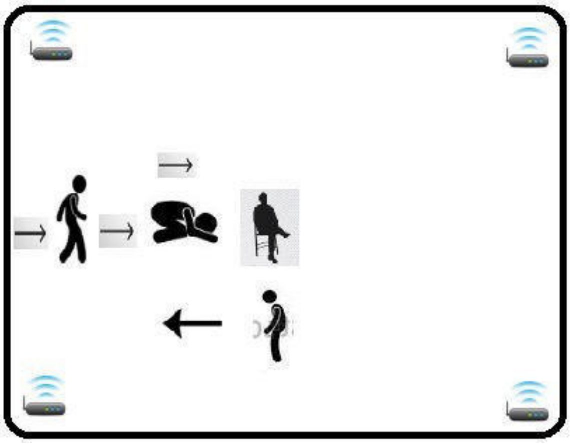


Fig.6. The man walking towards the center of theroom, crawl then sit and finally come back

The case studies were carried out over the course of a day, and the sampled data were continually recorded by the RSSI sensor. The shortest path distance from the object to the sensor is taken for detection, and the fluctuation of the signal along this path is measured. In addition, the signal's second path is evaluated, and the variance is recorded. The average RSSI value is then used as sample data.

VI. RADAR BASED APPROACH

Radar, as opposed to wireless sensor networks, has piqued the curiosity of many due to its wide-area surveillance capabilities. Sensors such as acoustic, seismic, infrared, magnetic, and ultrasonic sensors are commonly used for data transport [13]. Radar can also be used to process data in this manner. Its ability to keep going in all weather situations and at night is an added benefit. However, because of its high power consumption, high cost, and big size, it is rarely employed in these systems. However, low-cost, commercial-off-the-shelf (COTS) radar nodes have recently been designed for use as part of a wireless surveillance network [14]. One such example is the Bumblebee Radar, which is used as part of a wireless radar network to track human movement inside the network's sensing range. The human micro-Doppler signature obtained by the Bumblebee radar is displayed and utilized as a basis for recognition for a number of activities. Several approaches for combining sensor data are investigated. The US Army Research Laboratory claimed in a workshop that sensors with enormous power supplies and connectivity cannot be utilized everywhere, but that simple inexpensive individual devices can be deployed in vast numbers. There is the implication of radar, which has significant advantages such as the ability to function in all weather conditions and at all times. The Bumblebee Radar is a 5.8 GHz coherent, pulse Doppler radar with a radial velocity of 2.6 cm/s to 2.6 m/s and a maximum Doppler frequency of 100 Hz that can make measurements with a relative precision of roughly 3 mm for objects within a sensing range of 1.5 m to 9.5 m. The Bumblebee radar's operational restrictions include the majority of human motion. There have only been a handful works that have used Bumblebee radars to date. Johns Hopkins University researchers employed the Bumble Bee radar to track a non-cooperative object using radial velocity measurements and an Extended Kalman Filter (EKF) in 2010 [15]. This experiment was carried out by researchers from Michigan Technological University, who discovered that the EKF performed well for linear trajectories but performed poorly for nonlinear pathways. The Bumble Bee, on the other hand, is capable of delivering far more target data than just radial velocity because users may directly access the raw data measured by the radar [16]. The micro Doppler signals of targets were collected and used as a basis for classification between people and dogs by Ohio State University researchers. Micro-Doppler has been used as a foundation for target recognition in various studies, with notable applications to pedestrian safety employing vehicle radar networks. Van Dorp and Groen [17, 18] identified human arm swing in 2010 using a COTS FMCW radar network based on human micro-Doppler. The goal of this effort is to investigate the use of low-cost radar sensors that produce a significantly lower quality measure of human micro-Doppler (lower signal-to-noise ratio, SNR) than standard military radars for human activity detection. The micro-Doppler signature is displayed for numerous different human actions (walking, running, and crawling). Using Bumble Bee Radar, an experiment is carried out to vary the aspect angles relative to the target motion, and the measured data is then compared and appraised. This section discusses methods for selecting and combining sensor data for maximum classification performance.

A. Technical Specifications

The Bumblebee radar is a battery-powered coherent, pulsed Doppler radar designed for use in wireless sensor networks. The primary frequency is 5.8GHz, and the inside antenna has a 60° conical coverage. At a maximum distance of 10 m, targets with speeds ranging from 2.6 cm/s to 2.6 m/s can be identified. The radar generates two outputs, an in-phase signal (I) and a quadrature phase signal (Q), which are sent to the Host PC on a regular basis at a frequency of about 185Hz. Aside from the central frequency, the documentation provided by the Bumblebee radar has little information about the transmitted chirp signal's properties, such as bandwidth or chirp slope, pulse duration, and pulse repetition frequency (PRF). The Bumblebee radar was therefore discovered by measuring the transmitted waveform with a 700 MHz - 18 GHz horn antenna and entering the received signal into a spectrum analyser. The frequency domain of the received signal spectrum, as determined by the spectrum analyser, corresponds to the Fourier transform of the pulsed Doppler envelope. As a result, the bandwidth of the LFM waveform was determined to be 240 MHz [19]. The transmitted waveform was measured using the spectrum analyser's pulse analysis module. The pulse duration was 40ns, and the pulse repetition frequency (PRF) was 2 MHz, based on this measurement.

VII. CONCLUSIONS

The benefit of RSS-based systems is mostly connected to the usage of data that is already available at WSN nodes without the need for extra hardware. Indeed, the RSS indication is available at the physical layer of the node structure, and it is concerned with the received power rather than the "quality" of the signal. It is a number of 8 or 10 bits, depending on the hardware of the WSN node, and is directly tied to the tracking system's accuracy. In due course, a comparison of the change of the employed signal frequency with increased accuracy for detecting human movement, particularly the activity of older folks, will be published.

ACKNOWLEDGEMENT

We are grateful to Techno India University in West Bengal for providing research facilities.

REFERENCE

[1] M. Beigl, H.W. Gellersen, and A. Schmidt., (2001) "Experience with design and use ofcomputer-augmented everyday artefacts"; Computer Networks, 35(4):401–409.
[2] S.W. Lee, and K. Mase, (2002) "Activity and location recognition using wearable sensors."; IEEE Pervasive Computing, 1:24–32.
[3] G. Ogris, M. Kreil, and Paul Lukowicz, "Using fsrbased muscule activity monitoring to recognize manipulative arm gestures."; In ISWC '07: Proceedings of the 2007 11th IEEE International Symposium on Wearable Computers, pages 1–4, Washington, DC, USA, 2007. IEEE Computer Society.
[4] D. Gordon, H. Schmittke and M. Beigl, "Introducing New Sensors for Activity RecognitionDistributed and Ubiquitous Systems"
[5] S. Sigg, M. Beigl and B. Banitalebi, (2011) "Efficient adaptive communication from resource restricted transmitters, In Organic Computing - A Paradigm Shift for Complex Systems"; Christian Mueller-Schloer and Hartmut Schmeck and and Theo Ungerer, Springer.
[6] M. Reschke, J. Starosta, S. Schwarzl and S. Sigg, (2011) "Situation awareness based on channel measurements"; 2011 73rd IEEE Vehicular Technology Conference (VTC Spring), pp.1-5, 15-18 May.
[7] F. Viani, P. Rocca, G. Oliveri, D. Trinchero, and
A. Massa, (2011) "Localization, tracking, and imaging of targets in wireless sensor networks: An invited review.", 10 September.
[8] F. Li , Md. A. A. Al-qaness , Yong Zhang , Bihai Zhao1and Xidao Luan, (2016) "A Robust and Device-Free System for the Recognition and Classification of Elderly Activities"; Academic Editors: Mianxiong Dong, Zhi Liu, Anfeng Liu and Didier El Baz, 1 December
[9] S. Sigg, S. Shi, Y. Ji, (2013) "RF-Based Device- Free Recognition of Simultaneously Conducted Activities."; UbiComp'13 Adjunct, September 8– 12, Zurich, Switzerland.ACM 978-1-4503-2215- 7/13/09.
[10] M. A. Youssef and A. Agrawala, (2005) "TheHorus WLAN Location Deter-mination System.";

in Communication Networks and DistributedSystems Modeling and Simulation Conference, , pp. 205–218.

[11] M. Moussa and M. Youssef, (2009) “Smart Devices for Smart Environments: Device-free Passive Detection in Real Environments.”; in The IEEE International Workshop on Intell. Pervasive Devices (PerDev09).

[12] R. R. Bouckaert and E. Frank, (2004) “Evaluating the Replicability of Signifi-cance Tests for ComparingLearning Algorithms,” in PAKDD. Springer, pp. 3–12.

[13] Md. A. A. Al-qaness , F. Li , X. Ma, Y. Zhang and G. Liu, (2016) “Device-Free Indoor Activity Recognition System.”; Academic Editors: Plamen Angelov and José Antonio Iglesias Martínez, 1 November

[14] J. Wilson, N. Patwari, “Radio Tomographic Imaging with Wireless Networks.”, IEEE Transactions on Mobile Computing. 2009;9(5):621–632.

[15] K. Woyach, D. Puccinelli, M. Haenggi, “Sensorless Sensing in Wireless Networks: Implementation and Measurements.”, 4th IEEE International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks. 2006:1–8.

[16] M. Youssef, M. Mah, A. Agrawala, (2007) “Challenges: Device-free Passive Localization for Wireless Environments.”, Proceedings of 13th ACM International Conference on Mobile Computing and Networking;. pp. 222–229.

[17] X. Chen, A. Edelstein, Y. Li, M. Coates, M. Rabbat, A. Men, (2011) “Sequential Monte Carlo for Simultaneous Passive Device-Free Tracking and Sensor Localization Using Received Signal Strength Measurements”, 10thIEEE International Conference on Information Processing in Sensor Networks (IPSN); pp. 342–353.

[18] O. Kaltiokallio, M. Bocca, N. Patwari, (2012) “Long-Term Device-Free Localization for Residential Monitoring.”, 37th IEEE International Workshop on Practical Issues in Building Sensor Network Applications, 991– 998.

[19] W. Wei, A. X. Liu, Md. Shahzad, K. Ling, S. Lu, “Device-Free Human Activity Recognition Using Commercial WiFi Devices.”, IEEE Journal on Selected Areas in Communications (Volume: 35, Issue: 5, May2017), Page(s): 1118 - 1131, 09 March 2017 ,Print ISSN: 0733-8716, INSPEC Accession Number: 16899027,DOI: 10.1109/JSAC.2017.2679658.

Educational Interventions for Sustainable Livelihoods

Amit Kumar
Assistant Professor, Mechanical Engineering Department, JBIT, Dehradun,

ABSTRACT

Livelihood is the single most important factor in the survival and spread of human civilization. There are physical, intellectual, psychological, and emotional implications to livelihood, and the organization of livelihoods and activities on an overpopulated world is also causing numerous difficulties in the ecosystem that all living things on Earth share. Thus, the concept of Sustainable Livelihoods emerges, which can withstand and recover from stresses and shocks, can maintain or enhance a household's assets while not undermining the natural resource base, and the shift in education must be toward the development of KBS (Knowledge Based Societies) if we are to address ALP (Alternative Livelihood Projects), an inclination towards better socio-ecological occupations. The restrictions imposed on teachers and students by overly institutionalised education systems diminish instinct, talent, interests, and application. The goal of KBS is to break through the barriers that so-called formal education erects in society and to educate for life-support systems. Information is no longer synonymous with knowledge, as technology enables its free and equitable availability.

Keywords - Sustainable Livelihoods; KBS (Knowledge Based Societies); ALP (Alternative Livelihood Projects); life-support systems

INTRODUCTION

Livelihood is the single most important factor in the survival and spread of human civilization. As it is directly related with the well-being, health, self-esteem, interest, satisfaction, and cohesiveness of individuals, families, and communities, livelihood has physical, intellectual, psychological, and emotional aspects. . In this day and age, there are concerns that the organization of livelihoods and activities on an over-populated world is causing many difficulties in the ecosystem that all living beings on Earth share. As a result, the notion of Sustainable Livelihood emerges, which is defined as "a type of human occupation that can withstand and recover from stresses and shocks, and can maintain or enhance a household's assets while not undermining the natural resource base." Technological changes do not threaten, but rather enhance, sustainable livelihoods. The issue arises when the general populace is supposed to make livelihood decisions based on these characteristics. The viewpoint here is not only ecological, but also socio-ecological. Certain factors influence livelihood decisions, such as

a. Perceiving an optimal balance between material advantages and risk - safety and security are two characteristics that every human being must consider when living their life and deciding what they want or do not want to do. Also, whether or not a high risk, high gain mindset is desired depends on the general psyche of the community and how they go about their day-to-day responsibilities.

b. Danger attitudes vary - different personality characteristics have different methods of visualizing danger and dread. Some people regard certain activities as dangerous, whereas others regard them as pleasure, adventure, or the natural sequence of events. What is judged harmful or dangerous by whom is heavily influenced by habit, familiarity, and training (all characteristics of informal education).
c. Interest, enjoyment, and finding purpose in work - this is probably or should be the most significant consideration in choosing a career. It is difficult for humans to continue doing something they do not wish to do for the rest of their lives.
d. Social mores and conditioning - social conditioning plays a significant influence in how each human being runs his or her life, as his or her aspirations, comfort, and emotional security are formed in the socio-cultural milieu in which one grows up. All humans have a strong need for acceptance and support from their family, peers, and so on, and individual and community livelihood choices are influenced by how well they will be accepted by those around them.
e. Geopolitical concerns - the geographical position and relief of the place where people live, particularly for an extended period of time, play a significant role in their decisions about the many jobs that they pursue. Climate, soil types, water availability, land availability, language, culture, and so on are all key drivers on livelihood choices and execution.

II. EXPLAINING THE CONCEPT OFLIVELIHOODS

Where does education fit into this picture? In a nutshell, everywhere. All five of these aspects are fundamentally influenced by educational trends and facilities in any given community, thereby connecting education inextricably with the socio-ecological concerns that we all face. If we are to address ALP (Alternative Livelihood Projects) interventions, we must shift education toward the development of KBS (Knowledge Based Societies), that is, a shift toward better socio-ecological occupations through a significant reduction in activities deemed to be environmentally damaging. When discussing ALP, we must abandon the false notion that one livelihood may readily be replaced by another, as needed socio-ecologically. But the truth is more complicated. A livelihood is only viable for an individual and a community if it is sustainable.

Effective - an effective livelihood is one that gives the best fit for the best individual in a community, taking into account personalities, multiple intelligences, community strengths, special abilities, talents, and hobbies. Indeed, the freedom to select livelihoods and education without compulsions or prejudices is a critical component for long-term sustainability

a. Efficient - the efficiency of a livelihood refers to its ability to meet the needs of individuals and the communities to which they belong. These needs and the methods for meeting them vary by area and culture.

b. Lower or equivalent risk engagement - Human beings require physical and emotional stability to survive. We have already addressed how threat analysis of dangers varies from person to person, but a sense of safety and self-preservation is necessary for people in any career. In fact, most people have a low threshold for accepting larger risks when it comes to their livelihoods, because it affects not only them but also their families, raising the danger perception significantly.

c. Concerns actual, locally defined demands - Livelihoods in any community or place grow in light of varied socio-cultural and geopolitical factors. History, geography, society, climate, fauna, flora, and natural resources all influence the kind of lifestyle choices that people around the world will and should choose.

d. Leads to beneficial social consequences - this is perhaps the most significant factor to consider when determining livelihood in cultures and communities. Livelihoods must improve the environment for the entire community, not just for a few people. A better environment signifies not only higher wages, but also higher quality of life in general, including food, water, air, health, education, infrastructure, leisure, and well-being.

UNDP has lately defined livelihoods as a development aim that includes, but is not limited to, employment. According to them, "livelihoods are essentially activities, means, and entitlements through which individuals make a living." Sustainable livelihoods are defined as "human goals derived from people's capacities to exercise choice, access opportunities and resources, and use them for their livelihoods in ways that do not preclude opportunities for others to make a living, now or in the future." According to the Oxfam Handbook of Development and Relief (1995), sustainable livelihoods are defined as "looking for impacts on social and gender equity, patterns of resource use, the creation of opportunities that do not involve cost shifting to the environment and that improve people's lives without impoverishing others or the next generation." Another phrase that comes up here is livelihood systems, which are defined as "sets of economic, social, and physical elements and interrelationships that serve as the foundation for livelihood decisions."

Herein lies the quandary of using the word "sustainable livelihood" to indicate "sustainable economic growth." This overemphasis on the financial or market-oriented meaning of livelihoods, or the Western mathematical model, has produced a problem, because one of the key engines of economic growth is replacing labour with energy obtained from inexpensive fossil fuels. As a result, we tend to overlook the [5] anthropological backgrounds of livelihoods, where it is clear that the central procedures of making a living are culturally modelled. This synergy of different institutional arrangements (kinship, political, magical-religious, and market) is at the heart of any understanding of sustainable livelihoods, as well as the educational preparations required to move populations toward such livelihood options. Furthermore, sustainable livelihoods are fundamentally subsumed in the larger concept of a healthy, sustainable community with a web of symbiotic ties between humans and between man and nature.

III. EDUCATION FOR SUSTAINABLE LIVELIHOODS

Many instructors are frustrated by the limits that highly formalized education systems impose on them and their students, weakening instinct, aptitude, interests, and application. Recognizing one's future as a KBS is the first step toward breaking down the barriers that so-called formal education erects in society. After all, information is no longer synonymous with knowledge, as technology enables its free and relatively equitable distribution. Education necessitates the formation of an environment in which students organically combine their intuitive modes of knowing [4] with scholastic and academic modes of knowing. To propel humanity forward, knowledge in all of its forms (academic, vocational, traditional, en.

Any member of society, regardless of age, can be educated reflectively for the purpose of encouraging critical examination and synthesis of ideas that contribute to the following life-support systems (LSS): environmental, and interpersonal) must be supported.

a. Economic development - as previously said, a narrow numbers-based understanding of economy is no longer the answer to livelihoods. With rapid changes in society and the environment as a result of massive population increase and automation, the ecological cost and impact of economic activities must be clarified to students at all levels of education. The educational need of the hour is changes in consumption patterns and the focus of occupational endeavours that lead to the preservation, protection, and restoration of already stretched survival resources [9]. The balance of a resource's anthropocentric and eccentric worth must be continually addressed in all economic activities, and training to do so must become an integral element of education at all levels. Indeed, by the mid-1990s, it was evident that the moral or aesthetic approach to natural resource management was not going to succeed, and there was widespread disillusionment among social planners. The "New Conservation Paradigm" then emerged, emphasizing the economic importance of nature. For example, the economic value of a rainforest in terms of sustaining sustainable livelihoods is far higher if it is measured in terms of flora and fauna availability, ecotourism, natural catastrophe mitigation, and enough rainfall rather than the one-time benefit of chopping it for timber. Education that focuses on these components not only via a topic lens, but also on allowing students to find these meanings proactively, will result in behavioural and attitude changes.

b. Social cohesion - One of the primary goals of sustainability is to achieve a more fair distribution of resources across the world's population while remaining within the carrying capacity of the environment. This is what generates a society that considers its fellow beings solely in humanitarian terms, rather than in terms of blue-collar or white-collar workers, numerical or materialistic status. This can only be accomplished through education, which is funded by survival and symbiotic skills of choice and aptitude, rather than by the cost of degrees and jobs. The dialogical ethic in education leads to idea enrichment for people from all areas of life.

c. Care for resources, biodiversity, and the earth ecosystem in order to meet the needs of the present without jeopardizing future generations' ability to meet their own needs - this is essentially the crux of the matter pertaining to sustainable livelihoods, and thus, this is where the educational thrust should be the greatest. One could argue that this is nothing new; we are attempting to in still resource appreciation in children through environmental education. But, can appreciation be created by teaching a text-book-oriented version of the topic in which pupils simply learn a few concepts, take an exam, and move on The answer is emphatically no. Education for a sustainable environment, and hence education for sustainable livelihoods, must be life-oriented, practice-driven, and application-focused. The questions that need to be answered through education are not what is wrong, but what we can do in our daily lives and professions to make it right, and how to do it. The best approach is to combine traditional ecological knowledge with modern research in a practical application context. A good example is Japan's [1] Satoyama and Satoumi landscaping experiments, with awareness and actions beginning in elementary school and continuing as a part of day-to-day life in many parts of the country. These are essentially land and water body planning concepts that result in dynamic mosaics of managed socio-ecological systems (secondary forests, farmlands, grasslands, irrigation ponds, coastal fisheries, and dense human settlements) that provide a bundle of ecosystem services for sustainable living. Education centered on such projects can develop citizens capable of combating eco-environmental dangers while also encouraging livelihoods that can benefit humanity regardless of age or technology.

d. . Employment and employability - educating for 'jobs' is increasingly being challenged by the need to build human capacity not only for earning their 'bread and butter,' but also for broader lifelong learning and adapting and 'coping' livelihood strategies in a fast moving and complicated world. The problem is this completely irrational belief that the global economy, based on free markets, economic competition, and international trade, is manna from heaven in terms of employment, or that democratic political institutions have the onus of providing cushy, comfortable elite tertiary employment. .However, all of this, as well as the golden dream of greater prosperity that comes with it, come with the large price of being entirely reliant on the burning of cheap fossil fuels and the fulfilment of services that may be readily taken over by machines. So, how can we prepare students for Competency Based Education (CBE), or skill development that relies heavily on human qualities, sensory inputs, judgment, and aesthetics? The solution is to restructure curricula, teaching learning activities, settings, and evaluation so that rote memorization, paper-pencil testing, and numerical marking are decreased. Internships and on-the-job training can provide valuable experiences for contributing to society rather than simply earning a salary. Many Kolkata-based entrepreneurs provide such in-service education, with Naman Ajit saria of Noodle Story, for example, educating all staff not only people skills, but also how to become chefs in their own right, and stepping up instead of merely hanging around.

e. Healthcare - Over the last five decades, medical research has advanced by leaps and bounds. While there are many advantages to this era, the disadvantages cannot be overlooked. Longevity has undoubtedly increased, as have lifestyle diseases such as diabetes, heart disease, and orthopaedic difficulties; disorders directly related to environmental degradation such as COPD, allergies, and gastroenteric problems; and, finally, treatment resistant microorganisms. If the human species is to establish a healthier self for itself, education must play a significant role. Pill popping appears to be as much a part of mainstream culture as disco music and denims, especially among the younger population. Education courses must emphasize that there are no shortcuts to good health, and that being healthy does not imply conforming to a Western ideal of the human bodily form. The importance of exercise and yoga for physical and mental well-being, the medicinal qualities of natural produce, and the dangers of indiscriminate medication will have to be emphasized through education, not through prescriptive text, but through experimentation, discovery, and a facilitating approach. [8] Because these indigenous medicinal forms provide work in a world attempting to preserve and create a healthier environment, the influence on sustainable livelihoods is significant.

f. Family welfare practices - as has been emphasised time and again, overpopulation can pose and livelihoods, and als

g. oemphasised is huge risk to sustainability of health, environment the point that a prescriptive family planning regime for India, at least, is doomed to fail. The only voice that will reach the people is of education, which on one hand, will promote better care, nutrition, and progressive child raising and educational approaches for both girls and boys

h. National and international citizenship - we must begin somewhere with the notion that education facilitates community building. Sustainable livelihoods are only conceivable if and only if a society is committed to mutual assistance and symbiotic activities, in which enough care is made to handle the environment delicately, as mankind should. And that's a lot simpler than it seems. After all, traditions of self-control, sharing, and avoiding 'waste' have characterized humans for generations. Suddenly, over the course of two decades, the concept of ostentatiousness has taken hold, as rampant urbanisation and the resulting centralisation of employment and health services push people towards more air travel, car ownership, central heating and cooling, and even the pursuit of the so-called 'best' educational services, which leads to further ostentatiousness. "Voluntary self-restraint may be the most important way for responsible individuals to create communities in a sustainable environment, where education must try to break the fallacy of an economic system that proposes that greater and greater happiness will follow every increase in our personal incomes and spending," writes [2] Chris Goodall.

i. Consumer consciousness - the importance of raising knowledge about the need of using environmentally friendly products, purchasing local produce to reduce transportation costs, and producing local produce that can lead to the selection of sustainable livelihoods cannot be overstated. The primary focus in this area can be made in education, with concepts such as fair trade, environmentally friendly lifestyle patterns, and interventions such as resource harvesting becoming part and parcel of the educational curricula beginning in primary school. . In fact, the Scandinavian countries have abandoned traditional book-based curricula in Favor of a problem-based approach in which students learn through discussion and study based on their daily activities and surroundings.

j. Good governance and individual safety - in today's terminology, good governance means minimal governance, and as previously indicated, the educational aim must be to support livelihood in entrepreneurship, skill development, and citizen and community initiatives. Semi-skilled pencil pushing comfy government-sponsored tertiary positions are a drain on resources, leading to their replacement by robots and also posing a problem for environmental sustainability. This type of unemployment can lead to youth discontent and a decrease in personal safety for individuals and communities. The sooner education recognizes this quandary and adapts to modern socioeconomic-environmental needs, the better; otherwise, we risk a major social crisis, and students must be trained in self-defence techniques as well as employable skills to subvert and cope with this crisis.

k. Strong value orientations develop positively toward truth, and who better to promote and represent these values than a teacher? And, to be optimistic, ethics, whether it is justice, caring, or adherence, are what create for sophisticated human civilisations. The reason for this is that teacher education for a qualitative rather than quantitative approach to education is urgently needed, as it would lead to greater adaptability and sustenance of students in a continuously changing livelihood context. Teachers must become members of [3] PLCs (Professional Learning Communities) in order to facilitate a collaborative, inquiry-based approach to learning for both teachers and students, in which constant action research and critical reflection on findings, as well as sharing those ideas, become important tools for effecting change in education.

IV. THE ROLE OF THE ORIENT

There must be a significant exchange of cultural knowledge and ideas through education between oriental cultures, as they have a very rich heritage, and the world, reeling from the ill effects of rampant westernisation or [6] cultural homogenisation (which has suppressed local preferences in providing goods, media, and education whose content is dictated by foreign entities), requires an alternative viewpoint, philosophy, and way of life for sustainable livelihood. This cultural homogenisation in the name of technological advancement is undeniably beneficial, but it is also gradually leading to a reduction in cultural diversity, through the popularisation and dissemination of a diverse range of cultural symbols, primarily customs, ideas, and values, where local cultures are completely subsumed by a dominant, pervasive influence. Older cultures are more vulnerable, but they also have the diversity and resilience to make this a two-way street, influencing and transforming the dominant culture in a variety of ways. The west has already begun to take notice of us, as Indians and other oriental cultures are most successfully bridging the gap between the traditional and modern worlds, retaining the values of both while incorporating the negatives (Yin and Yang) and benefiting from both. A process of reverse cultural homogenisation can be achieved through increasing educational and cultural exchange mechanisms amongst Oriental countries. How can that be accomplished? Glocalization (a combination of globalisation and localisation) refers to the adaptation of worldwide products to the specifics of the local culture in which they are sold. [7] The term initially appeared in the Harvard Business Review in the late 1980s. At a 1997 conference on

"Globalisation and Indigenous Culture," sociologist Roland Robertson stated that glocalization "means the simultaneity - the co-presence - of both universalising and particularising tendencies." Surprisingly, the idea comes from another powerful Asian civilization. It comes from the Japanese phrase dochakuka, which meaning "global localization." It initially refers to the modification of general farming techniques to local weather, soil, labor availability, and so on. In the current context of long-term employment, glocalization could entail, on the one hand, more fusion, mixing, and matching of specific characteristics of Asian cultures in order to build a stronger and more enlightened hybrid that leads to a better existence for the human and his surroundings. . On the other side, it would imply developing alternative education systems that highlight dynamic livelihood pathways, stepping up and out of traditional stereotypes to learn and earn while also making it possible for future generations to do so.

REFERENCES

[1] Nakamura, D. Watanabe, T. Nishi ED. (2012). Satoyama Satoumi Ecosystems and Human Well-Being: Socio-Ecological Production Landscapes in Japan. United Nations University Press.

[2] Goodall, C. (2007). how to live a low-carbon life, Earthscan, London.

[3] Forde, M. and Martin (2011). Contemporary issues in learning and teaching. Sage, London.

[4] Scottish Executive Education Department (SEED) (2002) Determined to Succeed: A review of Enterprise in Education. Edinburgh, the stationary office.

[5] Wiener MJ. (2004). English Culture and the Decline of the Industrial Spirit. Cambridge University Press.

[6] Sengupta, M. (2016). Indo-China, The cultural Terra-firm of the World. paper read at International Management Instiute.

[7] Shamsuddoha M. (2008). Globalisation to Glocalisation: A conceptual analysis. University of Chittagong.

[8] Young Jacqueline "Eastern Healing" Duncan Baird (2001).

[9] Weiler and Hall (ed.). (1992). Special Interest Tourism, Belhaven Press.

Design of an Arduino WIFI Module-Based Low Cost Home Automation System

Ravi Shankar
Assistant Professor, Mechanical Engineering Department, JBIT, Dehradun,

ABSTRACT

The architecture and technology of a low-cost, adaptable home control and environmental monitoring system are presented in this study. For remote access and appliance control, it uses an embedded mini web server in the Arduino Mega 328PU microcontroller with IP connectivity. The devices can be operated using an Android-based smart phone app or a web application. Comparatively speaking to other systems, the suggested system offers a novel communication protocol to monitor and control the home environment with capability beyond just switching, and it does so without the need for a dedicated server PC. Devices like light switches, power plugs, temperature sensors, gas sensors, and motion sensors have been combined with the proposed home control system to demonstrate the viability and effectiveness of the system.

Keywords—micro web server; microcontroller; arduino; wi-fimodule; relay; home automation;

1. INTRODUCTION

The current technology created in recent years has a significant impact on both our personal and professional lives. Technology has evolved over time, changing everything from how we shop for goods to how we live now. It has also changed how we communicate, how we travel, how we learn, and many other things. The need for developing the type of technology is clear given how quickly people's needs and lifestyles are changing [1]. Almost all of the things we use now have undergone improvements to meet higher standards so that we can stay up with the rapidly changing times. Because of its simplicity of use and lower prices, wireless communication is increasing more quickly than other technological developments in the twenty-first century. People can benefit in numerous ways from wireless home automation and WIFI-based electrical gadgets to make their lives easier and less stressful [2]. This essay suggests a low-cost, straightforward, and effective method for managing home appliances. The device and method described, which is based on Wi-Fi and Arduino, will demonstrate how to raise living standards while reducing stress in daily life. It is especially effective for people with disabilities who have few options for receiving care from other family members. The security system in the suggested technology is safer and also very effective.

II. HOME AUTOMATION SYSTEM BASED ON WIFI

People with physical limitations or disabilities frequently find it difficult to comfortably reach close to or operate household equipment. Because of this, home automation cannot be carried out for them very effectively. In actuality, it becomes challenging and not secure for all intents and purposes the majority of the time. We have created a straightforward home automation **system with a Wi-Fi** interface module to help reduce these issues. The device will give its owners the ability to control their home's electrical systems from anywhere in the world using wireless communication, more especially by utilizing WIFI [3]. Figure 1 depicts the block diagram of the suggested Wi-Fi-based system.

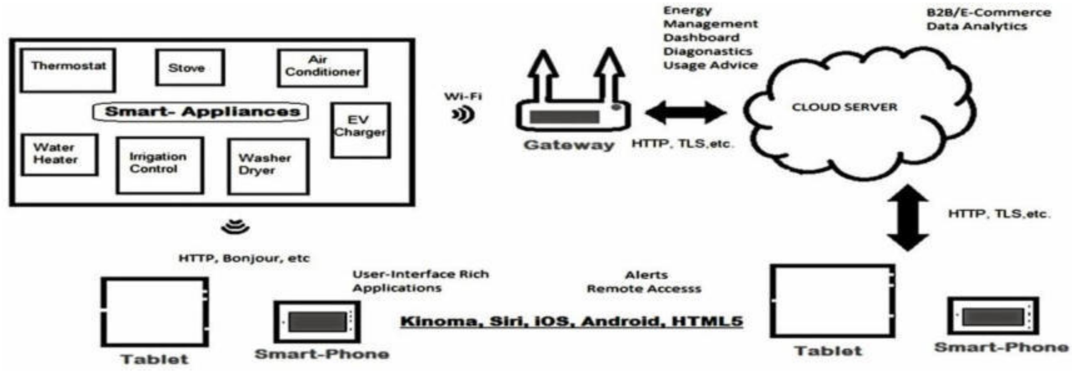


Fig. 1 Block diagram of Wi-Fi based system

3. METHODOLOGY

The module of the Wi-Fi-based system diagram is shown in Figure 2. It's vital to remember that the system's primary control component is the Arduino. The Arduino's connection to the various facilities will allow for the appropriate control of all home applications. In fact, Arduino is to control a number of sensors, including temperature, IR sensors, and others, while the system LCD will be used to show the entered password [4].

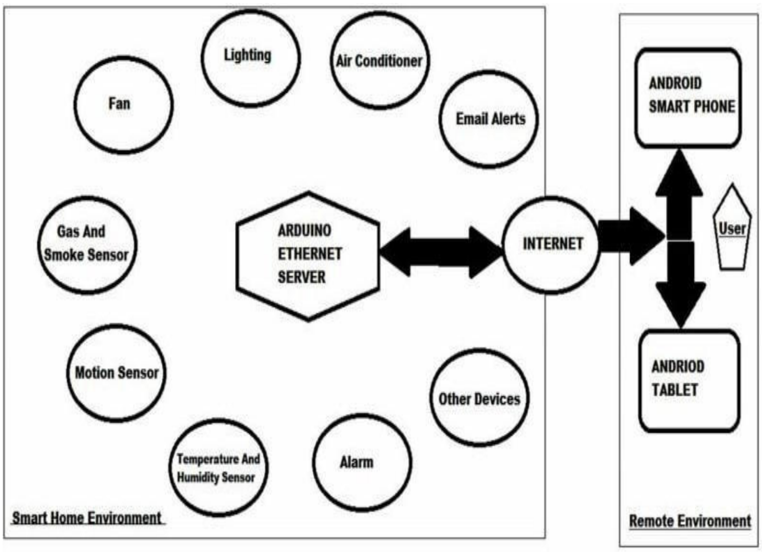


Fig. 2 Module of Wi-Fi based system

Fig. 6 Arduino IDE Software

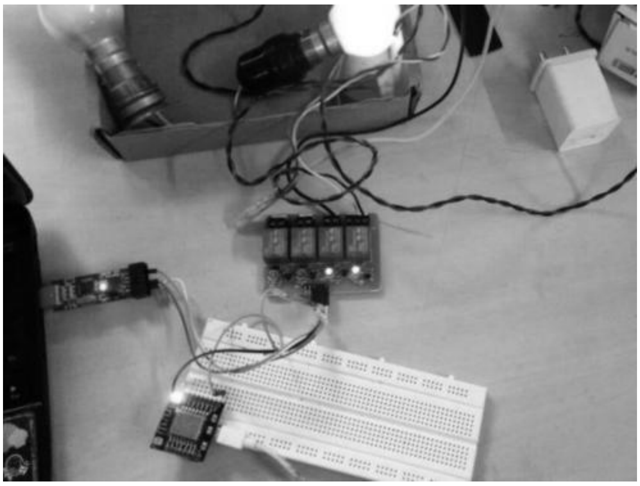


Fig. 5 The AI-Thinker Prototype

V DESIGN AND IMPLEMENTATION

Figure 4 depicts a smart home system we created that is affordable and effective. Figure 5 displays the system's circuit diagram. The hardware interface module and the software communication module are its two major modules. The Arduino Mega 328 PU, which can serve as both a micro web server and the interface for all the hardware modules, is the brains of the entire system. However, the ESP 8266 Module AI- Thinker can be used more easily in the current system than the standard ESP 8266. This system employs generic AI. The module is a microprocessor by itself that uses relays to control all the tubes and fans in a home automation system [5]. The altered programme

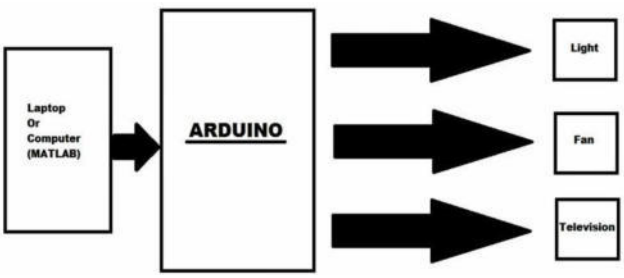


Fig. 4 Procedural Diagram of Wi-Fi based system

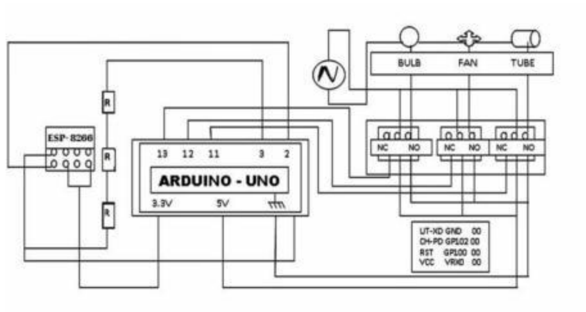


Fig. 5 Circuit diagram of Arduino based system

The key benefit of this technique is that it is a cheap but extremely effective tool for the job. In compared to the suggested model, the cost of the system increases significantly if we utilize Arduino UNO and ESP 8266. The use of the AI-Thinker in this system makes the circuit simpler to manage while significantly lowering the cost. The AI-Thinker used is depicted in Figure 3

The accompanying algorithm, which demonstrates the many operational actions to be taken, is provided below:

Step 1: BEGIN

Step 2: Define the header files for the Arduino and WiFi modules

Step 3: Declare the header information for the web server client

Step 4: Define all the integers for the various components, such as fans, tubes of light, or bulbs

Declare output modes for components in step five.

Step 6: Configure the WIFI module router using the provided username and password

Step 7: Create web link switches to control fans, tube lights, or bulbs

Step 8: End

V. WEB APPLICATION AND OTHER ADVANTAGES

Today's world is experiencing a new internet revolution called the Internet of Things (IOT). a setting where the real, digital, and virtual all work together to build intelligent environments that can cover a wide range of topics more effectively [6, 7]. There are a lot of server-based and Android applications now. The value of the web server will be displayed on the device's GUI (Graphical User Interface) or web server through wireless connection in the proposed system, and the device will be automatically controlled in addition to being operated over WiFi. In my setup, an ESP 8266 AI-Thinker should be linked to a WiFi device—such as a mobile phone or a home router—via a hotspot [8]. the launch date of this WiFi system. The automatic on and off feature helps save energy in homes. After 6 pm, the door lock password-based system can be employed as the key security technology in both large city office buildings and educational institutions. Additionally, it can be utilized effectively to control the speed of the fans. Unauthorized movements are detected by the security system's motion sensor, which also alerts the user when it does so.

VI. CONCLUSION

The suggested Arduino-based home automation system with a WIFI module is adaptable, cost-effective, and very practical. The handling of household equipment, such as turning off lights, fans, or air conditioners, or even locking cars or other electronic devices, may be very challenging for people, especially adults. These common issues will be resolved by the suggested technology. This smart city project can undoubtedly increase a person's quality of life because it is labor, cost, and energy efficient. Additionally, the proposed approach will greatly benefit elderly, handicapped, and impaired persons. Future versions of the basic prototype home automation system might cover more ground.

ACKNOWLEDGEMENT

We appreciate the ongoing encouragement from Techno India University in Kolkata, West Bengal, and the technological assistance provided by Ardent Computech Pvt. Ltd.

REFERENCE

[1] Kumar, P. P., Vasu, G. T., (2015) "Home Automation System and Security System using Arduino", International Journal of Emerging Trends in Engineering Research. 3, 190-194.

[2] Choudhary, V., Parab, A., Bhapkar. S., Jha, N., Kulkarni, M., (2016) "Design and Implementation of Wi-Fi based Smart Home System", International Journal of Engineering and Computer Science, 5, 15852-15855.

[3] Gurek, A., Gur, C., Guraki, C., Akdeniz, M., Kumova, S., Korkmaz, M., (2013) "An android based home automation system, High Capacity Optical Networks and Enabling Technologies (HONET-CNS)," 10th International Conference on IEEE, 121-125.

[4] Mattia, G., Gonella, A., Palazzi, E.C., (2015) "Design issues and solutions in a modern home automation system, Computing, Networking and Communications," International Conference on. IEEE.

[5] Kelly, S.D.T., Suryadevara, N.K., Mukhopadhyay, S.C., (2013) "Towards the Implementation of IOT for Environmental Condition Monitoring in Homes," IEEE, 13, 3846-3853.

[6] Godha, R., Prateek, S., Kataria, N., (2014) "Home Automation: Access Control for IoT Devices", International Journal of Scientific and Research Publications, 4, 1.

[7] Patil, P.B., Patil, R.R., Patil, S.V., Telepatil, A.R., (2016) "Home Automation System Using Android and Arduino Board", International Journal of Innovative Research in Science, Engineering and Technology, 5, Issue 4, ISSN 2319-8753 (Online),.

[8] IOT Based Home Automation System Using Arduino Board, Harsh Mehta, Kunal Jadhav, Avinash Mishra , Prof. Anushree Deshmukh , International Research Journal of Engineering and Technology (IRJET), 4, Issue-01 | Jan -2017, e-ISSN: 2395 -0056, p-ISSN: 2395-0072.

Can fish condition serve as a proxy for salinity change?

Ankit Kumar
Assistant Professor, Mechanical Engineering Department, JBIT, Dehradun,

ABSTRACT

In June 2017, two of the Indian Sundarbans' key estuaries served as monitoring sites for the condition index of dominant fish species that are significant for commerce. Due to receiving the fresh water discharge from the Farakka barrage, the Hugli estuary in the western sector has a lower salinity than the Matla estuary in the central sector. Due to siltation of the Bidyadhari River from the late 15th century, the center sector is extremely salinized. In the current study, fourteen commercially significant fin fish species were taken from the Hugli and Matla estuaries, located in the western and central regions of the lower Gangetic delta, respectively, and their condition factors were assessed. A negative impact of hyper salinity on the growth and condition factor of all the species obtained from the Hugli estuary (compared to those collected from the Matla estuary) is indicated by relatively higher values of condition factors.

Keywords: salinity, fin fish, marine species, condition index.

1. INTRODUCTION

The metabolism and growth of fin fish are regulated by salinity fluctuations, according to scientific consensus. This is demonstrated by the fin fish species' condition factor, which depends on the species' total weight and length. Numerous species of fin fish spawn and live in the lower Gangetic delta, which includes the mangrove ecology of the Indian Sundarbans. The fish population in the current research region can be divided into migratory and permanent residents. Resident species are those that have individuals of various sizes that are visible throughout the entire year in any zone of the estuary. The important resident fin fish species are Mugil parsia, Mugil tade, Polynemus paradiseus, Polydactylus indicus, Otolithoides biauritus, Lates calcarifer, Hilsa toli, Arius jella, Harpodon nehereus, Setipinna taty, Ilisha elongata, Setipinna phasa, Coilia ramcarati, Pama pama and Sillaginopsis panijus. The transient or migratory fishes enter and spend a brief time in the estuaries connected to the Bay of Bengal. The migrants are categorized into three categories based on their migratory patterns and directions[1,2].

(1) Freshwater species that spawn in saline areas of the estuary, like Pangasius pangasius;
(2) Marine species that spawn in less saline areas of the estuary, like Arius jella; and
(3) Marine species that migrate upstream and spawn in freshwater areas of the estuary, like Tenualosa ilisha, Polynemus paradiseus, Sillaginopsis panijus, and Pama pama.

In the current study, we have employed the condition factor as a stand-in for the stress that the aquatic phase's salinity poses. Since the price of the fish mostly depends on its growth (in terms of length and weight), our main goal is to ascertain the impact of salinity fluctuation on the condition factor of the 14 fin fish species that have been chosen as being economically significant.

2. MATERIALS AND METHOD

The entire network of the current study is made up of the collection of 50 individuals of the chosen species (Tenualosa ilisha, Pama pama, Pampus spp., Ilisha elongate, Lates calcarifer, Pangasius pangasius, Liza parsia, Liza tade, Tenualosa toli, Polynemus paradiseus, Otolithoides biauritus, Tachysurus The chosen species' individual length and weight were measured to determine the condition factor according to the following expression:

$$K = \frac{\overline{W}}{(\overline{TL})^3} \times 10^3$$

K is the condition factor, and is the average total length (cm), together with the average weight (g). The existing data bank contained secondary data on surface water salinity for the areas 2, 4-8.

3. RESULT & DISCUSSION

It is clear from the data set that fin fish species obtained from the Hugli estuary have considerably higher condition factors than fin fish species gathered from the estuarine water of Matla (Table 1). The secondary data bank provides information that suggests that this may be related to variations in aquatic salinity. When compared to the water of the Matla Estuary in the research area's center sector, the Hugli Estuarine water is relatively less salinized [2, 8].

Conditions of the chosen fin fish species in the western and central study areas are shown in TABLE 1.

S. No.	Commercially important fin fish	Western sector (Hugli estuary)	Centralsector (Matla estuary)
1.	Tenualosa ilisha (Family: Clupeidae)	0.886	0
2.	Pama pama(Family: Sciaenidae)	1.113	0.621
3.	Pampus spp. (Family: Stromateidae)	1.431	0
4.	Ilisha elongata (Family: Pristigasteridae)	0.838	0
5.	Lates calcarifer (Family: Centropomidae)	1.299	0.491

6.	Pangasius pangasius (Family: Pangasiidae)	**0.908**	**0.438**
7.	Liza parsia(Family: Mugilidae)	**1.098**	**0.665**
8.	Liza tade (Family: Mugilidae)	**0.869**	**0.677**
9.	Tenualosa toli(Family: Clupeidae)	**0.998**	**0.459**
10.	Polynemusparadiseus (Family: Polynemidae)	**0.904**	**0.593**
11.	Otolithoidesbiauritus (Family: Sciaenidae)	**1.105**	**0.880**
12.	Tachysurus jella (Family:Ariidae)	**1.025**	**0.693**
13.	Sciaena biauritus (Family: Sciaenidae)	**1.098**	**0.895**
14.	Eleutheronema tetradactylum (Family: Polynemidae)	**0.984**	**0.688**

The absence of the species in the estuary water is indicated by the value 0 (zero).

An indicator of an organism's health, the condition factor is based on the idea that heavier fish of a given length are in better condition than light-weight fish of the same species [9, 10]. It has been employed as a measure of growth and feeding frequency [11, 12], declines with length [11, 13, 14], and has an impact on fish reproduction. In light of this, we used this metric as a proxy to determine how salinity affected the current study region. Aquatic salinity affects fish stocks that are utilized commercially, ideally for a living, in both direct and indirect ways. Fish physiology and behaviours are affected directly, which changes growth, reproduction, mortality, and distribution. The makeup of the marine and estuarine ecosystems, on which fish depend for food and survival, as well as changes to aquatic productivity, biotic community structure, and other events are examples of indirect effects. Fisheries production will undoubtedly be significantly impacted by changes in primary and secondary production, but accurate quantitative predictions of changes in global marine primary production solely due to salinity fluctuation caused by climate change are currently not possible [2]. Our first order study amply demonstrates a considerable difference between the two sectors in the condition factor of the chosen species. The species gathered from the Hugli estuary, where the aquatic phase is hospitable in terms of salinity, showed a noticeably greater condition factor of commercially significant fin fish. The discharge from the Farakka barrage, which is located in the upstream section of the Ganga-Bhagirathi-Hooghly River system, may be responsible for this hyposaline habitat. The average water discharge from the Farakka dam over a ten-year period (1999 to 2008) was (3.7 1.15) 103 m3s-1. With an average discharge value of 3.81 x 1.23 m3s-1 during the monsoon and a maximum of 4524 m3s-1 during freshet (September), higher discharge values were noted. Pre monsoon had discharge levels that were noticeably lower, with an average of (1.18 0.08) 103 m3s-1 and a minimum of 846 m3s-1 in May. According to earlier researchers [2], values during post monsoon discharge were modest with an average of (1.98 0.97 103 m3s-1). Tenualosa ilisha can migrate to the Gangetic Delta's upstream section to breed thanks to the hyposaline conditions, and various species of fin fish that are significant for commerce can grow up in this area as well (Table 1). The introduction of seawater and subsequent rise in salinity in the Matla Estuary fully reversed the situation, resulting in lower condition factor values in fin fish species (Table 1). The main contributing factor to the lack of fresh water in this lower Gangetic delta estuary from the late 15th century may be the siltation and obstruction of the Bidyadhari River 2, 7, 8.

(i) negative effects on fish metabolism in hypersaline environments
(ii) loss of major food sources (mostly plankton) as a result of the organisms' poor tolerance for salinity (plankton), and
(iii) direct mortality as a result of the extremely salty environment [2].

However, a lengthy investigation of about 50 years is advised to identify the negative effects of hyper salinity on the development and wellbeing of fin fish species in the lower Gangetic delta that are significant for commerce.

REFERENCES

[1] Jhingran, V.G. (1982). Fish and Fisheries of India. Hindusthan Publishing Corporation (India), Delhi.

[2] Mitra, A. (2013). Sensitivity of Mangrove ecosystem to changing Climate. Springer DOI: 10.1007/978-81-322-1509-7, pp. 323.

[3] Chow, S. & Sandifer, P.A. (1991, 92). Differences in growth, morphometric traits and male sexual maturity among Pacific white shrimp, Penaeus vannamei, from different commercial hatcheries. Aquaculture, 165–178.

[4] Ray Chaudhuri, T., Fazli, P. Zaman, S., Pramanick, P. Bose, R. & Mitra, A. (2014). Impact of acidification on heavy metals in Hooghly Estuary. Journal of Harmonized Research in Applied Science,2(2), 91-97.

[5] Chakraborty, S., Zaman, S., Pramanick, P., Raha, A.K. , Mukhopadhyay, N.,Chakravartty, D. and Mitra, A. (2013). Acidifications of Sundarbans mangrove estuarine system. Discovery Nature, 6(14),14-20.

[6] Sengupta, K.., Roy Chowdhury, M., Bhattacharyya, S.B, Raha, A., Zaman, S. and Mitra, A. (2013). Spatial variation of stored carbon in Avicennia alba of Indian Sundarbans. Discovery Nature, (ISSN:2319-5703), 3(8), 19 -24.

[7] Mitra, A. & Zaman, S. (2014). Carbon Sequestration by Coastal Floral Community; published by The Energy andResources Institute (TERI) TERI Press, India; Copyright The Energy and Resources Institute; ISBN- 978-81-7993- 551-4.

[8] Mitra, A. & Zaman, S. (2015). Blue Carbon Reservoir of the Blue Planet. Published by Springer; ISBN 978-81-322- 2106-7 (Springer DOI 10.1007/978-81- 322-2107-4).

[9] Bagenal, T.B. & Tesch, A.T. (1978). Conditions and Growth Patterns in Freshwater Habitats. Blackwell Scientific Publications, Oxford, pp: 75 -89.

Abowei, J.F.N & George, A.D.I (2009). A study of the length - weight relationship and condition factor of Callinectes amicola (De Rochebrune, 1883) from Okpoka Creek, Niger Delta, Nigeria. International Journal of Animal and Veterinary Advances, 1(2), 66-72.

[10] Fagade, S.O (1979). Observations on the Biology of two species of Tilapia from Lagos Lagoon, Nigeria. Bulletin d'Institut Français d'Afrique Noire, 41, 627–653.

[11] Abowei, J.F.N., Davies, O.A. & Eli, E.E (2009). Study of the length - weight relationship and condition factor of five fish species from Nkoro river, Niger Delta, Nigeria. Current Research Journal of Biological Sciences, 1(3), 94-98.

[12] Bakare, O. (1970). Bottom Deposits as Food of Inland Freshwater Fish. In: A Nigerian Man Made Lake. Kainji Lake Studies, 1, (Visser, S.A. and Lake, K., Eds.), Ecology, NISER, Ibadan, Nigeria.

[13] Abowei, J.F.N. (2009). The abundance, condition factor and length - weight relationship of Cynoglossus senegalensis(Kaup, 1858) from Nkoro River Niger Delta, Nigeria. Advanced Journal of Food Science and Technology, 1(1), 56-61.

Barkhausen Noise Analysis of different shaped sample of mild steel

Ravi Shankar
Assistant Professor, Mechanical Engineering Department, JBIT, Dehradun,

Barkhausen noise analysis is a non-destructive technique which is based on magnetic properties of the material which is a fast technique for material characterization and testing of surface integrity. This method can be integrated into the manufacturing environment such as grinding shaping etc for online testing of produced parts or working machine parts. Due to the shape of the test sample, the BNA the barkhausen noise signal may get affected and that can fluctuate the results. Hence the aim of this research work is to present the experimental investigation of how varying the shape of the test sample can affect the results of the material characterization by the magnetic Barkhausen Noise method. The measurements were made on five samples of the ground and annealed sample to examine the effect of microstructural changes as well. First, all samples of base metal were cut into different sizes and later, all samples were subjected to heat-treatment process annealing. The results concerning magnetic Barkhausen noise were discussed in terms of RMS values, the shape of Barkhausen noise profiles, the position of the peak values and mathematical analysis of barkhausen data obtained from the test performed.

In this study, the HL and BN of the mild steel sample were experimentally measured by varying the frequency, MFI, and waveform using magnetic Barkhausen noise analyser. Barkhausen noise analysis frequency was applied from 20 Hz, 30Hz, 40Hz, 50 Hz at 800 Oe constant and MFI varies from 250 Oe, 500Oe, 750Oe, 1000 Oe at a constant magnetizing frequency of 25 Hz. For hysteresis loop analysis sinusoidal waveform was applied at a magnetizing frequency of 0.1 Hz to 0.4 Hz at 500 Oe constant magnetic field intensity, t, and 150Oe, 300Oe, 400Oe, 600Oe magnetic field intensity at 0.1 Hz constant magnetizing frequency.

The result for magnetic Barkhausen noise of the base sample and the annealed sample of mild steel of different thickness and size were observed by graphical variation with frequency and MFI.

1 INTRODUCTION

1.1Background

Properties of material (especially mechanical) depend on its chemical composition, crystal structure defects, shape, etc. Thus, the study of these parameters and the relation between these and the property of the material is necessary. Material characterization refers to the processes that are used to determine material properties and structure. It is a fundamental process in the field of material science and engineering, without which no specific understanding of materials could be achieved. There is various kind of material characterization methods/technique can be classified into two categories [1-2].

1. NDT (non-destructive testing)
2. Destructive testing

The term "non-destructive testing" (NDT) is used for material testing methods that can be applied without compromising the usefulness of the material. Tests can be applied to materials, parts, assemblies or structures. Most non-destructive methods are indirect, producing an estimation of the quality, strength or serviceability of the tested object. Destructive methods can also be applied to material testing. It is; however, the tested object is lost in such a testing scheme and thus cannot be applied to objects that are later used in service.

Non-destructive methods offer many advantages to the industry. These advantages mainly fall into four categories: increased productivity, increased serviceability, safety and identification of materials. There is a wide variety of non-destructive testing methods utilizing different physical phenomena. Test methods can be divided into visual, pressure and leak, penetrant, thermal, radiography, acoustic, magnetic, etc. Conventional testing methods such as Optical microscope, scanning electron microscope (SEM), X-ray diffraction (XRD) and hardness measurement are time-consuming and cannot be used for online testing [3]. But these methods are very time consuming and expensive. In opposite to these time-consuming laboratory methods, Magnetic Barkhausennoise turns out to be the best alternative. It is a fast, reliable and practical method to detect mass production volume. It is a very important tool for non-destructive characterization [4-6] of ferromagnetic materials.

Barkhausennoise analysis is one such non-destructive technique which is based on magnetic properties of the material which is fast and can be integrated into the manufacturing environment for online testing of produced parts or working machine parts etc. BarkhausenNoise was discovered in 1919 by H. Barkhausenwhen he wound a ferromagnetic specimen with a wire and hooked it to an external speaker. He found that by changing the magnetic field around the specimen, he could induce a rushing sound in the speaker. This rushing sound was the result of many small abrupt changes in magnetic flux that was occurring within the confines of the coil. These step variations in magnetic flux occur randomly and are what is commonly known as Barkhausn Noise. It is an advanced material characterization technique which has many advantages over other NDT's.

1.2 BarkhausenNoise Background

1.2.1Magnetism

Magnetism is a complex phenomenon. It is caused by and affects electric currents. These electric currents can be of any scale, down to the scale of electron spin, as this can also be seen as moving electric charges and thus as an electric current. In order to understand the background of using magnetic properties to evaluate the microstructure, some aspects of magnetism are explained in this chapter, starting with the most important definitions, related to this topic.

1.2.2 Ferromagnetism

When a material is kept in an external magnetic field it can respond in many ways. Some materials have a tendency to repel the flux line from their core and as a result, it experiences a small force of repulsion from the magnetic field, such materials are known as diamagnetic materials. While some materials show the tendency to concentrate the flux lines to their core, as a result, it experiences attraction force from the external magnetic field, these materials are classified as paramagnetic materials. Ferromagnetism is based on the extent of attraction force they experience from the external field. The force that occurs in diamagnetic and paramagnetic materials are much weaker, and materials exhibiting such behaviours do not spontaneously produce their own magnetic field. While ferromagnetic materials show strong attraction towards the external field and are easily magnetized in the external field. In general, language when we say the material is magnetic, we usually mean it exhibits ferromagnetic behaviours.

1.2.3 Magnetic field (H)

One of the most fundamental ideas in magnetism is the concept of the Magnetic Field. A magnetic field can be produced by a permanent magnet. In a permanent magnet, there are the orbital motions and spins of electrons within the permanent magnet material which lead to a magnetization within the material and a magnetic field outside. A magnetic field can also be produced whenever there is an electrical charge in motion This can be due to an electrical current flowing in a conductor for example, as was first discovered by Oersted in 1819 [1]. The strength of this field is proportional to the current that is passed through the field winding in the sensing device or sensor. In the commercial BarkhausenNoise products, this is a common system parameter setting or control, which is used to control the field winding current. Often this term will be used to refer to the magnetizing current, which is the current that is used to generate the time-varying external magnetic field around the inspection specimen.

1.2.4 Excitation Field

The excitation field term refers to the magnetic field that is used to excite, or influence, the ferromagnetic specimen. This excitation causes emission of BarkhausenNoise as the field is changing from one polarity maximum to the other. This field has to change with time to cause the Barkhausenemission to occur.

1.2.5 Magnetic Domains

Magnetic domains are commonly discussed in the articles pertaining to BarkhausenNoise technology. A domain is a region in a ferromagnetic material that is defined by a magnetic polarity boundary. As an external field is applied to the material, the boundary of the magnetic domain will transform towards an equilibrium position. The transition of this domain shift is semi-predictable and is commonly a single part of a series of changes at once. The effect within a material can be described as an avalanche, which is usually the term used in the technical literature.

1.2.6 Irreversibility

With magnetic types of inspection and phenomenon, there is an aspect that one frequently encounters. The aspect of irreversibility is displayed in a ferromagnetic material's inability to return to the original magnetic state. In other words, once a ferromagnetic material has been placed in a magnetic field and taken from the field, there will remain in the material some amount of residual magnetism. This characteristic occurs on the order of the individual magnetic domains within a material, thus causing a very unrepeatable transition when the magnetic field is changing within a material.

1.2.7 Magnetic Hysteresis

When the magnetic field applied to ferromagnetic materials is cycled in time, the magnetization does not trace its initial path, resulting in magnetic hysteresis. This hysteretic behaviours is related to the influence of the applied magnetic field on magnetic moments which are aligned in particular crystallographic directions in different regions in the material. Such regions are known as magnetic domains and the crystallographic directions in which the moments align are called easy magnetization directions. In neighbouring domains, the moments within each domain are aligned along with different directions as seen in Fig. 1.1 (Top). The interfaces between adjacent domains (called the domain wall) can be a few hundred atomic layers thick or even a few atoms (based on the material) and the orientations of the moments change progressively within these layers from that of one domain to that of another. When an external magnetic field is applied to a ferromagnetic material, as in Fig. 1.1 (Bottom), at magnetic field strengths sufficient to move the domains past any pinning sites, the magnetic moments within each domain then switch to crystallographic easy directions closest to their orientation. With sufficient field to overcome the anisotropy energy, they switch to the direction of the applied magnetic field to attain a state of minimum energy [Jiles and Atherton (1986); Bertotti (1998)]. During the magnetization process, the domains oriented in the direction of the external field (favourably oriented domains) grow at the expense of neighbouring less favourably oriented ones; which shrink. The presence of imperfections or defects within the material serve as a source of lag during magnetization by acting as pinning sites to the domain walls. At sufficiently high magnetic field strengths, all domains will become oriented to the direction of the applied field. A sufficiently strong magnetic field can even reorient the magnetic moments oriented along the favourable crystallographic direction in the direction of the applied magnetic field. Beyond this, no further magnetization is possible and the material is then said to be saturated. If the direction of the magnetic field is reversed, the magnetic moments realign along the favourable crystallographic direction thereby reducing the magnetization mainly because this reduces the total energy of the system. The hysteresis loop is illustrated in Fig. 1.2. The imperfections and impurities in the material affect the shape of the hysteresis loop. Magneto crystalline anisotropy also influences the hysteresis loop because it affects the ability of domain walls to align along the field direction.

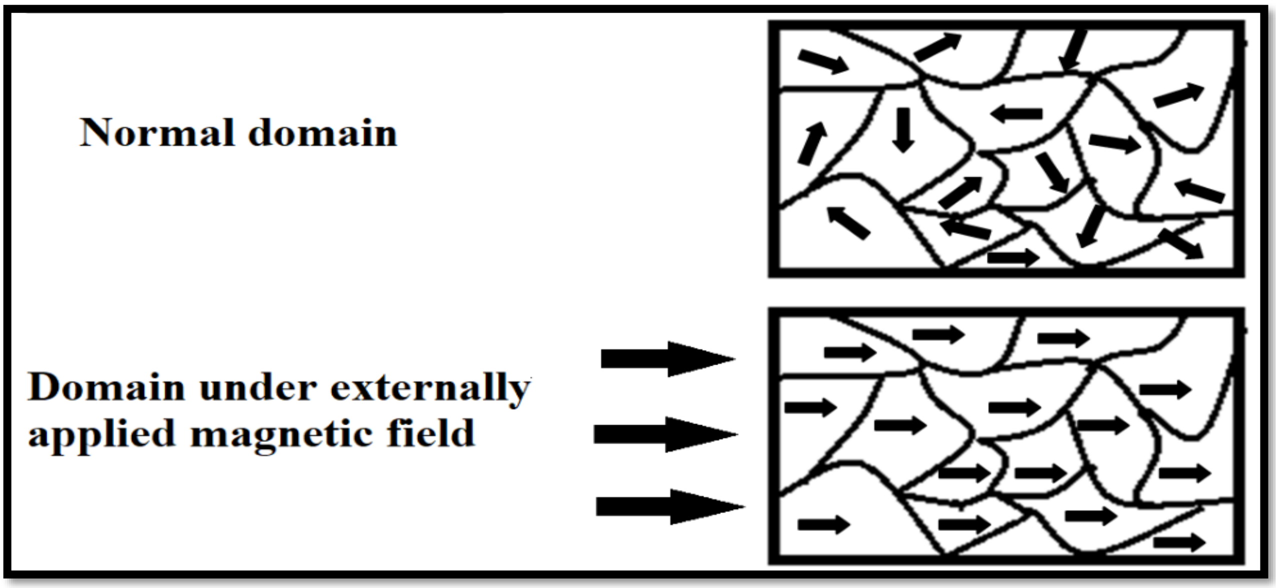


Figure 1.1: Schematic illustration of magnetic domains within grains. The arrows represent the magnetic moments which are randomly oriented before magnetization (top) and are oriented along the direction of the external magnetic field (bottom)

For ferromagnetic materials, the hysteresis process can be described mathematically. If an external magnetic field, H, is applied to a ferromagnetic material with relative permeability of free space, μo, the magnetic induction, B, within the material is:

$$\mathbf{B = \mu o(M + H)}$$

Where M is the magnetization of the ferromagnetic material. On the microscopic level, the hysteresis process can be divided into the following processes. In a demagnetized state, the magnetic moments are randomly oriented such that the net magnetization is zero. At saturation, all the magnetic moments align in the direction of the applied magnetic field. The magnetization which remains after removal of the externally applied magnetic field is known as the remanent magnetization as observed in Fig. 1.2

The magnetic field when the net magnetization is zero is known as the coercive field as seen in Fig. 1.2 Describing the hysteresis loop allows for predicting the magnetic properties such as the coercivity or remanence for magnetic materials and in turn, allows for improving their performance in devices. Historically, several models have been proposed to predict this hysteresis behaviours. Some earlier work suggested a frictional force responsible for hysteresis and others considered hysteresis as a byproduct of the interactions between the magnetic moments [Jiles and Atherton (1986)]. It is now understood that both of these physical phenomena contribute to hysteresis. The apparently smooth nature of the hysteresis loop is attributed to a frictional force opposing the change in magnetization. This is due to the pinning of domain walls by defects in specimens which cause an opposing force resisting changes in magnetization. The mutual interactions between the magnetic domains are also contributing factors.

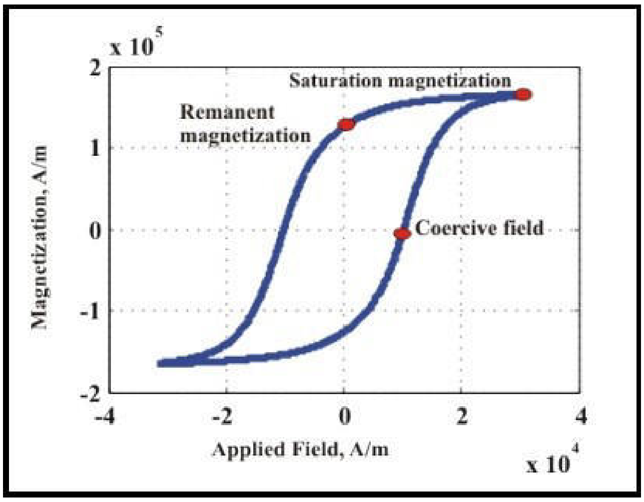


Figure 1.2: Illustration of the magnetization process

1.2 Mechanism of BarkhausenNoise Analysis (BNA)

BarkhausenNoise Analysis (BNA) method, is based on a concept of inductive measurement of a noise-like signal, generated when a magnetic field is applied to ferromagnetic materials. ferromagnetic materials consist of small magnetic regions resembling individual bar magnets called domains. Each domain is magnetized along a certain crystallographic easy direction of magnetization. Domains are separated from one another by boundaries known as domain walls or Bloch walls. Under the externally applied magnetic field domains with the direction close to the applied magnetic field (fig 1.1) get increased in their size which leads to the magnetization of the specimen. If an AC magnetic field is applied it will cause domain walls to move back and forth, this is known as Barkhausenjump and can be recorded in the form of BN signals. Barkhausennoise has a power spectrum starting from the magnetizing frequency and extending beyond 2 MHz in most materials. It is exponentially damped as a function of distance it has travelled inside the material. This is primarily due to the eddy current damping.

1.3 Factors affecting the Noise signal

1.3.1 Frequency
The frequency of the AC voltage applied to the magnetizing coil, which determines the penetration depth. The sensor is sensitive to greater depths if a lower frequency is used. High frequencies induce eddy currents that damp the signal as already explained. Higher frequency also causes vibration due to magnetostriction.

1.3.2 Applied magnetic field intensity
The sensor varies the amount of electrical current passing through the magnetizing coil, and therefore the strength of the external magnetic field. The field should be strong enough that the hysteresis loop is relatively large, but not so strong that it saturates the sample.

1.3.3 Material properties
Different materials react differently to an applied magnetic field. As the part material changes, so does its hardness, grain size, magnetic permeability, etc.

1.3.4 Chemical composition

At high machining speeds, the chemical composition has been shown to be the same as the bulk material, most likely because the carbon does not have time to diffuse. In contrast, at lower machining speeds significant cementite presence was found in white layers. These differences are explained by the occurrence of phase transformation at higher machining speeds.

1.3.5 Grain size

Grain boundaries may impede the movement of domain walls, and therefore change the shape of the hysteresis curve. The Barkhauseneffect is also responsive to the location, size, and type of carbide precipitates. Typically this is assumed to be aliased with other factors, especially the material type and hardness.

1.3.6 Texture/Surface finish

The surface finish is usually neglected because it is similar enough for each of the parts to be considered approximately the same.

1.3.7 Inclusions

Inclusions affect the sensor response because they have different properties than the bulk material. Inclusions may affect the overall permeability, hysteresis loss, and coercivity of the material.

1.3.8 Thickness of test sample

The limitation of BNA is it can only be used to detect changes in the very near to the surface region of the material. The depth of penetration can be governed by the same skin depth equation of the electromagnetic field.

$$\boldsymbol{\delta} = \frac{\mathbf{1}}{\sqrt{\boldsymbol{\pi f \sigma_m \mu_o \mu_r}}}$$

Where, δ - depth of penetration in material

f - Excitation frequency

σ_m - conductivity of material

μ_o - permeability of vacuum

μ_r - relative permeability of the material

1.4 Signal analysis

A typical Barkhausennoise signal of 3 cycle (6 burst) is shown in Fig 1.3. the figure consists two half, the upper half show the raw data obtain from measurement and the lower half show the filtered signal. Usually, some feature is calculated from this signal and then compared with studied material properties.

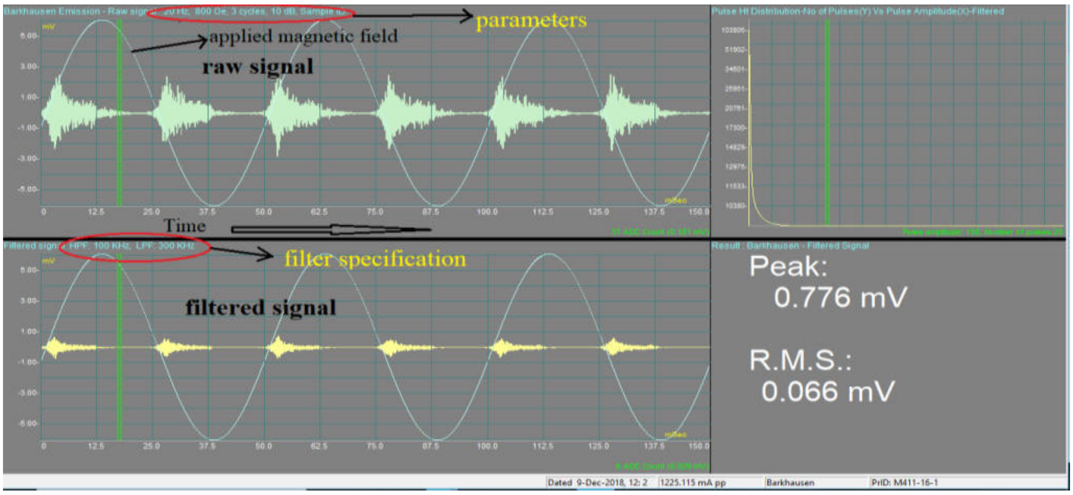


Figure 1.3: Output display of BN test on Megastar technofour

The root-mean-squared (RMS) value of the signal is the most usual one. It has been used, for example, in (Lindgren &Lepisto 2002) and (O'Sullivan,2003).Also the signal can be plotted and the properties of the curve can be analyse. The fig1.4 shows the graph between rms in milli volt and time in milli second. the black hached line shows the actual variation of rms and the red smooth line show the best fit polynomial. The properties of this polynomial such as skewness, kurtosis, Area under the curve can be calculated and then compared with the material properties.

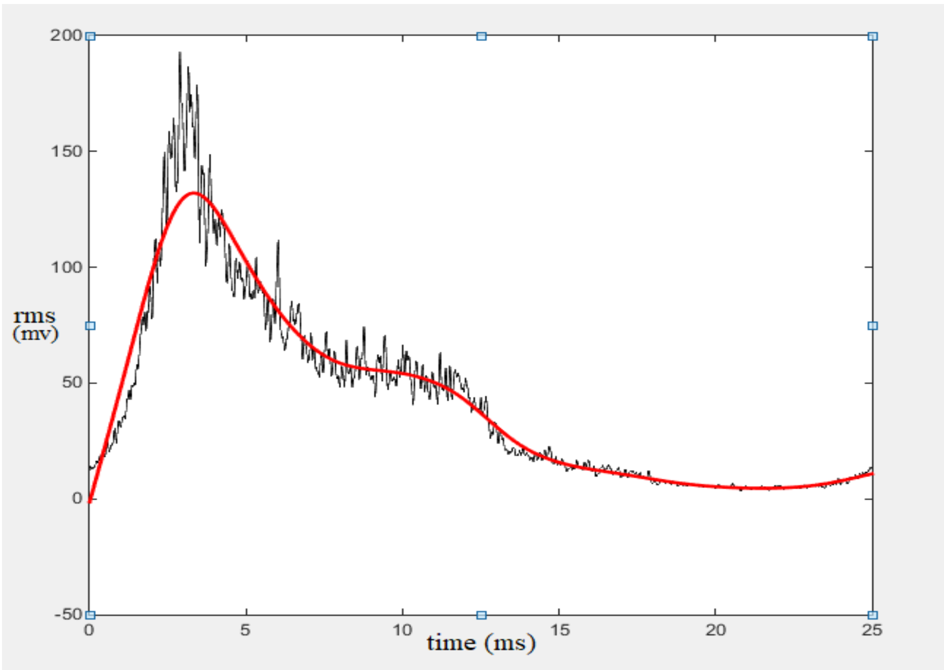


Figure 1.4: variation of RMS VS time for a rectangular sample at 800 Oe magnetic field intensity and 20 Hz excitation frequency.

1.5 BarkhausenNoise Analysis - the Applications

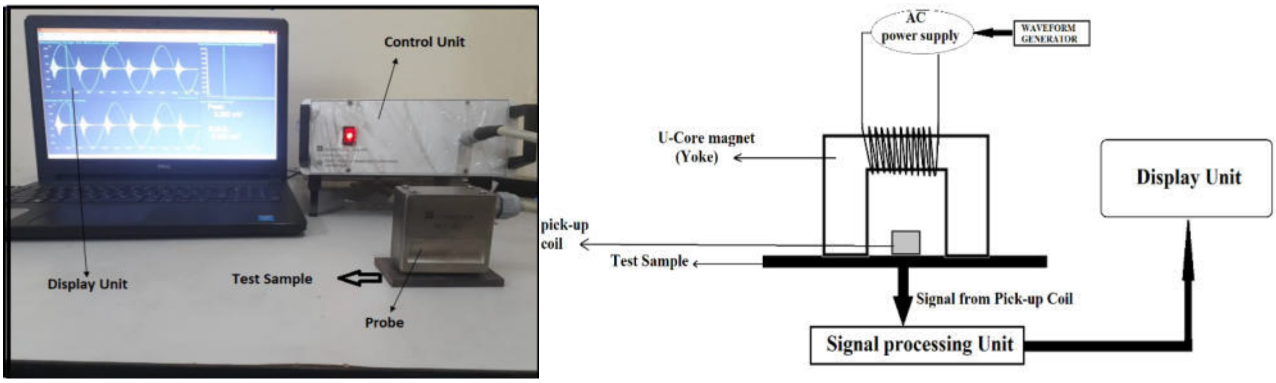
Many common surface treatments such as grinding, shot peening, carburizing and induction hardening involve some modification of both stress and microstructure and can be readily detected using the method. Various dynamic processes such as creep and fatigue similarly involve changes in stress and microstructure and can also be monitored with BNA. Practical applications of the BNA can be broadly divided into three categories:

- Evaluation of residual stresses; provided microstructural variables can be reasonably controlled.
- Evaluation of microstructural changes; provided level of stress can be reasonably controlled.
- Testing of the following surface defects, processes and surface treatments that may involve changes in both stresses and microstructure.
- Detection of grinding defects and grinding process control.
- Detecting surface defects through Cr-coating.
- Evaluation of shot-peening effect in steel.
- Measurement of residual surface stresses in steel mill rolls and steel sheet.

3 INSTRUMENTATION

3.1 Experimental set-up

The measurements of backhouse noise were carried out on the Mag star system supplied by Techno four, India. The apparatus is shown in fig 3.1.It mainly consists of an AC power supply, a control unit, a sensor/probe, and a display unit. The probe (fig 3.2) consist with U shape magnetizing yoke to to generate magnetic field inside the test sample with the help of alternating current from power supply. A pick up coil at the centre was used to gather the signal generated as magnetic response of the work material



(a) (b)

Figure 3.2 (a) experimental setup (b) schematic diagram

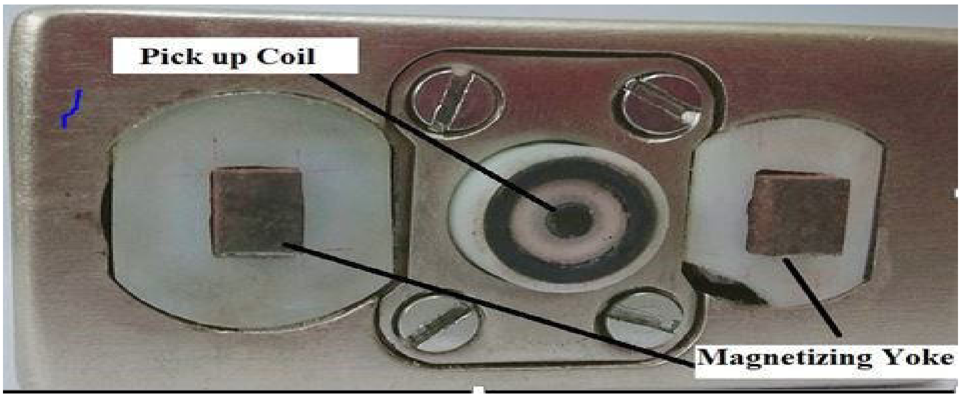


Figure 3.3: Bottom view of probe

3.2 Material selection

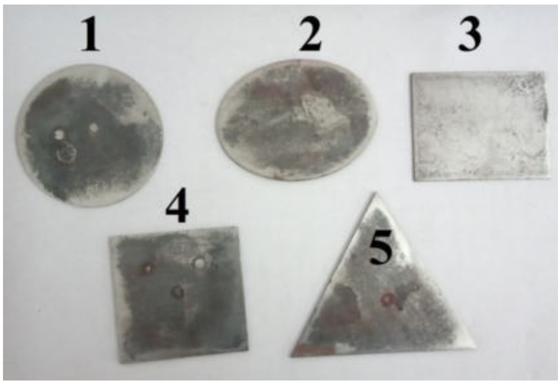
The unhardened low carbon steel has very good magnetic properties. It is widely used in the automobile industry, pipes and pressure vessel, etc. hence it covers a wide spectrum of application. For experiment five sample was prepared from hot rolled IS-2062 steel sheet of 1.54 mm thickness. The chemical composition of the of the material are given in table 3.1.

Table 3. 1: Chemical composition of IS-2062 steel

Element	C	Si	Mn	P	S	Cr	Fe
Wt %	0.17	0.045	0.32	0.007	0.013	0.3	Rest

3.3 Sample preparation

The shape of the sample and their respective dimensions are shown in fig 3.2. Since the objective was to study the effect of shape of the sample hence the dimensions were chosen such that the total volume of each sample remains equal. The sample were cut with help of CNC milling. Surface contamination such as dust, oil, corrosion etc affects the formation of hysteresis loop to avoid such problem test sample were cleaned using emery paper with successively fine mesh girt of 120, 320,400 and 600 to make the surface of sample scale free.



1. Circle (d= 52 mm)

2. Ellipse (2a= 60 mm, 2b= 45 mm)

3. Rectangle (41mm x 52 mm)

4. Square (a= 46 mm)

5. Equilateral Triangle (a= 70 mm)

Figure 3.4: Sample used in the experiment

3.3.2 Annealing of sample

Annealing was carried out in pit type electric furnace in which sample were first placed into the furnace at 850ºC temperature and then holding them at constant temperature for 15 minute followed by cooling upto room temperature in furnace. The cooling take place in approximately 5-6 hr.

3.4 Microstructure and Microhardness analysis

For observation of microstructure, samples (base and annealed) were cleaned by different emery paper with successively fine mesh girt of 120, 320, 600, 800, 1200 and 1500 followed by cloth polishing with alumina paste until a mirror-like surface was achieved. The sample was first cleaned using running water then etched for 10 second using 3% nital solution. The sample was immediately rinsed using running water and dried using hot air. To obtain the microstructure of the sample 'Dewinter' microscope is used and the microstructure is captured by 'Dewinter Biowizard' software.

The microhardness (HV) tester (Micro Mech Technologies, India) was used to examine the microhardness of base sample and annealed sample. The microhardness test at the subsurface was carried out with 100 gm (981 mN) load 10 second dwell time on the cross section base sample. The indentations were done with a Vicker indenter starting from depth 15 µm from the edge and reading are taken in HV. The hardness measurement was performed up to depth 120 µm from the edge at a regular gap of 15 µm. To avoid interference between each indentation the indentation is performed in 2 lines. To compensate for the experimental tolerances, five hardness measurement is taken at each depth and the average value was considered for analysis. The hardness measurement of annealed samples was also taken with 100 mg load and 10 second dwell time five time each and their average is taken for analysis. Fig. 3.4 shows the Identation of the micro hardness identator which was observed on the surface of sample during the hardness testing and the table 3.2 shows the Computation of indent diameter and Vickers Hardness Number for every trial.

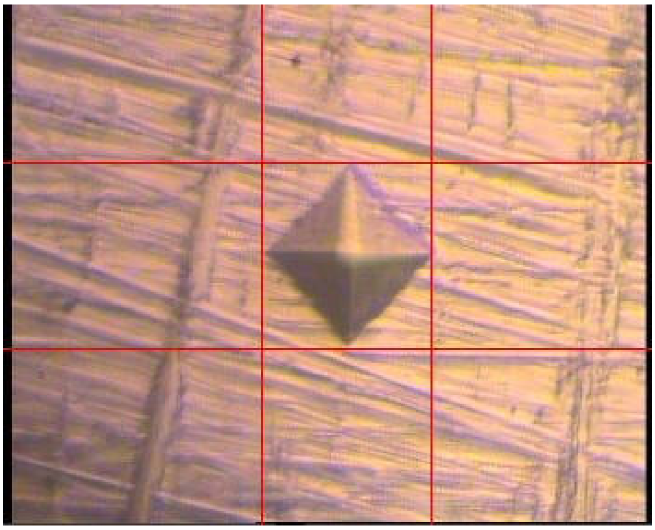


Figure 3.5:Identation of the micro hardness identtor

Table 3. 2: Computation of indent diameter and Vickers Hardness Number

S.N.	Base sample			Annealed sample		
	D1 (µm)	D2 (µm)	Vickers Hardness Number (HV)	D1 (µm)	D2 (µm)	Vickers Hardness Number (HV)

1	36.33	36.13	141.25	58.37	58.03	109.47
2	37.55	37.59	131.35	37.96	37.59	129.93
3	38.78	38.69	123.57	57.14	56.57	114.71
4	37.14	37.23	134.08	38.37	39.05	123.73
5	37.96	37.96	128.66	56.73	56.93	114.81
	Average Vickers hardness number		**131.782**	Average Vickers hardness number		**118.53**

3.5 BN data collection

The experiment was conducted in two phases at different magnetization conditions. In first phase magnetic field intensity was kept constant while in second phase excitation frequency was kept constant. Parameter for MBN and hysteresis loop (HL) analysis are given in table 3.3 And 3.4 respectively.

Table 3. 3: Parameter for BNA

Common data for both phases	No of cycles	3
	Gain	10 dB
	High pass filter (HPF)	100 KHz
	Low pass filter (LPF)	300 KHz
BN phase-I	Magnetic field intensity (MFI)	800 Oe
	Magnetic frequency (MF)	20, 30, 40, 50 Hz
BN phase-II	Magnetic field intensity (MFI)	250, 500, 750, 1000 Oe
	Magnetic frequency (MF)	25 Hz

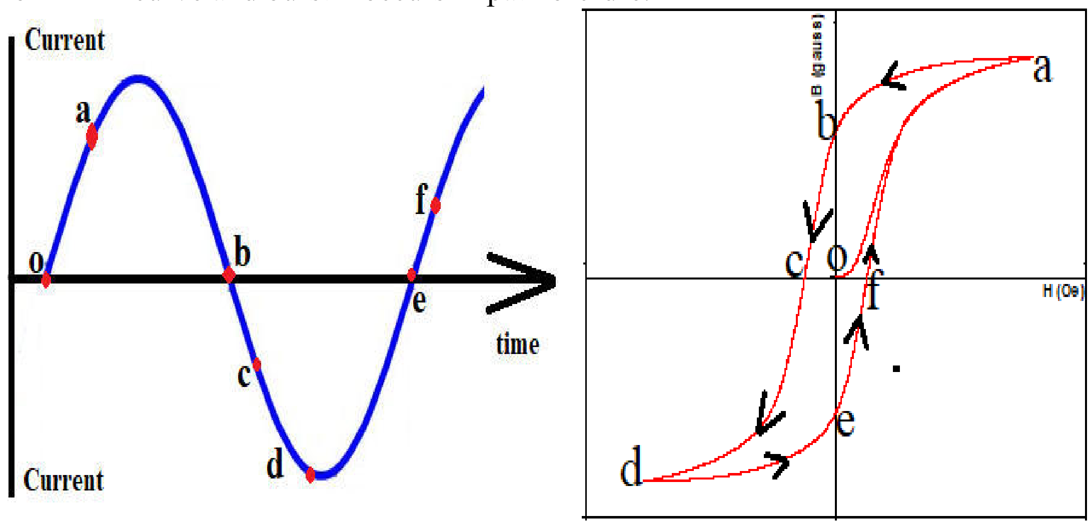
Table 3. 4: Parameter for HL

HL phase-I	Waveform	Sine wave
	Magnetic field intensity (MFI)	500 Oe
	Magnetic frequency (MF)	0.1, 0.2, 0.3, 0.4 Hz
HL phase-II	Magnetic field intensity (MFI)	150, 300, 400, 600 Oe
	Magnetic frequency (MF)	0.1 Hz

3.6 Post-processing analysis of BarkhausenNoise Data

3.6.1 Raw BN Data

It is very difficult to interpret information from a raw BN signal due to background noises, and vibrations, leading to stochastically nature. At one cycle of applied field, two bursts are obtained as illustrated in Figure 3.5(b) in a BN measurement of 3 cycle there are 6 burst with alternate magnetizing and demagnetizing in nature. Burst 1 occurs when magnetization takes place in path e-f-a-b in B-H curve and burst 2 occurs in path b-c-d-e.



(a) **(b)**

Figure 3.6: (a)applied magnetic field (b)showing the path on the B-H curve

3.6.2 RMS Profile

The RMS signal was obtained from the raw signal with zero phase filtering. The RMS distribution of k signal (k can take 1, 2...any integer), defined as:

$$rms = \sqrt{\frac{1}{n}\sum_{i=k-n}^{k} x_i^2}$$

Where, $x_i$is raw BN signal, n is sampling interval. This filtering was done using MATLAB program. Here, filtered BN signal shown in figure 3.6(a). Since, 3 cycles of applied magnetic field are used to perform BN test so 6 burst are obtained. Then, the burst 1, 3 and 5 are averaged to obtain required RMS distribution shown in figure 3.6(b), because these three bursts correspond to the same path e-f-a-b in B-H curve explained in figure 3.5. Single peak fit with Gaussian distribution is used to fit this modified signal with Levenberg Marquardt algorithm in ORIGINPRO also shown in figure 3.6(b). This was used because process annealing and facing would not cause any profound phase change from surface to the bulk. Thus, signal peak is expected for all samples.

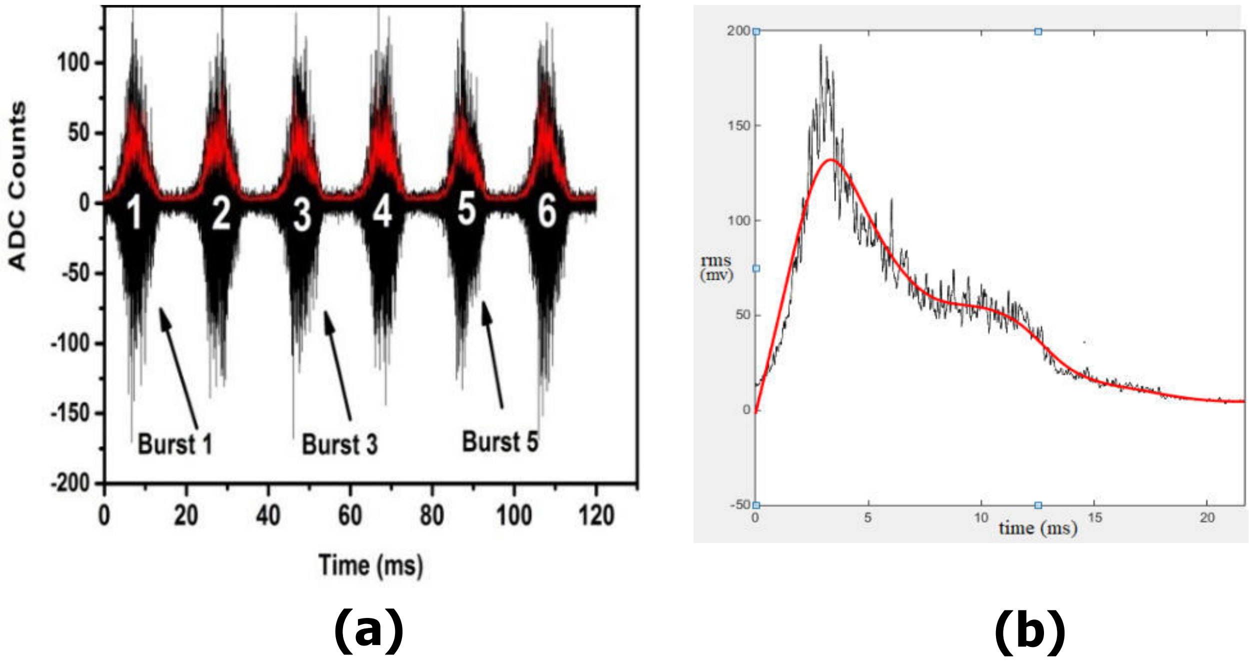


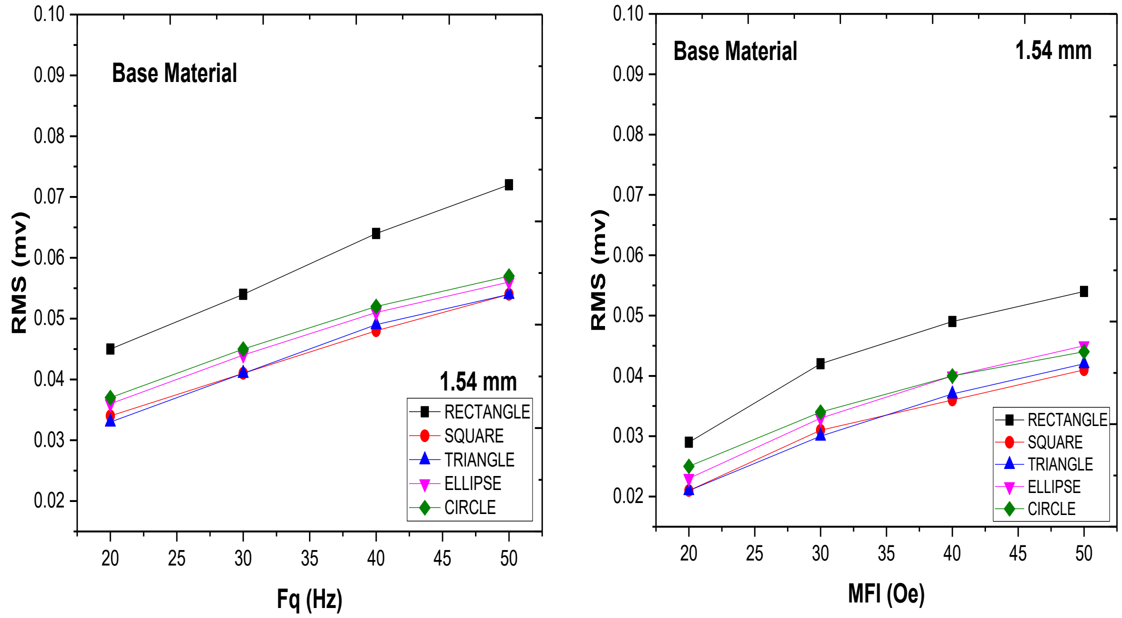
Figure 3.7: (a)Measured BN signal along with filtered Signal in at 25 Hz,(b) Gaussian fit

RESULTS AND DISCUSSSIONS

4.1 Part I: effect of shape on BNA

4.1.1 Variation of RMS with Fq and MFI

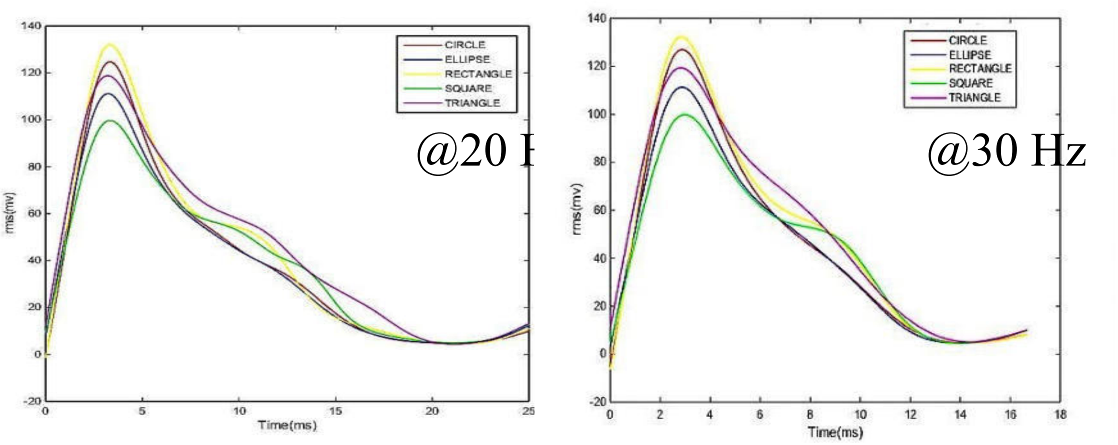
It can be seen f rom the variation of rms with excitation frequency and magnetic field intensity as shown in figure it is evident that the BN response for Rectangular shaped sample is strongest and that for the square shaped sample is weakest, while others are in between them. This can be due to shape anisotropy.



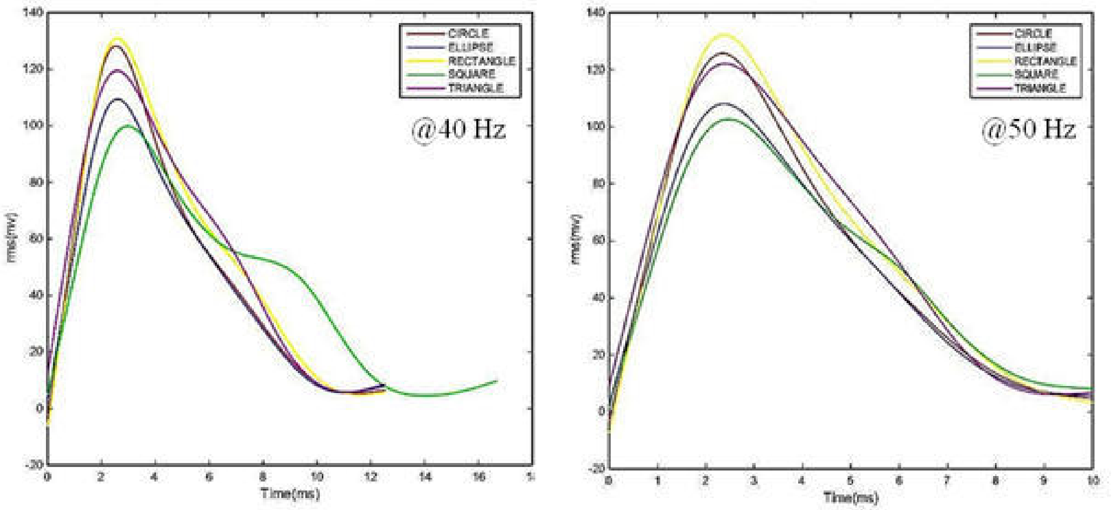
(a) **(b)**

Figure 4.2: (a) BN signal rms variation wrtMF, (b) BN signal rms variation wrtMFI

4.1.2 Variation of RMS with time



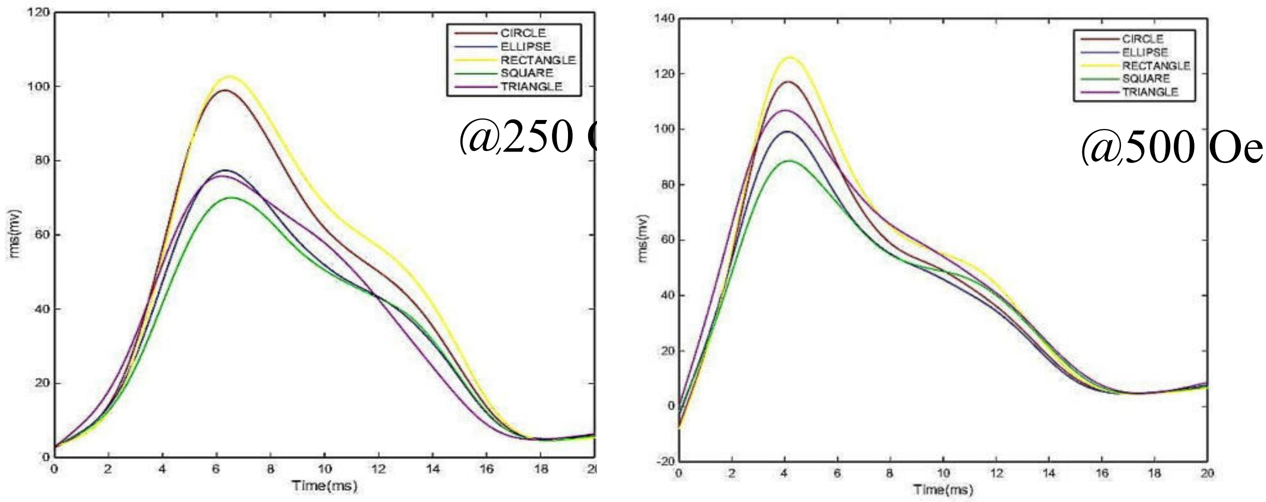
(a) **(b)**



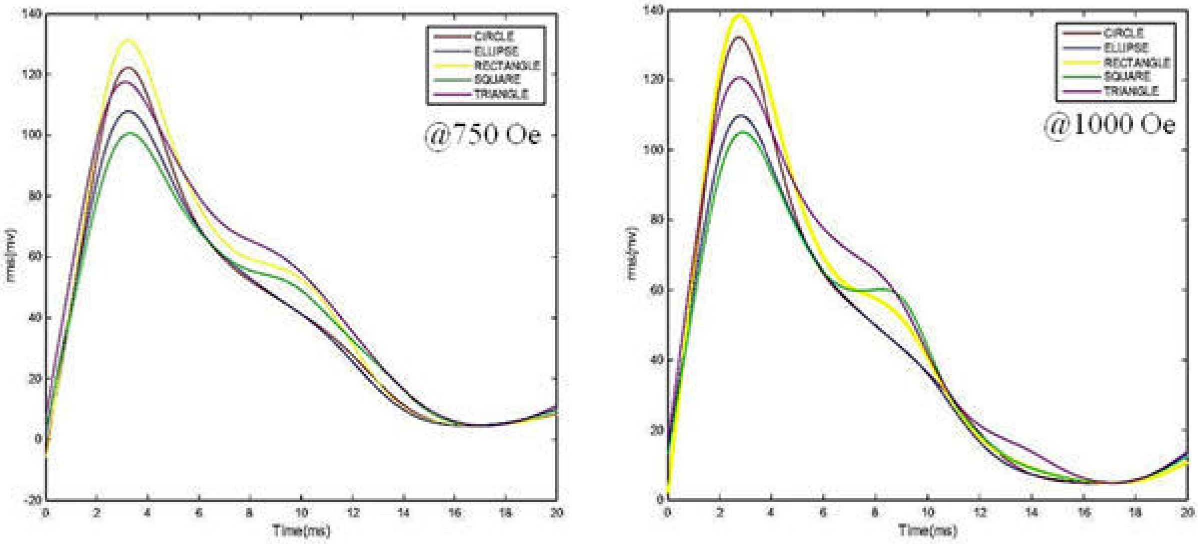
(c) **(d)**

Figure 4.3: BN signal rms variation wrt time at different excitation frequency

Figure 4.2 and 4.3 shows the variation of rms with respect to time at different frequency and at different magnetic field intensity respectively. when sinusoidal applied field varies along this path, the field increases to maximum, and then decreases to zero to complete B-H curve on first quadrant Form the graph it is quite clear that change in frequency doesn't affects the peak value of erstwhile on the increase in magnetic field strength we get stronger BN response from all the sample. The peak value for rectangular sample is largest and smallest for square shaped sample that can be again due to shape anisotropy.



(a) **(b)**



(c) **(d)**

Figure 4.4: BN signal rms variation writ time at different applied magnetic field intensity

CONCLUSIONS

1. The BN signal obtain from the Rectangular shaped sample were strongest and weakest for square shaped sample hence the best suited sample for BNA is rectangular shaped sample.
2. For the measurement of remanence based properties the shape of the sample is not a factor since remanence was unaffected by the change in shape.
3. RMS value of BN signals increases after annealing .
4. RMS value were found to be higher at lower hardness.
5. No fixed change in skewness and Kurtosis were observed on changing the shape of sample.
6. No fixed change in skewness and Kurtosis were observed after annealing
7. In case of both the base and the annealed material linear variation is observed between Barkhausennoise (rms) and MF & MFI.
8. Average permeability increases with the decrease in micro-hardness of material.
9. Coercivity for base sample is lesser as compared to that of annealed sample.

Plan and Stress Investigation of Tractor Arm and Cam

Ankit Kumar [1]Manik Pal Shah[2],

[1,2,]Assistant Professor,

JB Institute of Technology, Dehradun

ABSTRACT

Earthmoving machines is presently a piece of industry and development handles nowadays. Backhoes are the versatile machines that are moved through either crawler track or elastic tired underside. Capability of tractor is to dig, dump, swing and lift material by its instruments. Multibody reenactment moving perspectives works with framework level kinematic and dynamic examination of entire backhoe, making it conceivable to concentrate on the response powers and stress variety in each part of framework. Dynamic way of behaving of stacking conditions are expected to produce account the results of pressure and vibration. In multibody dynamic examination we are worry with elements of multibody interconnected different unbending bodies. The goal is to reproduce the whole working cycle which comprise of digging swinging unloading and swinging back to starting position. Investigation of stresses created in different parts is a lot of significant in load lifting gadgets, which cause seal disappointment and decrease of weakness life of chambers. In this paper, a 30-ton water driven earthmover is utilized for this specific review. Last results wanted are the response powers at all joints and to assess the burdens at all check area. Modular examination of tractor arm lifting system was completed in ANSYS. Tractor arm of various composite materials can be made out like steel, aluminum, compound, primary steel and so on. Examination by utilizing ANSYS 14.0 the outcome acquired that primary steel is liked as great material for planning of backhoe arm.

Keywords: Excavator, Digging, Swing, Dumping, Stress,kinematic, Dynamic, Cad, Cam, Simulation

INTRODUCTION

Tractors are portable machines that are moved through either crawler track or elastic tired underside. Backhoe digs, lifts, swings and dumps material by the activity of its component, which comprises of blast, arm, container and pressure driven chambers. The plan of different parts of a backhoe is intricate because of the way that the response powers, removals and stresses change with time all through the full pattern of activity [1]. Regular strategies for configuration for this situation result in overdesigned models since the planner is compelled to utilize a higher component of wellbeing because of absence of accessibility of information for full pattern of activity [2]. Nonetheless, Multi-Body Reenactment Moving Perspective/Movement Address works with framework level kinematic and dynamic examination of the entire tractor, making it conceivable to concentrate on the response powers and stress variety in each part of the framework all through the pattern of activity. It helps in foreseeing the greatest pressure at every area during the cycle and hence offers a method for streamlining the plan [3]. The extension is to reenact a full pattern of activity of a 30-ton tractor utilizing Multi Body reproduction capacities of Altair Movement View/Movement Settle and contrast the outcomes and accessible test information. Tensions of pressure driven chambers, Strokes of water powered chambers, Pail load and uncovered mass of soil are applied as information. The full pattern of activity comprises of three significant stages, Digging, Swing and Unloading. By characterizing the part under concentrate as an adaptable body, it is feasible to recover pressure values at check areas utilized in genuine testing, which can be utilized to work out exhaustion life of welds which is of most extreme interest to the planner [4]. Moreover, it is feasible to create load cases for point-by-point static examination from the response force yield [5]. The pressure results at measure areas are contrasted and both genuine testing and static FEA by other business programming. It is additionally significant that in the ongoing reenactment, numerous suppositions in comparable past recreations are refreshed [6-7] with genuine qualities from field tests, similar to container tip force. Universally useful multibody elements investigation programming like MBDyn (Multibody Elements) has been created at Politecnico di Milano. MBDyn empowers us to mimic complex mechanical frameworks like vehicle suspensions, robots, and wind turbines and study their movements and powers. The film underneath shows an illustration of a robot arm reenactment with MBDyn. This is a straightforward robot arm model for demo. With MBDyn we can build a multibody framework model, for example, this and study its movements and powers without unequivocally figuring out complex conditions of movement. MBDyn has been grown basically determined by research. In any case, it has now been developed all around ok for modern use. In spite of the fact that MBDyn doesn't have its own pre-processor and post-processor as of now, its functionalities are strong. Notwithstanding the essential functionalities of multibody elements examination, MBDyn upholds many high level functionalities, for example, treatment of adaptable bodies as modular components, connect with regulator plan programming, and constant reproduction. One particular component of MBDyn is that it is outfitted with plentiful air versatile and water powered components because of its underlying foundations in aviation design research (particularly of rotorcraft and wind energy)

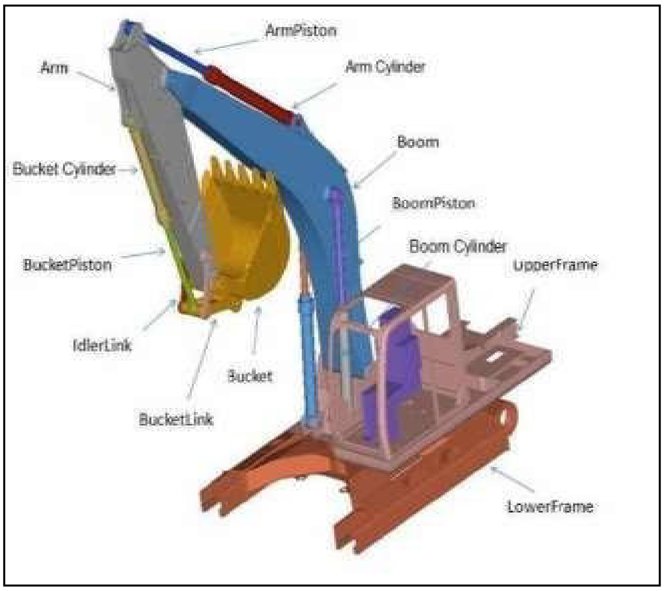


Fig. 1: various component of excavator

I. PROBLEM IDENTIFICATION

The functioning pattern of an earthmover comprises of digging, swinging, unloading and swinging back to the underlying position. The goal is to mimic the whole pattern of activity. A 30-ton pressure driven earthmover is utilized for this specific review. Last result wanted are the response powers at all joints and to assess the anxieties at all check areas.

- 3D Math or lattice information of each and every connection to be displayed in the gathering.
- Network information of parts to be broke down for pressure (adaptable body).
- Strain on chamber side and cylinder side of all chambers during pattern of activity.

- Stroke of all chambers during pattern of activity.
- Swing engine rotational speed during pattern of activity.

METHODOLOGY

An excavator consists of many links and joints, the analyst has to segregate the mechanism into different links and decide what kind of joints these links are connected with. The procedure to set up the problem is explained as follows. All the links of the mechanism are imported and assembled with appropriate joints in Creo Parametric. The lower frame is grounded. Both geometry and mesh files can be imported for rigid body simulation, but in case of flexible bodies, mesh files are required. Cylinder pressures are converted into forces and applied at respective bodies.
{Considering the Structural Steel as engineering material.}:

1) Earth moving equipment having displacement 5 mm in x, y, z directions considering the structural steel as an engineering material. Considering bucket load capacity of 23500 kg.
2) Earth moving equipment having displacement 5 mm in x, y, z directions considering the structural steel as an engineering material. Considering bucket load capacity of 28000 kg.
3) Earth moving equipment having displacement 5 mm in x, y, z directions considering the structural steel as an engineering material. Considering bucket load capacity of 36000 kg.

Liu Gong Excavator model no. 922D(HD) have following specifications: -

Engine	Cummins QSB 7
Gross Power	166 hp @ 2050 rpm
Max. Digging Depth	5,875mm
Bucket Capacity	$0.73m^3 – 1.2m^3$
Operating Weight	22,000 kg
Track Length	4456 mm (LC)

Table 1: Equipment Specifications

Earth moving equipment having displacement 5 mm in x, y, z directions considering the structural steel as an engineering material. Considering bucket load capacity of 23500 kg.

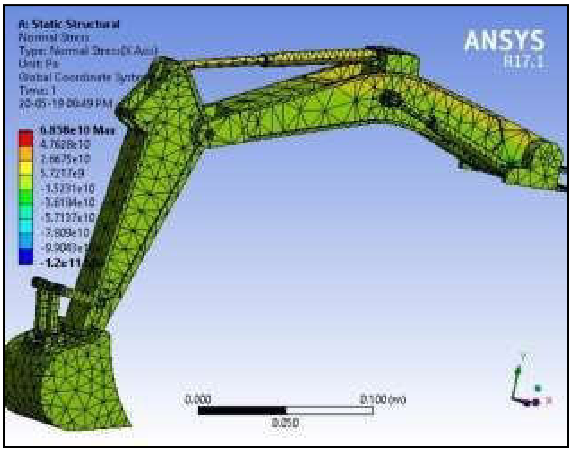


Fig. 2: meshing of excavator arm

Earth moving equipment having displacement 5 mm in x, y, z directions considering the structural steel as anengineering material. Considering bucket load capacity of 28000 kg.

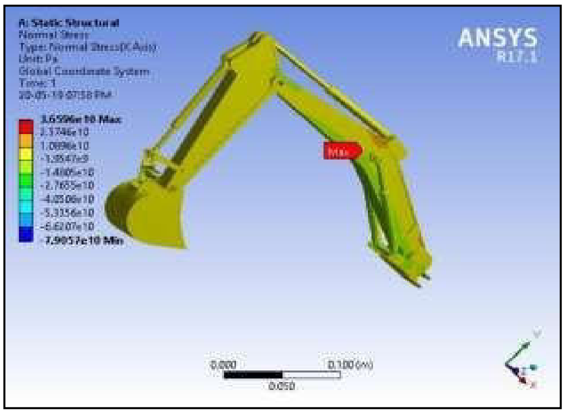


Fig. 3: results of analysis of excavator arm without vibration

Earth moving equipment having displacement 5mm in x, y, z directions considering the structural steel as anengineering material. Considering bucket load capacity of 36000 kg.

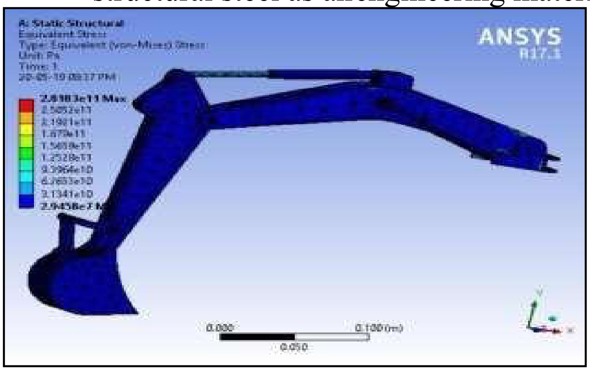


Fig. 4: results of analysis of excavator arm with vibration RESULT AND DISCUSSION

Liu Gong Excavator 922D(HD) is considered

The model of Excavator arm and bucket is made in Creo Parametric 2.0 and for analysis purpose of the bucket, IGES file is imported in ANSYS Workbench 17.1 and then the model is analysed further and various solutions were calculated (Von misses stress, Normal stress).

After analysis of “Liu Gong Excavator 922D(HD)” the main focus of the analysis is to increase bucket loading capacity with change in design if pin of the bucket. Hence, the following results are obtained: -

1) Excavator base having displacement of 5mm in x, y, z directions. And when the bucket loading is 23500 kg then the pin of the bucket is safe because the factor of safety provided by the company.
2) Excavator base having displacement of 5mm in x, y, z directions. And when the bucket loading is increased by4500 kg which means, now the operating weight is28000 kg then the pin of the bucket breaks because of the excessive stress on the pin. Which means our designwill fail if the bucket loading is more then it’s safe limits.
3) Now in this scenario we increased the thickness of the pin of bucket, which results in the more weight carryingcapacity of the Excavator bucket. We have increasedthe operating weight to 36000 kg and the Excavator is able to easily with stands that loading without breaking of the pin.

CONCLUSION

Computer aided design model of the earthmover is created in Cero Parametric 2.0 and this model is imported to ANSYS Workbench 17.1 for handling work. A Measure of burden
352 KN is applied along the periphery of the backhoe's container made of Underlying STEEL, and base have uprooting of 5mm in x, y, z headings. Following are the ends from the outcomes acquired:

1) Since von-misses stresses are not exactly a definitive strength, talking redirections into account, Underlying Steel is liked as great material for planning of tractor.
2) Excavator pail pin of various composite material can be made out like steel, aluminum compound, magnesium combination. titanium compound, manufactured steel wheel or the mix of the various materials, to expand the heap conveying limit of the pail

Table 2: quantitative outcomeACKNOWLEDGEMENT

STRESS	VIBRATION	LOAD (kg)	RESULT
Normal stress	5mm	23500	Pin safe
Normal stress	5mm	28000	Pin fail
Equivalent stress(von-mises stress)	5mm	36000	Pin safe

REFERENCE

[1] Azemi, Fatmir, Xhemajl Mehmeti, and Bekim Maloku. "The Importance of CAD/CAE systems in developmentof Product Design and Process of Optimization." (2018).
[2] Malo, Drissa Mohamed, Erol Uzal, Sagnaba Soulama, and Abdou-Salam Ganame. "Design and Finite Elements Analysis of a Hydraulic Excavator’s Robot Arm System." American Journal of Mechanics and Applications 7, no. 3 (2019): 35-44.
[3] Dang, Tri Dung, Tri Cuong Do, Hoai Vu Anh Truong, Cong Minh Ho, Hoang Vu Dao, Yu Ying Xiao, EunJin Jeong, and Kyoung Kwan Ahn. "Design, Modeling and Analysis of a PEM Fuel Cell Excavator with Supercapacitor/Battery Hybrid Power Source." 16, no. 1(2019): 45-53.
[4] Chumbale, Shilpa D., and Prasad P. Mahajan. "Failure Analysis and Optimization of Excavator Arm-A Review." IJSRD-International Journal for Scientific Research & Development 3, no. 02 (2015).
[5] Solazzi, L., A. Assi, and F. Ceresoli. "New design concept for an excavator arms by using composite material." Applied Composite Materials 25, no. 3 (2018): 601-617.
[6] Ramesh, G., V. N. Krishnareddy, and T. Ratnareddy. "Design and optimization of excavator." Int. J. Recent Trends Eng. Res. 3, no. 4 (2017): 535-549.
[7] Solazzi, Luigi, Ahmad Assi, and Federico Ceresoli. "Excavator arms: numerical, experimental and new concept design." Composite Structures 217 (2019): 60- 74

Proficient Dynamic Energy Recuperation Framework for Vehicle

Manik Pal Shah

Assistant Professor,

Department of Mechanical Engineering

JB Institute of Technology, Dehradun,

ABSTRACT

KERS is by and large used to speed up the running force of the four wheel drive in particular to the motor speed. This framework is for the most part deals with energy retention head when then, at that point, vehicle taking a turn as we realized there was a frictional contact was in the middle of between the four wheel drive and street surface consequently the there will be huge lost of dynamic energy which is then disseminated as an intensity to the climate to use this lost of motor energy this framework is utilized which clandestine this lost of motor energy into vehicle speed increase.

Keywords: Energy, Acceleration, Reservoir, Efficiency

INTRODUCTION

KERS is the inbuilt framework that assists with using waste intensity and dynamic energy during deceleration is first changed over into power then same energy is utilized to speed up the vehicle at a momentary point subsequently works on standard on speed increase with impeding rate. It serves and give a way to use squander heat implies it likewise work for using the illicitly disseminating energy this gadget recuperate motor energy introduced in the waste intensity made by the vehicle for the most part during slowing down process. UP to 88 BHM for 8.8 sec or 500 KJ of waste in power was put away. KERS manufacturers, Flybrid frameworks exhibited a functioning F1 gadget at the auto sport global show. However, numerous F1 groups went against it at it hushed up costly so it was prohibited in 2010 season. At 2011 North American Worldwide car exhibition ,Porsche 918 idea vehicle which utilizes a flywheel based KERS.A bike hustling organization KTM covertly tried this framework in their vehicle yet They were restricted as that framework was unlawful and unsound for cruisers.

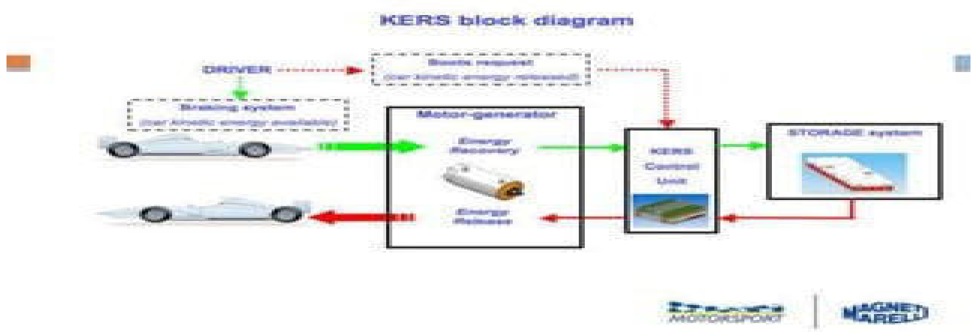


Fig. 1: Kinetic Energy Recovery System Block Diagram works on the basis of two basic cycle charge cycle and boots

WORKING PRINCIPLE

KERS is deals with the rule that it stores the motor energy during deceleration of the vehicle and same lost of dynamic energy is then changed over into ability to speed up the vehicle. For the most part when the vehicle taking a turn a driver applies a break and motor energy is lost because of grinding between the street surface and a wheel this lost of energy is utilized to boots vehicle speed. The standard KERS framework cycle during charge cycle when the speed of the vehicle is lessens as it takes a turns an actuator unit retain the waste intensity from the back slows down this put away energy is then gone through the focal having unit and into stockpiling unit. These units are situated midway to keep up with the position, adjusting and ground leeway of the vehicle.

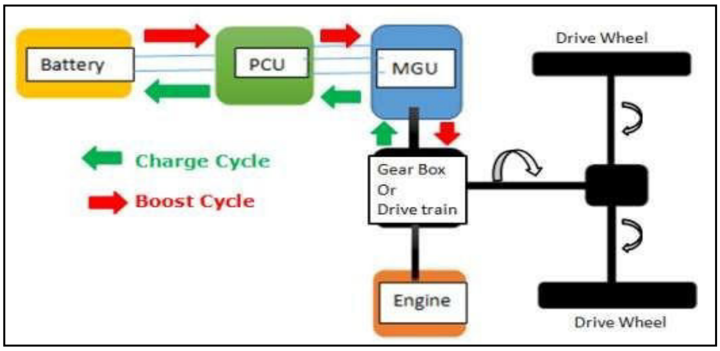


Fig. 2: working Principle

MECHANICAL KERS

The mechanical KERS is for the most part utilized the blend of flywheel, ceaselessly factor transmission framework (CVT), and a grip associated with CVT. Whenever the vehicle proceeding or when the speed of the vehicle is decreases the grasp is withdrawn and associated with the flywheel now the flywheel is turn up to speed of 60000 rpm and put away close to around 60-80 KW of energy now the grip is isolated from the flywheel and permit it to pivot as a solitary unit under this conditions the flywheel has a put away energy of 60-80 KW this energy id then given to the back tire or front wheel according to the necessity of the drive and once more the wheel speed is boots from a quick place of the vehicle as required. The mechanical KERS is chips away at the standard of regenerative slowing down as like an electrical engine is associated with the wheel drive it very well might be back tire or front wheel. At first the engine drives the wheel by outer sources and when the breaks are applied the engine shaft is turn in inverse bearing and goes about as a generator and produce an electrical energy this created electrical energy is then put away in the battery as substance energy and again supply back to the engine at whatever point there is the necessity is exist however while utilizing this framework there is constant exchange of energy from electrical to compound and from synthetic to mechanical which may decreases the enhancer to 30 percent and utilizing flywheel gives viable outcomes over engine.

Electrical KERS frequently utilized engine creating unit, power control unit and a battery thus it is extremely savvy as contrasted and mechanical dynamic energy recuperation and on the off chance that an investigate their efficiencies, the electrical KERS is exceptionally successful then the mechanical KERS and on the off chance that we consider plan installation of both, mechanical KERS is fairly cumbersome then the electrical as the whole framework is set at the focal point of the vehicle body it assists with improving and kept up with the adjusting and ground leeway of the vehicle body.

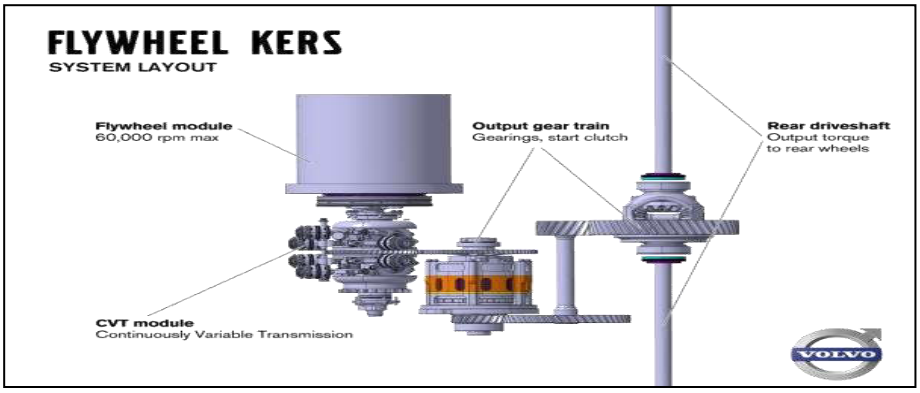


Fig. 3: Mechanical KERS

ADVANTAGES

1) High power ability.
2) Good efficiency.
3) Proper adjusting and ground freedom to the vehicle.
4) Truly green arrangement.
5) Environment agreeable with less contamination.
6) Effective use and recuperation of waste energy.
7) Light weight and little size.
8) High effectiveness stockpiling and recuperation.
9) Long framework life up to 250000 kms.
10) Completely safe and ergonomically great.

CONCLUSION

Consequently the motor energy recuperation framework is exceptionally productive as it serves to using waste intensity and changing over something very similar into speed increase in this manner energy from the breaking framework was used successfully and same is then used to support its speed in this manner it additionally serves to diminished the exhaust outflow and fuel utilization is likewise decreased as the framework is developed at the focal point of the vehicle outline the body adjusting of the vehicle is likewise be kept up with which serves to kept up with the ground.

REFERENCE

[1] Chibulka J., (2009), "Kinetic Energy Recovery System by means of Flywheel Energy Storage", Advanced Engineering Vol. 3, No. 1, pp. 27-38.

[2] Siddharth K. Patil, (2012), "Regenerative Braking System in Automobiles", International Journal of Research in Mechanical Engineering & Technology Vol.2, pp 45-46.

[3] Ricardo Chicurel (2009), "A Compromise Solution for Energy Recovery in Vehicle Braking", International Journal of Research in Mechanical Engineering & Technology Vol.24, pp.1029-1034.

[4] Radhika Kapoor, C. Mallika Parveen, (2013), Member of IAENG, "Comparative Study on Various KERS",Proceedings of The World Congress on Engineering, Vol.3, pp.152-160.

[5] Siddharth K. Patil, "Regenerative Braking System in Automobiles", ISSN: 2249-5762 (Online), IJRMET Vol.2, Issue 2, May - Oct 2012.

[6] Radhika Kapoor, "Comparative Study on VariousKERS", Proceedings of the World Congress on Engineering 2013 Vol. III, WCE 2013, July 3 - 5, 2013, London, U.K.

[7] Sharma P., Bhatti T.S., "A review on electrochemical double-layer capacitors," Energy Convers Manage,2010.

[8] R. Johri, Z. Filipi, "Low-cost pathway to ultra efficiencycar: series hydraulic hybrid system with optimized supervisory control," SAE 2009-24-0065, 2009.

[9] T. Lin, Q. Wang, B. Hu, W. Gong, "Research on the energy regeneration systems for hybrid hydraulic excavators," Automation in Construction, vol. 19,pp.1016–1026, 2010

[10] Karden E, Ploumen S, Fricke B, Miller T, Snyder K., "Energy storage devices for future hybrid electric vehicles," Journal of Power Sources, pp.2-11, 2007.

Why Bio-diesel Not Popular in Indian Vehicles

Devesh Sharma

Assistant Professor,

Department of Mechanical Engineering

JB Institute of Technology, Dehradun,

ABSTRACT

This paper examines the factors that contribute to bio-diesel's lack of acceptance in Indian automobile applications. The manufacturing of bio-diesel and the development of automobiles that use it as fuel are both supported by the Indian government. Bio-diesel has beneficial effects on the environment that are safe, such as a decrease in the global warming. Even though the auto industry has invested a lot of time and money in researching bio-diesel vehicles, neither the media nor the general public give them the attention they deserve. The nation's goal for full self-sufficiency—a cornerstone of our energy security strategy—has made the development of bio fuels as a substitute and renewable energy source for transportation important. We will be able to achieve stricter emission regulations with the aid of environmentally beneficial bio-fuels like ethanol and bio-diesel. Experience from other countries has demonstrated the benefits of using ethanol and methanol as fuel for cars. The choice to mix 5% ethanol with motor spirit has already been made in a number of states because blends with less than 10% ethanol do not cause an issue and reduce hazardous emissions. A coordinated program of biomass usage for conversion to alcohol is required to achieve higher mixing, and this includes expanding the area used for cultivating sugar cane.

Introduction

It contains practically no sulphur, no aromatics, and has around 10% underlying oxygen, which assists it with consuming completely. Its higher cetane number further develops burning. Bio-diesel is similar to petroleum diesel in that it is an ethyl or methyl ester of fatty acids. Bio-diesel takes its place, much like HSD. Bio-diesel's specifications allow it to be mixed with any diesel fuel. Bio-diesel typically has a cetane number (CN) between 48 and 60 and a sulphur content of less than 15 parts per million. The amount of particulate matter in engines reduced by 25 to 50 percent in studies using bio-diesel. Be that as it may, a minor expansion in NO (1-6%) is likewise detailed; However, either optimizing the engine components or employing a De-NO catalyst can address the issue. HC and CO outflows were additionally answered to be lower. PAHs and other unregulated emissions were likewise observed to be lower. As a result, bio-diesel can add to the variety of eco-friendly fuels available here in the future. In regular diesel fills, the decrease in sulphur content is remunerated by the expansion of a fuel infusion siphon (FIP) grease added substance. Bio-diesel is answered to have fantastic lubricity.

The consistency of bio-diesel is higher (1.9 to 6.0 cSt) and is accounted for to prompt elastic development on the injector, chamber liner, and so forth. On the other hand, blends of up to 20% shouldn't be a problem. While a motor might be intended to utilize 100 percent bio-diesel, existing motors might utilize a 20% bio-diesel mix with no change and force decrease. In the United States, a bio-diesel blend of 20 percent is used, while blends of 5 to 15 percent have been adopted in Europe.

The bio-diesel's flash point is high (> 1000 C). Its mixing with diesel fuel can be utilized to increment the blaze point of diesel particularly in India, where the glimmer point of 35 °C is well underneath the world normal of 55 °C. From a safety standpoint, this matters.

It does not require a separate infrastructure because it can be stored in the same manner as petroleum diesel. In the United States, bio-diesel is accepted as a clean alternative fuel. Bio-diesel can be used as a fuel for diesel engines (either as B5 or B20 or B100, which is a mixture of 5% bio-diesel and diesel gasoline). USA utilizes bio-diesel B20 furthermore, B100, France involves B5 as obligatory in all diesels.

The following factors influence the production of bio-diesel in India for use in diesel blending:

- Bio-diesel is an earth preferable fuel over HSD;
- The utilization of bio-diesel becomes convincing as to the fixing of the car business vehicle discharge guidelines and lawful mediation;
- The need to guarantee energy security, particularly for rustic regions;
- The need to make occupations;
- Supplying the soil with nutrients and regulating soil degradation and erosion;
- Rebuilding of debased regions through greening;

Feasibility of producing bio-diesel as a replacement for diesel

It is not practicable to divert edible oil for use in bio-diesel manufacturing since global demand for edible oil exceeds domestic supply. Many different species of trees produce seeds that are rich in oil. It can be planted on fallow ground, on farmers' farms as agroforestry, on under-planted forest plots managed by J.F.M. committees, farmer field margins to produce protective hedges, and agricultural crops, public land adjacent to railroad tracks, highways, canals, and village-owned and community-owned land. It may also be planted as a part of initiatives to fight poverty that focus on enhancing the soil.

The country does not have any oil reserves, but it does have a lot of arable land, good climate (tropical), and it gets enough rain in many places to make a lot of biomass every year. It is not possible to use this oil to make bio-diesel because there is a greater demand for it than there is domestic production. Fortunately, inedible oil-seeds can be grown on a significant amount of degraded forest land, unused public land, field borders, and farmers' fallows. Oil-rich seeds are produced by a wide variety of tree species. From these, some encouraging tree species were assessed and it was observed that there are various them, for example, Jatropha carcass and Pangamic Pinnata (Honge or Karanja) which would be entirely appropriate in our circumstances.

Jatropha carcass bio-diesel's economics

Oil cake and glycerol, the by-products of jatropha seed bio-diesel, have high commercial value. These leftovers will depending on the price these goods may attain, the cost of bio-diesel can be reduced. The price of the seeds, their collection and oil extraction, their transesterification, and their transportation all contribute to the cost of diesel. Cost of transesterification-produced bio-diesel the cost of the seeds needed to transport the seeds and oil will be very close to the price of the oil produced from Jatropha carcass seeds. Because the cost of extracting the oil and transforming it into bio-diesel is recoverable, the cost of the bio-diesel produced by trans esterifying the oil obtained from the seeds of the Jatropha carcass plant will be very close to the cost of the seeds needed to produce the amount of bio-diesel largely as a result of ingesting by-products like oil cake and glycerol. Remembering these components, the cost of bio-diesel has been worked out expecting a seed cost of Rs. 5 for every kg, 3.28 kg of seed, yielding one later of oil and different side-effect costs. The cost of bio-diesel changes between Rs. 16.59 to 14.98 per later on the off chance that the cost of glycerol is between Rs 60 and Rs 40 for each kg.

Blending esters and diesel

Currently, the most popular method of making bio-diesel is by mixing conventional diesel fuel (DF) with esters of vegetable oils, often methyl esters. The most popular mix, known as "B20" for 20% bio-diesel level, is 80% conventional diesel and 20% vegetable oil ester. There have been multiple instances of these blends significantly reducing emissions. In larger-scale tests, including city bus fleets using the B20, no engine issues were recorded. Fuel usage was similar to that of DF2, with the consumption of the bio-diesel blend only being 2-5% higher. The ease of making fuel from bio-diesel blends, which simply requires mixing the components, is another benefit. Ester mixes have reportedly been found to be stable; for instance, a blend of 80% DF and 20% peanut oil did not separate at room temperature after three months. DF and peanut oil mixed 50:50 was also discovered to be quite stable. Blends of diesel and bio-diesel have been demonstrated in numerous experiments to reduce smoke opacity, carbon dioxide, carbon monoxide, unburned hydrocarbons, and particle emissions all decreased, but nitrous oxide emissions marginally increased. The tendency of bio-diesel to crystallize at low temperatures below 0°C is one restriction on its use. Vegetable oils' methyl and ethyl esters will separate from diesel at temperatures frequently encountered during winter operation. Such crystals may clog fuel filters and lines, impairing fuel pumping and engine performance. One-solution to this issue might be the utilization of spread chain-esters, for example, isopropyl esters. The isopropyl esters of soya-bean oil solidify 7 to 11°C lower than the corresponding methyl esters. One more strategy to 58 further develop the virus stream properties of vegetable oil esters is to eliminate high-dissolving immersed esters by inducing crystallization with cooling, a cycle known as winterization.

Bio-diesel storage

It is advised to keep bio-diesel in tanks that are clean, dry, and authorized. Despite the high flash point of bio-diesel, storage measures similar to those for storing diesel fuel must be adopted. Bio-diesel can be kept in closed containers with low headroom for extended periods of time, however the container needs to be shielded from low temperatures, direct sunshine, and weather. In colder climates, underground storage is preferred, but if items must be kept in the open, suitable insulation, heating, and other equipment must be provided. Depending on the blend's pour point and cloud point, B 20 fuel can be kept in above-ground tanks. Bio-diesel may gel at low temperatures.

Added substances can be utilized for low temperature stockpiling what's more, siphoning. The bio-diesel/its blends should be put away basically higher by 15 dig C that the pour point of the fuel. When splash blending the bio-diesel, extreme fuel temperatures should be avoided because the saturated compounds may crystallize and separate, resulting in fuel line and filter blockage. Buildup of water in the tank ought to be stayed away from as hydrocarbon-corrupting microorganisms and form can develop and utilize bio-diesel as food. When fuel contains water, bio-diesel and its blends are susceptible to microbe growth. Biocides are chemicals that, in low concentrations, kill bacteria and Molds that grow in fuel tanks. However, biocides do not remove sediments. Besides, capacity of bio-diesel in old tanks can release accumulated stores furthermore, sludge and can cause extremely serious channel and siphon blockage issue. For long haul Stockpiling steadiness of Bio-diesel and mixes satisfactory information are not accessible. In view of involvement that far is suggested that bio-diesel can be store up to a most extreme period of a half year Some enemy of oxidant added substances are likewise utilized for longer times of capacity. Likewise periods are material for stockpiling of bio-diesel and its mixes in vehicle gas tank. The colour of the fuel and fitting will begin to change as the sediments develop. Use storage tanks constructed of steel, aluminium, or another material.

Treatment of Bio-Diesel

Vegetable methyl esters used in bio-diesel don't include any volatile organic chemicals that could release harmful or unpleasant fumes. There are no chlorinated hydrocarbons or aromatic hydrocarbons (benzene, toluene, or azylene). No lead or sulphur exists to react and produce any poisonous or corrosive fumes. However, in the case of bio-diesel blends, there may still be significant emissions from benzene and other aromatics included in base diesel fuel. When in contact with the eyes, bio-diesel may irritate the eyes. To prevent splashes or mist on the face and eyes, wear safety glasses or a face shield. Firefighting procedures must be carried out in accordance with the fire hazard categorization. Burns may result from hot fuel. Gloves should be worn when handling bio-diesel because it might make your skin soft. Skin irritation that is mild can happen. According to German regulations, items are either classified as NWG (non hazardous to water) or WGK 1, WGK 2, or WGK 3 with increasing water danger. Methanol and bio-diesel are both categorized as WGK 1. The glycerine belongs to the same category.

Considering that bio-diesel has a high flash point and low vapor pressure (less than 1 mm Hg), there is no danger of vapor explosions. Large-scale bio-diesel spills may cause harm. While not totally safe for fish and crustacean larvae, bio-diesel is less dangerous than petroleum-based diesel fuel. In comparison to petroleum diesel, which contains highly hazardous chemicals including benzene, toluene, and azylene and is more water soluble (saturation concentration of 7 ppm in sea water and 14 ppm in fresh water at 17 deg. C), bio-diesel methyl esters have a relatively low solubility in water. However, the methyl esters generate a transient emulsion of tiny droplets when the bio-diesel is vigorously blended with water, which appears to be damaging to the swimming larvae. Vegetable methyl ester biodegrades around four days at 17 degrees Celsius, which is twice as quickly as diesel fuel. Testing in the lab revealed that rapeseed methyl After 23 days, the degradation of the food was 95% whereas that of the diesel fuel was only 40%. Compared to petroleum diesel, which contains more hazardous substances, any unintentional discharge or leak of modest volumes of bio-diesel should have little effect on the environment. Additional aromatics that are water soluble. The methyl esters can nevertheless be dangerous. Vegetable oil and animal fat spills are still viewed negatively by the EPA. It's unlawful to spill bio-diesel in water just like it is to spill gasoline. Laws should be reviewed to make sure that bio-diesel is included in the same class, if not already, and that it is treated the same as other petroleum fuels.

It is essential to take the proper handling measures, such as wearing gloves and eye protection, when using biocides to kill germs in the fuel tank. One must confirm whether the regulations for the disposal of petroleum products also apply to bio-diesel. Check to see if there are laws governing spill control and prevention for those who make or store bio-diesel. Animal and vegetable fat discharges have a physical influence on the environment that is far less than that of petroleum discharge since they do not produce carcinogenic chemicals and are actually biodegradable by microorganisms. However, excessive releases of vegetable oils, bio-diesel, and animal fats can have a detrimental effect on aquatic life. Comparing bio-diesel spills to petroleum oil spills, they are better. It is necessary to distinguish between vegetable oils and petroleum oil by separating animal fats and vegetable oils from petroleum oils and applying different standards based on the physical distinctions between the classes. Bio-diesel facilities and tanker vessels transporting bio-diesel continue to be controlled in the same way as if they were petroleum oil facilities or tanker vessels transporting petroleum oil. Currently, bio-diesel is controlled in the same way that animal fats, vegetable oils, and petroleum oils are controlled under oil spill laws and regulations.

Analysis of technologies with reference to Indian resources & requirements

India has a vast variety of plants and oil-seeds in its abundant and rich forest resources. If the government decides to employ these oil-seeds for making diesel fuel, the production of these oil-seeds can be increased significantly. The expense of transporting diesel across great distances to outlying markets in India as well as the price of crude oil determine the viability of bio-diesel from an economic standpoint.

Additionally, the cost of producing conventional diesel fuels will increase due to the rigorous rules on the aromatic and sulphur content in diesel fuels. Due to the comparatively high costs of vegetable oils, the manufacture of ethyl esters from edible oils is now substantially more expensive than that of hydrocarbon-based diesel fuels. If non-edible oils are used in place of edible oils for frying, the price of bio-diesel can be decreased. Neem, Mahua, Karanja, Babassu, Jatropha, and other non-edible oils are widely accessible around the world, including India, and are extremely affordable when compared to edible oils.

APPLICATION LIMITS FOR BIODIESEL

- Bio-diesel is an excellent solvent that can be used to clean the fuel tank, injectors, fuel system, and fuel lines. Albeit not a awful thing, it implies that the cleared gunk frequently gets unloaded into the fuel channel, which might obstruct and make harsh running or a drop in execution. Individuals frequently botch a straightforward fuel channel blockage as motor harm because of utilizing bio-diesel. On the off chance that an absence of speed increase or unfortunate running is experienced after around 300 to 1000 miles of utilizing bio-diesel, then, at that point, normally a fuel channel change is everything necessary. Once finished, it just requires changing at the typical stretches (it is intriguing to experience ensuing channel blockages after the underlying change over to bio-diesel).
- Because it reacts with the chemical additive that the ECU (engine control unit) periodically injects into the fuel system, bio-diesel by itself should be avoided in newer vehicles that have DPF (particulate filters) fitted. These vehicles can still run on a 50/50 blend of normal diesel and bio-diesel without experiencing any negative consequences.
- Pure bio-diesel should not be used in vehicles made before 1992 unless the rubber fuel components and fuel pipes have been replaced with more recent models (newer vehicles do not use rubber parts). Using bio-diesel for longer than a month may result in issues with fuel pumps, hoses, and O-rings, which could result in fuel leaks and seal issues. Rubber reacts with bio-diesel over time. Steel or sturdy rubber might be used in their stead, or corrosion can be lessened by utilizing a 20/80 mixture of conventional diesel and bio-diesel.
- Even though the majority of biodiesel is produced using natural gas, which is unavoidably a fossil fuel, methanol can be produced from biomass (such as wood) if needed. This goes somewhat against the idea that biodiesel is an entirely environmentally benign fuel, unless ethanol is utilized. Although some ethanol is created from petroleum, the majority is made from plants, thus technically using this in manufacturing is greener (albeit this is more challenging and not for beginners).
- Depending on the oil used, biodiesel may begin to harden at 4-5°C (40°F), which might cause difficulty beginning in cold weather. A 50/50 blend of conventional diesel and biodiesel should be used in the winter.

- There just aren't enough people using biodiesel at the moment to make it worthwhile for manufacturers to invest the time and money in conducting testing on their vehicles using this fuel. However, just because a car hasn't been given the go-ahead to operate on biodiesel doesn't guarantee that it won't run smoothly when you do. However, using biodiesel in a brand-new car that is still covered by the manufacturer's warranty is definitely not a good idea. If you do, at least make sure the fuel tank is filled with standard diesel anytime the vehicle is brought in for maintenance or warranty work.

Operating conditions in India

These various operational circumstances were taken into consideration in this study:

- Distinctive Road conditions
- Various Traffic situations
- Variations in combustion chamber design
- Varying altitudes Varying compression ratios
- Various load conditions
- Various speed scenarios
- Various injection techniques

Key causes of Non-Popularity of Bio-diesel

Changes to engine design

- piston rings and rubber reactions;
- water availability in the fuel;
- deposits and clogging;
- an increase in NOx;
- a lack of pumps;
- the need for more farmland;
- nickel plating of fuel lines and tanks.

CONCLUSIONS

Thus, it is evident that biodiesel made from non-edible oil is ideal for blending with diesel, namely HSD. It should be able to combine biodiesel in increasing proportions as its manufacturing capacity rises. Some of the actions that must be made to increase the acceptance of biodiesel among the nation's citizens are listed below:

- Petroleum-based goods distributors might be urged to provide biodiesel.
- The usage of biodiesel must be promoted to the public.
- Government will establish Free Engine service centres.
- Prices for diesel should be significantly higher than those for biodiesel.

REFERENCES

1. Singh Onkar, Yadav Ashok, “Investigations on diesel engine performance based on jatropha, karanja and neem biodiesels”, Proceedings of the Institution of Mechanical Engineers, Part A, Journal of Power and Energy, U.K., DOI: 10.1177/0957650912445016, Vol.226:pp 674-681 (2012).
2. Robert L. McCormick, Teresa Alleman, Aaron Williams, Yoshio Coy, Andrew Hudgins, and Wendy Dafoe, “Status and Issues for Biodiesel in the United States”, National Renewable Energy Laboratory, October 2009
3. Singh Onkar, Yadav Ashok and Kumar Naveen, “Evaluation of Energy Ratios for Karanja and Neem Biodiesel Life Cycles”, Samriddhi - Journal of Physical
4. richard l. ottinger ,”biofuels – potential, problems & solutions”, Sustainable Bioenergy: A Framework for Decision Makers, UN- Energy (April 2007) at P. 39.
5. Dr Ian J. Potter, “Biofuel Applications in Internal Combustion Engines” Biofuels: Policies, Standards and Technologies World Energy Council 2010.
6. Singh Onkar & Kumar Mukesh, “Study of Biodiesel as a Fuel for CI Engines and its Environmental Effects: A Research Review”, International Journal of Advances in Engineering & Technology, ISSN:2231-1963, Vol.5, Issue 2, Jan,2018, pp. 100-107.

Development of continuously cooled high strength bainitic steel through microstructural engineering at Tata Steel

Jitendra Kumar

Assistant Professor,

Department of Mechanical Engineering

JB Institute of Technology, Dehradun,

ABSTRACT

The strength of bainitic steels, which are changed at very low temperatures, derives from the nanostructured bainitic plates, while the ductility is provided by a thin coating of austenite sandwiched between two bainite sheaves. This structure's primary flaw is its lengthy transformation time, which makes it unsuitable for industrial use.

By carefully choosing the alloy composition and process factors, microstructural engineering allows for the manipulation of the extent and kinetics of transformation. The key difficulty is delaying transformation until the coiling step and allowing bainite production only during coil cooling. In the current work, a method that can meet the criteria to create a steel with 1300 MPa UTS combined with 20% elongation (min) will be demonstrated, starting with alloy design based on thermodynamics and ending with cooling after coiling.

Introduction

In an effort to lighten the weight of the entire vehicle, the use of ultra-high strength (UHS) steel sheet has multiplied recently. However, the UHS steel sheet is difficult to apply to a wide range of automobile components because to its poor formability. Therefore, a hot rolled thin steel sheet with high tensile strength (>1300 MPa) and high (>20%) elongation is required for use in automotive components like long and cross members, including bumpers.

In the existing documents, the process for making UHS-steel is described, and the main source of strengthening is provided by nanoscale bainitic ferrite sheaves. Although previous art technology can manufacture steel with the highest strength, it is highly challenging to economically produce these steels through hot strip mills and adapt them for use in automotive applications.

The steels either have a high carbon content, which makes welding difficult, can't be manufactured using a hot strip mill's continuous cooling transformation method, or have expensive alloying components, which makes the steel highly expensive.

The purpose of the current work is to develop a carbide-free bainitic steel strengthened by very fine bainite plates with a minimum tensile strength of 1300 MPa and the presence of at least 20% retained austenite in the final micro-structure to overcome the challenges of combining excellent ductility and high formability in hot rolled ultra-high strength steel sheet for automotive long and cross member applications.

Thermodynamical design

In order to create a carbide-free bainitic steel with a very high strength (>400 VHN), diffusional products such polygonal ferrite and cementite must be prevented from forming. The diffusional bay of the time-temperature-transformation (TTT) diagram needs to be moved to the right side so that even at a modest cooling rate, ferrite does not form. This is necessary to prevent the potential creation of another high temperature diffusional product called polygonal ferrite. The notion of the potential time-temperature combination for diffusional and displacive transformation was obtained using the MUCG83 program.

A key idea in bainitic transformation is T_0. On a temperature versus carbon concentration map, it shows the location of all the locations when stress-free austenite and ferrite with the same composition (in terms of both interstitial and substitutional alloying elements) have the same free energy. Until the carbon concentration in the residual austenite approaches its theoretical limit, which is specified by the T_0 curve, the bainitic transformation can advance by the sequential nucleation of sub-units of bainitic ferrite. It results in the conclusion that the retained austenite carbon concentration, which cannot exceed the limit set by the T_0 curve, limits the maximum quantity of bainite that may be generated at any given transformation temperature.

Since the volume fraction of bainite can be theoretically anticipated from information of the composition of the steel, it is theoretically possible to predict the toughness/ductility behaviours of bainitic steels composed entirely of bainite and retained austenite. A minimum of 20% austenite must remain in the micro-structure following transformation in order to produce a minimum of 20% elongation. Regions of untransformed and residual austenite following the isothermal bainitic transformation may undergo martensite transformation upon additional cooling or quenching. This type of austenite has a blocky morphology and appears triangular in two-dimensional sections.

The sources of strengthening are severely constrained in a micro-structure where austenite and bainite are the only constituent phases. The steel can gain its strength from the solid solution strengthening of austenite and bainite, from the dislocations produced during the isothermal bainitic transformation, and from the very fine plates of bainites. Following Bhadeshia, the theoretical strength of this type of micro-structure can be stated as

$$\sigma = \sigma_{FE} + \Sigma\, \sigma_{ss,i} + \sigma_c + K_L\,(L_3)^{-1} K_D\, \rho_D^{1/2} + K_P\, \Delta^{-1}$$

where K_L, K_D, and K_P are constants, Fe is the strength of pure annealed iron, $\sigma_{ss,i}$ denotes the solid solution strengthening caused by substitutional solute i, σ_c denotes the solid solution strengthening caused by carbon, L_3 denotes the thickness of the bainitic ferrite plate, ρ_D denotes the dislocation density, and Δ denotes the separation of any carbide particles. The last term won't be relevant for bainitic steels free of carbides; hence it won't be taken into account when determining the ultimate strength.

A specific chemistry (Table 1) was chosen for the final testing while taking into account all the conditions listed above. Fig. 1 displays the computed TTT diagram for this particular grade. This figure demonstrates that the diffusional bay can be avoided with a minimum cooling rate of 20°C sec^{-1}, which is typical of any hot rolling mill. The operating window for performing the process to produce bainite is rather large due to the difference between B_s and M_s temperatures. The production of bainite, which is indicated by the T_0 curve shown in Figure 2, where nearby austenite becomes enriched with C as a result of the rejection of C from bainitic ferrite, will further suppress the M_s.

As demonstrated in Fig. 2, the enrichment of C in austenite increases as the transition temperature decreases. Therefore, it is anticipated that all of the austenite will be preserved until the end of the bainitic transition. After hot rolling and continual cooling to room temperature, it was predicted that there would be about 20% austenite left behind, which would result in an elongation of more than 20%. The calculated overall strength of the planned steel can reach over 1500 MPa, with the ultra-fine bainite plates (80-120 nm,) and the dislocation density, which was estimated to be in the range of 4-6 x 10^6, serving as the main sources of strengthening.

Experimental procedure

At Tata Steel's R&D Division, a 25 kg heat was produced using an air-induction furnace using the chemistry shown in Table 1. The cast steel was then forged to a 40 mm thickness and homogenized for 48 hours at 1100°C. After then, laboratory scale rolling with coiling simulation was used to conduct hot rolling investigations.

X-ray diffraction analysis, TEM, and optical microscopy were used to describe the final micro-structure. 2% natal was used as an etchant and the typical polishing procedure was utilized for the optical microscope. The Rietveld refinement was followed by quantitative XRD analysis. Tensile samples were created in accordance with the guidelines outlined in ASTM E80 for sub-size samples in order to evaluate the mechanical properties.

C	**Si**	**Mn**	**Cr**	**Ti**	**Cu**	**V**	**Nb**
0.21-0.38	1.2-2.0	1.0-3.5	0.5-2.5	0.00-0.09	0.00-1.30	0.00-0.02	0.00-0.02

Results and discussion

The optical and TEM images of the freshly created, hot rolled, and constantly cooled steel are shown in Figure 3. Figure 3a displays the primarily bainitic micro-structure, while Figure 3b depicts the extremely dislocated and ultra-fine bainite plates. The thicknesses of the bainite plates are in the range of 100-150 nm, as can be observed in Fig. 3b, which is in good agreement with the preliminary calculations.

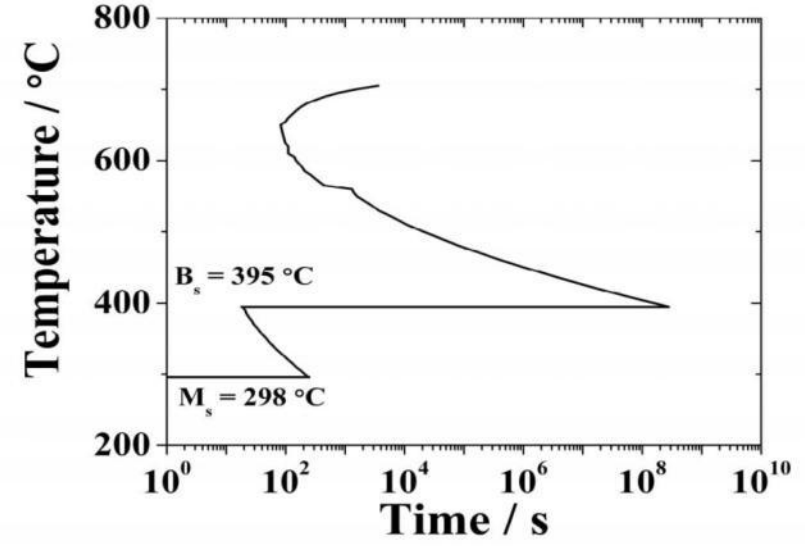


Figure 1 Calculated TTT Diagram

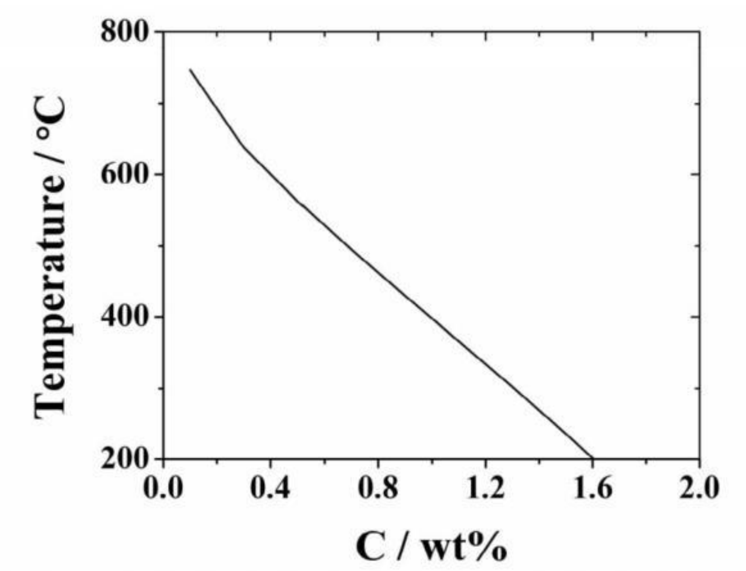


Figure 2 Calculated T_0

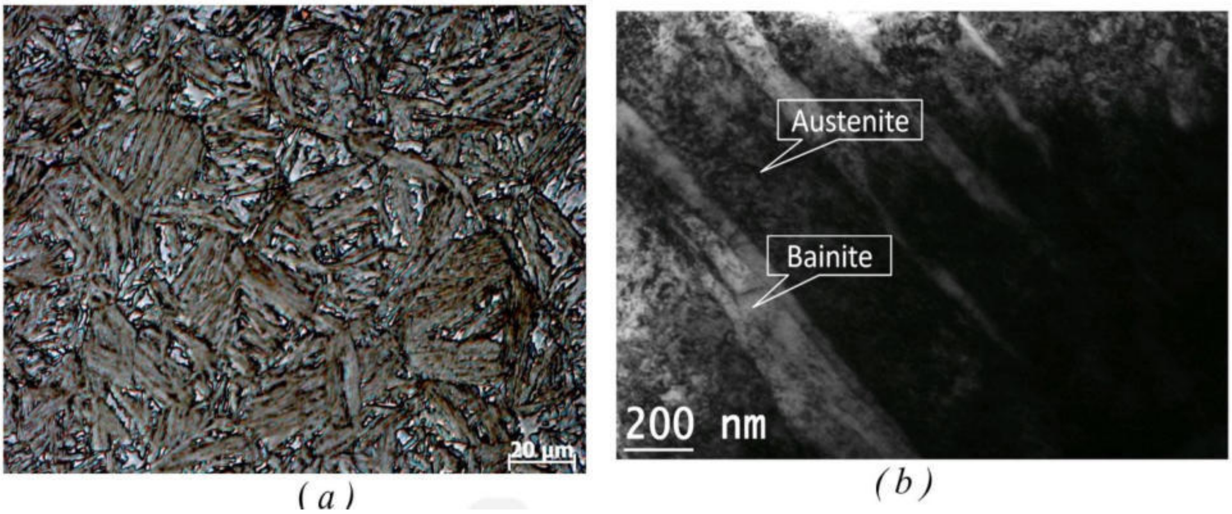


Figure 3 Micro-structures of the new steel. Optical microscope (a) and TEM photograph (b)

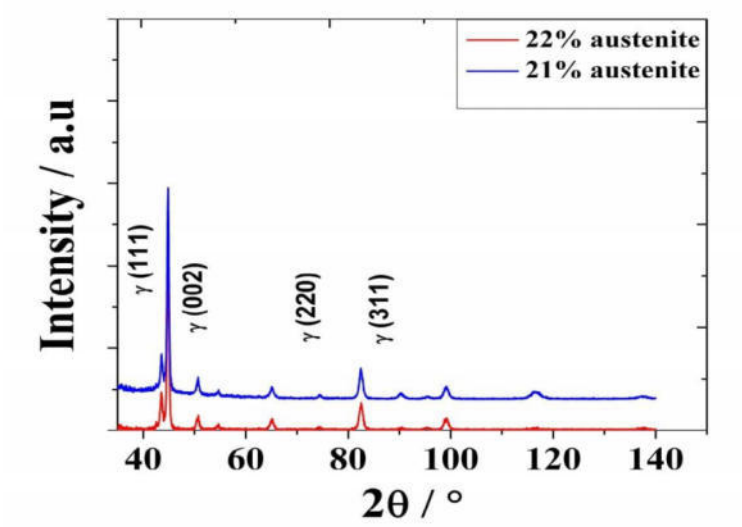


Figure 4 Intensity-2ϴ plot after XRD experiment

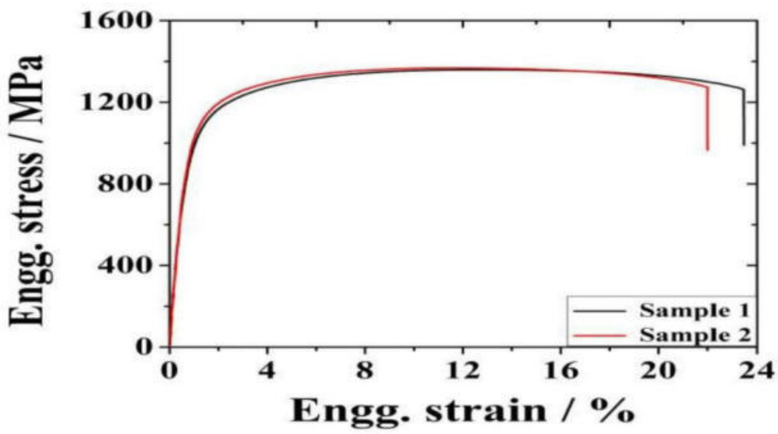


Figure 5 Tensile stress-strain plot

The sample's XRD analysis is shown in Figure 4. The research shows that after processing, there was >20% preserved austenite in the micro-structure. The newly produced steel has YS: 950 MPa, UTS: 1360 MPa, uniform elongation: 11%, and total elongation: >22%, as shown in Fig. 5's tensile stress-strain diagram. Such an excellent elongation is exceptional when the strength level is taken into account.

CONCLUSION

The current work exhibits the approach of influencing the kinetics of phase change and microstructural engineering to produce ultra-high strength materials with exceptional ductility.

REFERENCES

1. F. G. Caballero, M. J. Santofima, C. Garcia Mateo, J. Chao and C. Garcia de Andres, Materials and Design, Volume 30, pp. 2077 – 2083, 2009
2. http://www.msm.cam.ac.uk/phase-trans/
3. H. K. D. H. Bhadeshia and D. V. Edmonds, Acta Metallurgica, Vol. 28, 1980, 1265
4. H. K. D. H. Bhadeshia, Bainite in Steels, 2nd edition, The Institute of Materials, London
5. H. K. D. H. Bhadeshia and D. V. Edmonds, Metallurgical Transactions A, Vol. 3, pp . 895, 1979.
6. S. B. Singh and H. K. D. H. Bhadeshia, Materials Science and Engineering A, Vol. 245, pp. 72 – 79, 1998
7. S. Das, Internal Project Report Number: R & D Report / 52 / 10, R & D Division, Tata Steel, 2010
8. R. A. Young, The Rietveld Method, Oxford University Press, New York, 2002
9. H. K. D. H. Bhadeshia, Materials Science and Engineering - A,Volume 481 – 482, pp. 36 – 39, 2008;
10. F. G. Caballero, H. K. D. H. Bhadeshia, K. J. A. Mawella, D. G. Jones and P. Brown, Materials Science and Technology, Volume 18, pp. 279 – 284, 2002;
11. C. Garcia-Mateo, F. G. Caballero and H. K. D. Bhadeshia, ISIJ International, Volume 43, pp. 1238 – 1243, 2003

Plan and Streamlining of Truck Burden Body

Devesh Sharma

Assistant Professor,

Department of Mechanical Engineering

JB Institute of Technology, Dehradun,

ABSTRACT

This Paper features the improvement of Truck industry which is a significant wellspring of transportation. With a typical truck going around 300 kilometers each day, each kilogram of truck weight is of worry to the business to get the best out of the truck. The primary target of this task is to expand the payload limit of car truck load body. Each kilogram of expanded vehicle weight will diminish the vehicle payload limit thusly expanding the assembling cost and lessening the efficiency by expansion in the fuel utilization. With the intension of weight decrease, standard truck body has been planned in Catia V5-21 and examined in ANSYS programming. At the underlying stage we are utilizing both C-Segment radiates and regular rectangular box segments to decrease the heaviness of the body. We are utilizing Underlying Steel and Light-weight Aluminum combination Al 6061 T6 material by contrasting the two properties utilized with increment the payload limit. The strength of the Truck stage is observed with regards to distortion and stress focus. These boundaries will be gotten in primary examination test condition climate. Likewise essential changes are done so the improved model has a superior pressure conveyance and a lot lesser weight contrasted with the ordinary model. The outcomes acquired by examining adjusted model are contrasted and standard model.

Keywords: Truck Load Body, Analysis, Payload Capacity, Modified Model, Standard Model, Optimization

INTRODUCTION

A. Transport industry assumes an essential part being developed of present-day industrialized nations economy. The complete load of the heap carried on the truck has been expanding radically. The present troublesome test of transport vehicle is to satisfy the rising need for better execution, not so much weight but rather more unwavering quality. This model needs to accomplish in brief term of time. There is an extensive spotlight on plan of the truck body, for expanding payload limit. Substitution of rectangular cross area radiates with C-cross segment radiates; utilization of Aluminium amalgams rather than underlying steel will be the plausible answers for expanding payload limit of the truck. With the utilization of aluminium, the strength of the truck decreases, which can be increased by utilizing the idea of light emissions strength?

B. Objective: The Main Objectives of the Work is:

- The principal objective of this study is to build the payload limit of the car truck.
- Contrasting Details of Standard Burden Body and Adjusted Burden Body
- To diminish pressure, focus by utilizing idea of light emissions strength.

C. Methodology:

- Geometric modelling of the models in Catia V5-21.

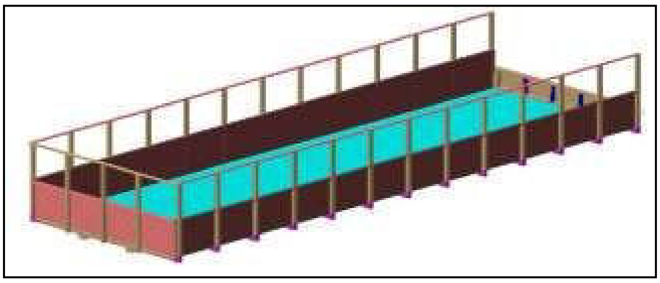
- Meshing and Analysis of the models at various tons.
- After analysing the models, a third model is developedand analysed.

PROBLEM DESCRIPTION

A. Today there is request on trucks, on the expense and weight perspectives as well as on the superior complete vehicle highlights and by and large work execution. Notwithstanding this number of variations that are conceivable because of various kinds of plans and modularization, require a few plan emphases to show up at a reasonable blend. The undertaking work manages load/dump body. There is significant extension to work on the plan of their item. For advancement of dump body plan, one standard model is taken from the nearby business.

B. Design Parameters Details:

Load capacity of the truck	15 tons
Length of the truck body	75338mm
Width of the truck body	2316mm
Height of truck body	2297.2563mm
Bottom Floor thickness	2mm
Side guard thickness	2mm
Head board thickness	2mm
Material of the truck body	Structural Steel
Side vertical members on both sides	13 (thickness=4mm)

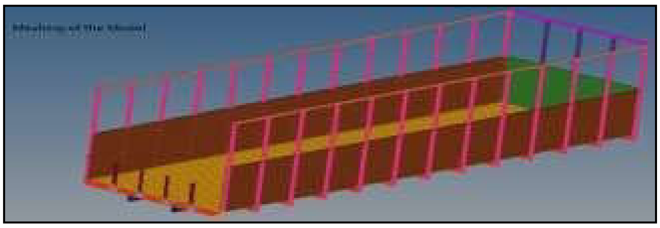


Geometric Model of Standard Load Body

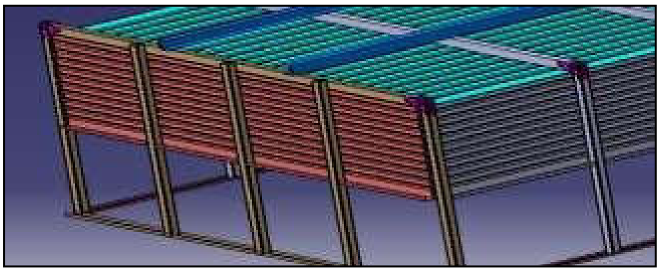
C. Properties of Structural Steel:

Modulus of Elasticity (GPa)	200
Yield Strength (MPa)	250
Ultimate Tensile Strength (MPa)	460
Poisson's ratio	0.3
Density (kg/m^3)	7850

D. Meshing of the Model:



E. New model with C-Beam:



F. Properties of Aluminium 6061 T6

Modules of Elasticity (GPa)	68.9
Yield Strength (MPa)	276
Ultimate tensile strength (MPa)	310
Fatigue strength (MPa)	96.5
Poisson's ratio	0.33
Density (kg/m³)	2700

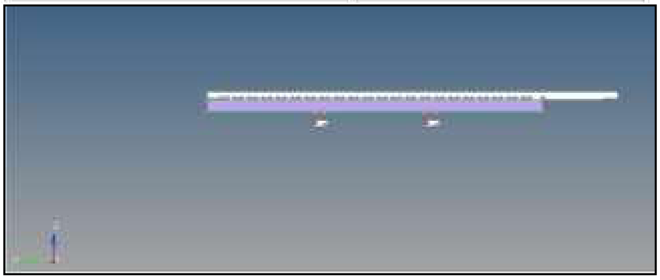


Fig. 1: Boundary Conditions

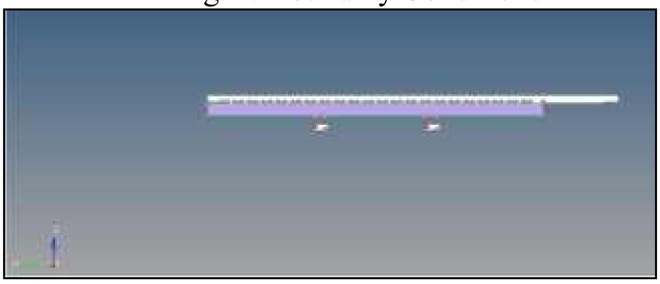


Fig. 2: Loading Methodology

The boundary applied to the model such that the fixed supports had given to the longitudinal bars at the bottom of the truck body, as shown in the figure. Since the longitudinal bars are placed on the chassis frame, so the Ux, Uy, Uz are taken as zero displacement.

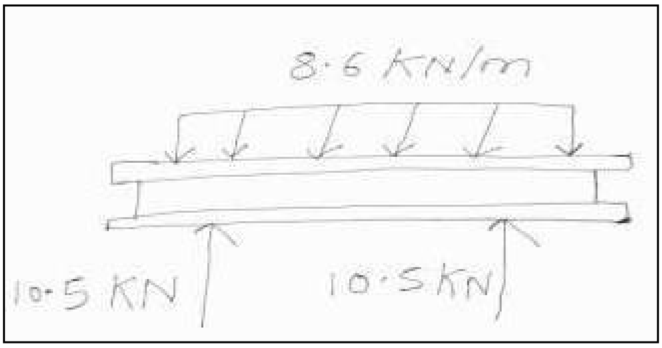
The modelled Truck body is loaded by transferring the forces from material it carries. The main load bearing elements of the truck body are floor, head board, and side guard. The side guard and head board are designed in such away that, it will carry the part load when the braking, turning, travel on the slopes.

- Floor : 100% of Load carried
- Side wall : 15% of Load carried

– Front wall : 15% of Load carried

I. CALCULATION

1) The truck has the capacity of carrying load up to 15tons.
Force exerted = 15000*9.81 = 147150 N.
So there are 13 members so force acting on eachmember = 147150/13 = 11319.23 N.
σt= F/A=6.6 N/mm^2



∑fy=0 Ra=10.5 KN Rb= 10.5 KN

By Bending Flexural formula,

$$\sigma_b = \frac{M}{I} \times y = 28.34 \text{ MPA}$$

Allowable Stress,

$$\sigma_a = \sigma_y / FOS = 207 \text{ MPA}$$

Beam of Constant strength of modified model

$$y = \frac{27.4 \times 83806635}{(34x^2 - 3722.1x + 2672628.6)}$$

A. Solution

1) Model 1-A (Iteration 1)

The Standard Truck body with Structural Steel as a materialis loaded for different loads such as 10,15,20 tons.

2) Model 1-B

To increase the payload capacity the light weight material inautomotive applications such as aluminum can be used.

Now the Standard Load Body with Aluminum alloy as amaterial is tested for different loads such as 10,15,20 tons

3) Model-2 (Iteration 2)

The standard truck body consists of rectangular cross section longitudinal beams at the bottom. Here the rectangular cross section beams are replaced by cross section beams. The weight of the truck will be reduced to some extent which leads to increase in payload capacity.

4) Model 2-A

Model 2-A represents the modified model having the C- Cross section longitudinal beams with structural steel as a material. The model is tested under different loads as 110,15,20 tons.

5) Model 2-B

Model 2-B represents the modified model having the C- Cross section longitudinal beams with aluminum alloy as a material. The model is tested with load conditions of 10,15,20 tons.

6) Model -3 (Iteration 3)

From the literature to reduce the stress concentration of the aluminum truck the concept of beams of uniform strength is used. The strength of the beam is dependent on the cross section of the beam. The concept of beams of uniform strength is the varying cross section which reduces the stress concentration by maintaining the constant bending moment.

B. Observation

The following table shows the weight of the different models:-

Model 1-A	1396.6 kg
Model 1-B	1252.63 kg
Model 2-A	1355.7 kg
Model 2-B	1239.2 kg
Model 3	1082.1 kg

Results for 10 tons load:

Model	Equivalent stress (MPa)	Total deformation (mm)
Model 1-A	75.4	0.5
Model 1-B	74.4	1.8
Model 2-A	48.6	0.6
Model 2-B	48.03	2.01
Model 3	37.6	1.8

Results for 15 tons load:

Model	Equivalent stress (MPa)	Total deformation (mm)
Model 1-A	112.6	1.1
Model 1-B	111.1	2.8
Model 2-A	72.3	1.01
Model 2-B	71.6	2.02
Model 3	56.01	1.8

Results for 20 tons load:

A		
Model 1-B	150	2.8
Model 2-A	97.7	1.3
Model 2-B	97.8	3.2
Model 3	76.3	2.8

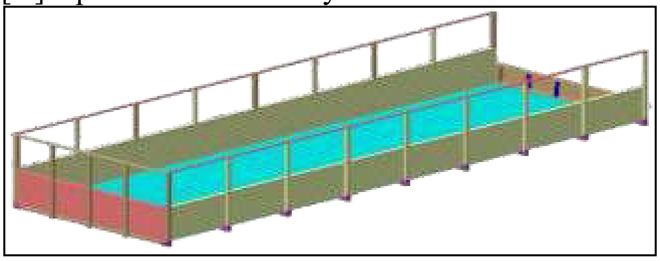
for 25 tons load:

Model	Equivalent stress (MPa)	Total deformation (mm)
Model 1-A	171.01	1.5
Model 1-B	166.3	3.7
Model 2-A	122.5	1.7
Model 2-B	120.4	4.3
Model 3	95.1	3.7

Payload Capacity of different models:

Model	Increase in payload capacity	% Increase in payload capacity
Model 1-A	-	-
Model 1-B	1.01	10.6
Model 2-A	0.3	0.3
Model 2-B	1.01	10.2
Model 3	0.8	8.6

[X] Optimized Load Body with C-beam:



C. Results and Discussion

- The Model 1-A is the standard truck having the originaldimensions and structural steel as a material considering the FOS=2 having the allowable yield strength 125 MPa has failed at 20 tons. This is because of at 20 tons load the equivalent stress is more than the allowable yield strength. The deformation is 1.2mm andthe weight of the truck is 1.6 tons.
- The model 1-B also tested under the same loads it is also failed at 20 tons because of the equivalent stress 150 MPa is more than the allowable yield strength 137 mPa. The deformation is more than the Model 1-A but the payload capacity is increases by 1.01 tons.
- Model-2A is tested under the loads of 10, 15, 20, 25tons load. The model is safe even at 25 tons, but the deformation is quite higher than the Model-1A at 20 tons. Here the increased payload capacity is 0.3 tons.

Model	Equivalent stress (MPa)	Total deformation (mm)
Model 1-	152	1.2

- Model 2-B has increase in payload capacity of 1.1 tons which is more than the previous models. The model is having the load carrying capacity of 25 tons keeping theminimum FOS=2 because the equivalent stress 120.4 MPa is less than the allowable yield strength 137 MPa of the aluminium alloy.
- The Model-3 has the increase in payload capacity of 0.8tons. The equivalent stress is less than all models at the respective loading conditions, which is desirableone. The deformation also less than the Model-2B. Comparing all the models of truck body the model-3 has the best result in terms of equivalent stress and total deformation.

D. Cost Analysis

Cost per kilogram of Structural Steel = Rs. 25 Cost per kilogram of Aluminum 6061 = Rs. 300

1) Model 1-A

Weight of Structural Steel Body = 1396.6 kgMaterial Cost= 1396.6*25 = Rs. 34915

2) Model 1-B

Weight of the Body = 1252.6 kg

Material Cost = 1252.6*300 = Rs. 375780

3) Model 2-A

Weight of the Body = 1355.7 kg Material Cost = 1355.7*25 = Rs. 33892

4) Model 2-B

Weight of the Body = 1239.2 kg

Material Cost = 1239.2*300 = Rs. 371760

5) Model 3

Weight of the optimized Body = 1082.1 kgMaterial Cost = 1082.1*300 = Rs. 324630

Cost difference for building a Baseline model and optimized model (Model-4) of body = Rs.176500. For every100 kg reduction in weight of a truck, the fuel efficiency increases by 0.5L per every 100 km.

By considering the model-4, a total of about 314 kgof weight reduction is obtained, so the reduction of fuelconsumption is 3.1*0.5 Liters per 100 km i.e., 1.55 Litersper 100 km.

Overall cost reduction when the truck fittedwith optimized Body runs for 100 km = 1.55*55 = 82.5 Rs. Number of kilometers the truck has to run to compensate theincreased price = (289715/82.55) *100= 46915 km.

On an average a truck travels about 300 kilometers per day, taking this into account, the number of days required to recover the extra money invested in aluminum body = 46915/300 = 156 days which is approximately equal to 5 and half months. After this period, for every 100 km runof the truck the owner gets an advantage of Rs. 201

CONCLUSION

- The Aluminum combination truck body with rectangular cylinder stiffener (Model 2B) of 4mm thickness for side wall has further developed payload limit by 1.01 ton, and the same pressure 120.4 MPa for 25-ton limit contrasted with standard model.
- The Aluminum combination truck body with uniform strength radiates (Model-3) has the rising payload limit of
0.8 tons, and the same pressure 95.1 MPa at 25 tons stacking condition.
- Out of these two models Model-3 has the improved outcomes regarding identical pressure and all out misshaping.
- The expense of aluminum amalgam body is very high. Cost examination has done to make sense of the Breakeven point, that is following five and half month the upside of the aluminum body can be accomplished.

REFERENCE

[1] N Nagendra Kumar, B Jithendra, Malaga Anil Kumar 2013 Optimization of Weight and Stress Reduction of Dump For Automotive Vehicles Int. J. Eng. Res. Technol. 2 (2013) 2278 0181.

[2] B Raghavendra Prasad Nayak, Ch Sambaiah 2012 Design and Analysis of Dumped Body Int. J. Mech. Indus. Eng. 2 (2012) 2231-6477.

[3] Bhaskar C V, Rangaswamy H, Imran Ali M R 2015 Optimization of Load Carrying Capability of Tipper Truck Cargo Body Using Non-Linear Structural Analysis Int. J. ign. minds 2 (2015) pp 60-64.

[4] S.Timoshenko and D.H.Young, Engineering Mechanics, McGraw-Hill International publication 4th edition.

[5] Mauritz Coetzee Axis Developments Ltd., Pretoria, South Africa, Heavy-Duty Lightweight, ANSYSAdvantage, Volume I, Issue 2, 2007.

[6] Sankararao Vinjavarapu, Unnam Koteswararao and V Lakshmi Narayana 2012 Design Optimization of Tipper Truck Body Int. J. Eng. Res. Dev. 4 (2012) pp 11-20.

[7] K Radhakrishna, S Srinivasa Rao, B Sudhakara Rao 2015 Design and analysis of Dump Body on Three wheeled auto vehicle Int. J. Cyb. Info. 4 (2015) pp 65- 73.

[8] R K Rajput 2006 Strength of materials S Chand, 2006