INTELLIGENT ELECTRICAL SYSTEMS

Dr. V Joshi Manohar
Pradeep Kumar Verma

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CONTENTS

Chapter 1. Role of Education in Future with Modern Technologies 1

— Dr. V Joshi Manohar

Chapter 2. Renewable Energy harvesting using Piezoelectric install at Railway Platform with Artificial Intelligence 10

— Dr. Jisha L K

Chapter 3. Use of Artificial Intelligence and Microcontrollers in Solar-Wind Hybrid Power Generation System 20

— Mr. K Sreekanth Reddy

Chapter 4. Protection System for Universal Motor Using Internet of Things 29

— Mr. Ravi V Angadi

Chapter 5. Micro Hydropower Generation and Distribution Using Artificial Intelligence 38

— Mr. Bishakh Paul

Chapter 6. Microcontroller Based Electrical Power Theft Monitoring System 48

— Ms. Priyanka Ray

Chapter 7. Microcontroller-Based Substation Monitoring and Control with Artificial Intelligence ... 58

— Ms. Priyanka Ray

Chapter 8. Design of an Automatic Irrigation System Using Soil Moisture Content and Arduino Uno Microcontroller 67

— Mr. Sunil Kumar A V

Chapter 9. Brief Analysis of the Fire Alarm and Fire Detection Model Which Made with Multiple Logic and Sensors 76

— Mr. K Sreekanth Reddy

Chapter 10. Smart Home Electric Energy Management System with the Internet of Things (IoT) ... 84

— Mr. Ravi V Angadi

Chapter 11. Analysis of the Internet of Things Based Smart Cities and Its Advantages 93

— Pradeep Kumar Verma

Chapter 12. Dual Axis Solar Tracker for Monitoring Power with the help of Internet of Thing (IoT) 102

— Umesh Kumar Singh

Chapter 13. An Optimize Design of an Electrical Substation Earthing System and Monitoring with a Wireless Sensor Network (WSN) 111

— Garima Goswami

Chapter 14. Comprehensive Review of DC Motor and Measurement of Its Speed Using High-End Microcontroller 121

— Shubhendra Pratap Singh

Chapter 15. An Approach for Digital Signal Processor Based Motor Control System..... 130
— *Shashank Mishra*
Chapter 16. Implementation of Artificial intelligence in Power Station..... 139
— *Mayur Agarwal*
Chapter 17. Artificial Neural Networks (ANN) in Process Control..... 149
— *Diwakar Pathak*
Chapter 18. Implementation of Artificial intelligence in Power Station..... 158
— *Ms. Priyanka Ray*
Chapter 19. Microprocessor Based Motor Speed Control of Direct Current (DC) motor..... 168
— *Umesh Kumar Singh*
Chapter 20. Arduino-based Smart Home Security System..... 177
— *Garima Goswami*
Chapter 21. Automation Vehicle Accident Detection and Messaging System..... 185
— *Mayur Agarwal*

CHAPTER 1

ROLE OF EDUCATION IN FUTURE WITH MODERN TECHNOLOGIES

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ABSTRACT:Technologies may assist and improve education in a number of ways, from making it easier for lecturers to create educational content to allowing learners to study and contribute in new ways. Learners can have quick access to information, learn faster, and practice what they've acquired in an engaging way thanks to technology. Technologies have changed the field of education and plays a significant role in all aspects of life. This research focuses on the Role of education in future world with the help of modern technologies. The author also depicts the positive impacts of technology in education system in this research. The data for this study is gathered through the responses from the respondents (Students and Educators) with the help of online survey. The results conclude that, by the utilization of technology in their learning it will assist the students and educators to make their learning easier.In coming days, the education system will be shaped in large portion with the use of technological advancements and with these modern technologies, students will be more active and smarter than they are now.

KEYWORDS:Education Systems, Learning, Modern Technologies, Online Course, Students.

1. INTRODUCTION

With increased connectivity as well as technological advancements it encourages advanced creativity and thinking due to which the sector of education has shifted rapidly in recent decades.Virtual classes, adaptive technologies in classrooms, as well as internet access for parents and students are all evolving to meet this "new normal" in schools.Introduction of advanced technology has altered schooling in a variety of ways.For one angle, innovative progressions have significantly expanded instructive potential outcomes. Books were remarkable all through the middle age period, and just a limited handful approached instructive conceivable outcomes. Individuals need to make a trip to scholastic foundations to get schooling. Gigantic amounts of data (books, music, photographs, and recordings) are currently reachable readily available simply because of the Internet, and formal learning choices flourishes through MOOCs, online classes, conventional web-based degree programs, as well as more. Today's learning opportunities are unsurpassed in scope only because of technological advancements [1]–[3].

Technology may assist as well as improve the level of education in a multitude of ways, from making it easier for educators to create teaching material to permitting individuals to learn as well as engage in new ways. A new generation of anytime, everywhere schooling is on the horizon, thanks to the Internet's worldwide reach as well as the broad access to new technologies which can connect with it. It will be up to professional teachers and school technology to harness the potential of technologies to boost learning so that everyone, everywhere may receive an efficient and effective learning. The twenty-first century is usually referred to as a technological period. Technology today plays a significant part in our existence and is seen as an economic development pillar. A technologically weak economy will never exist in today's world. It’s because technologies facilitates and expedites our work [4]–[7].

The effect of technology may be seen in almost every industry, including education. The future of higher education will be marked by several developments in the coming years. Educators and Information Technology (IT) administrators at colleges and universities must anticipate and prepare for these inevitable developments, such as adopting a phone system for schools to remain connected. Rising education technology usage that facilitates remote delivery and student-teacher engagement, individualized learning, as well as accessibility measures will aid university educators and administrators in making the transition to the new era of education as unified as possible[8].

1.1. Modern Technology in Education:

As of the latest researches on how modern students are using technology and also how technology impacts their learning. When students use current equipment, technology, as well as tools in their schooling, their education and engagement improve. When technology is used to assist students, they perceive it to be lot more participatory and fuller of interesting destinations. Information exchange becomes extremely simple, enjoyable, as well as efficient. Our brains prefer to function quicker whenever supported by contemporary technology in all aspect of life, including academics. Even at today's schools, institutions, as well as colleges, this reliance and dependency on technology which just makes things easier as well as faster is unavoidable[9]–[12]. Today's students may utilize technology in a variety of ways, including:

1.1.1. Using Projectors and Visuals:

As comparing to language, visual images are always more appealing.Another excellent example of specialized application is the use of projections as well as graphics to improve teaching and learning. Top establishments all over the world are increasingly relying on wonderful PowerPoint presentations as well as projections to make picking appealing and engaging. The use of innovative technology in schools and institutions, such as projectors, may help to boost motivation while also increasing dedication and interest. Understudies like captivating images and anything that encourages them to think about anything more than merely comprehending language. When it comes to adaptive technologies, schooling is also becoming more productive [13]–[15].

1.1.2. Digital Footprints in the Education Sectors:

The usage of contemporary media in the classrooms has expanded whenever it comes to the internet as well as learning.This availability has permitted learners to speak with one another at any time of day or night, and also engage in a range of dialogues in which they may seek assistance with various tasks. As the computerized force grows, more apps will assist learners in their improvement and progress.

1.1.3. Online Degrees with the utilization of Advanced Technologies:

Online degrees and courses have become increasingly popular in recent years. Individuals prefer to attend online courses to upgrade their skills and acquire certifications. Top colleges provide excellent online programs employing a variety of technologies including the internet.Working learners and teachers throughout the world have become more comfortable with online degree choices.

1.2.Importance of Technology in Education:

Students can have quick access to information, learn better, and practice whatever they've acquired in an engaging way by the help of technology. It allows students, particularly in Science, Technology, Engineering and Mathematics (STEM) fields, to investigate new

subjects and get a better understanding of complex concepts. There is no dependency on the institute or teacher having technology-based education. Learners can understand anytime as well as from the comfort in their homes. Students can also benefit from e-learning by having easy access to all relevant information related to their subject of study. This low dependency can result in students from any field accessing e-learning resources, expanding their horizons as well as exposing them to the world beyond their city or country.Many learners do not thrive in a traditional classroom setting, so providing availability of digital courses might help them attain credentials they might not otherwise be able to acquire. Because it is difficult for the students to remain interested in what they are being taught, the use of technology is critical to allowing them to gain knowledge more efficiently while maintaining their consideration. Technology helps them to get high quality education.

1.3. Positive Impacts of Technologies in Education:

There are several positive impacts of modern technologies in education which is illustrated in Figure 1. Technologies in education makes life easier with the comparison of simplest form of learning. With these modern technologies learners and educators get several benefits in their education and makes it easier. The utilization of such modern technologies enhanced their teaching and learning skills, learners are able to gain knowledge from at any distant and also it provides ease of access to information related to their problems in education.

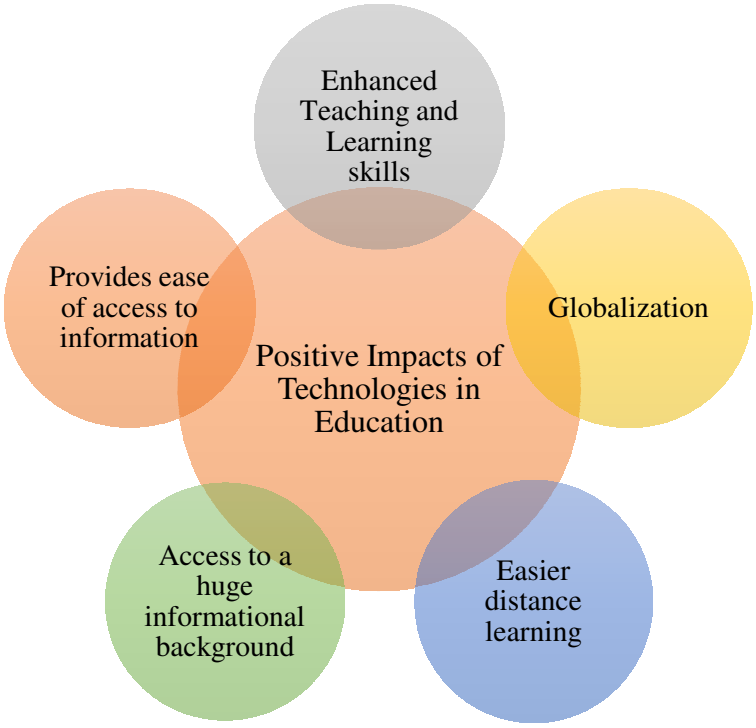

Figure 1: Illustrating the Several Positive Impacts Learners get by Utilizing Modern Technologies in their Education.

This research focuses on theRole of education in future world with the help of modern technologies. The present research is characterized into five different sections where the first of which is introduction and the second section is the reviews and suggestions of previous studies from diverse literatures. After that, the methodological portion of the study is mentioned where the data is examined in the following sub-sections. Furthermore, the result and discussion part are discussed where the results are compared with the existing data, followed by the methodologies. Lastly, conclusion of this research is declared where the author provides the final outcomes as well as suggestions of the present research.

2. LITERATURE REVIEW

D. Nadrljanski et al. states that Learning is an essential factor of the complex development process, as it is linked to population growth, labor force skills, as well as cultural and infrastructure development. Their research expresses some of the most vital educational and societal aspects. According to their research it is estimated that around 2020, 1.5 million new digital employment are expected to be offered around the world and Simultaneously, IT skills are in limited supply in 90% of firms, and 75% of lecturers and learners believe there is a gap among their IT abilities as well as job requirements. Education must adapt rapidly to the ever-growing and rising demands for IT abilities in order to deliver the competence necessary for a digital world.The authors study explores concepts as well as a possible future path for education which combines artificial intelligence, informational technologies, as well as a variety of other factors. The future of educational systems across the globe is personalized learning, experiential learning, as well as skills-based learning as per their research[16].

G. Paudyaltheir study depicts a change in Nepal as a result of the utilization of information and communication technology (ICT) into learning and teaching activities. The objective of his paper is to look at how online courses have changed traditional teaching methods. As the globe rapidly moves to the digital age, it examines the usefulness and problems of online classrooms. The Government of Nepal's policies and objectives are focused at integrating ICT tools to modify traditional teaching methods, acknowledging the need and value of utilizing technologies in education. Although students face certain challenges and online courses utilize flexible delivery options to support and solve the problems of diverse prospective learners by giving numerous paths as well as chances for individuals pursuing additional education in the future according to his research. The author also subjected that During the COVID-19 epidemic, all schools and colleges in Nepal are shifted to online classrooms to maintain continuity in learning as well as teaching. This epidemic may provide an opportunity for academic institutions to enhance technology-based education by creating online learning and teaching infrastructures [17].

F. Mikre highlighted the importance of ICT in education, and information and communication technology now affects every aspect of human life. According to the author, information and communication technology (ICT) plays a vital role in the workplace, learning, business, and leisure. Many people also consider ICTs as catalysts for change in educational settings, information handling and sharing, instructional methodologies, learning strategies, academic research, as well as access to information. His study concluded that, despite all of its limitations, ICT education systems in providing high-quality education in a modern learning perspective [18].

U. Abdurahimovna the objective of the research was to examine the adoption and the use of information and communications technologies (ICT) in higher education specialties, as well as to educate teachers how to utilize ICT to increase the quality of teaching and learning. His article addresses the problems of increasing students' attention in the educational process as well as their ability to implement their knowledge for the future by the use of information and communications technologies. According to the author information and communication technologies provide a significant contribution to the enhancement of educational processes at educational institutions where information and communications technology are an innovative aspect. To achieve this high standard, the educational institution not only to upgrade its technology capabilities, but also adapt its teaching methods [19].

The above reviews of the literatures represent that using modern technologies in education system are an opportunity for academic institutions to enhance technology-based

education by creating online learning and teaching infrastructures. In this present study the author establishes the need of technologies in their learning and how technology-based education will become a prospect for learning institutions as well as students to improve their learning and teaching methods.

Research Questions:

- Why do students need technology in the classroom?
- What are the benefits of using technologies in education?

3. METHODOLOGY

3.1.Design:

This research is carried out by using an online survey through the various parts of India which includes different academic institutions, students of different age groups, teachers etc. In this research all the data is collected by asking the questions to the respondents or learners. The primary data of this research is gathered by asking questions to the respondents to gain relevant information about how modern technologies are affecting the education system. The secondary data for this present research is gathered by questionnaires, which are collected through online surveys such as Google forms, News, articles, magazines etc. The design of this research deals with the role of education in future by using of modern technologies.

3.2. Sample:

The collection of the data completed through the help of questionnaires.The simplest and most useful method of gathering information is through survey questions. The different types of question is used to gather the information abouteducation with the help of modern technologies and how it help the learners as well as educators in teaching and learning. The survey asked to the 200 different students and educators belonging from several regions of India as well as having various educational background.

3.3. Instruments:

In this section the researchers used to collect the data and also determine the impacts of digital technologies in education system. The data is gathered from the learners which are belongs various parts of the India and different educational backgrounds. The authors take their opinion towards the impacts of modern technologies in their education. Some of the survey questions which were used to frame this study are listed below.

- Aremodern technologies in education system are beneficial?
- Are your institutions introducing technologies in education system?
- Are modern technologies is changing the educational system?
- Is it cost-effective to use technology in education?
- How many learners are agreeing and disagree by using modern technologies in their education?
- Why do students need technology in the classroom?
- What are the benefits of using technologies in education?
- How technologies affecting the health of learners?

3.4. Data Collection:

Technological advancements may help and enhance the education system in a variety of ways, from providing more efficient for instructors to producing effective teaching materials. This study is done through a survey by asking question to the respondents related to this

research. To gain the relevant information about the importance of technology in education sector the primary and secondary data were used for this study. The data collected is shown inseveral figures which are listed below, and the collected data is displayed in different stages. The collection of data is done through taking the responses as well as information's from the different learners and educators who came from several regions of India having different education backgrounds.

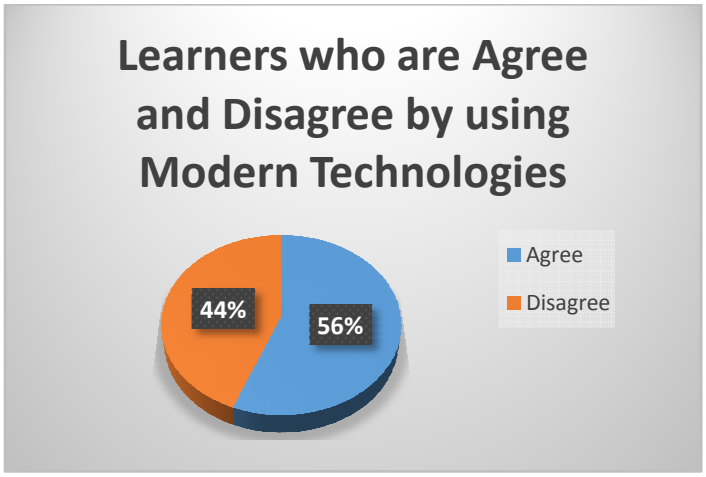

Figure 2: Represents the Learners who are Agree and Disagree by Using Modern Technologies in their Education.

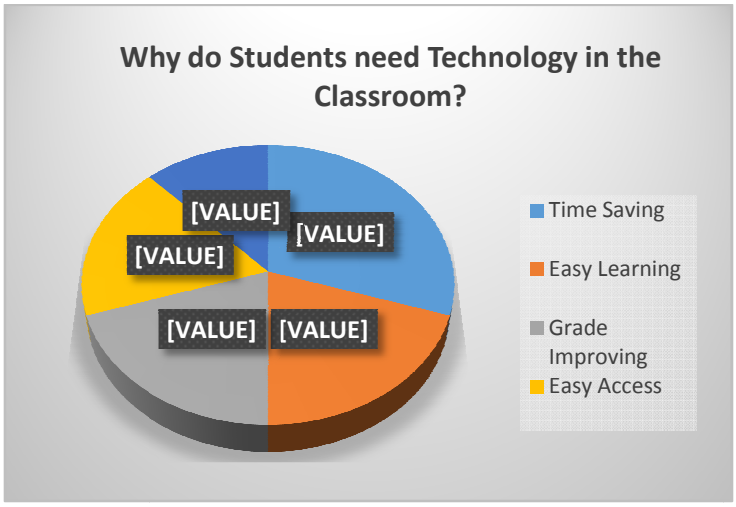

Figure 3: Illustrates the Reasons why Modern Technologies are Crucial for the Students in the Classrooms.

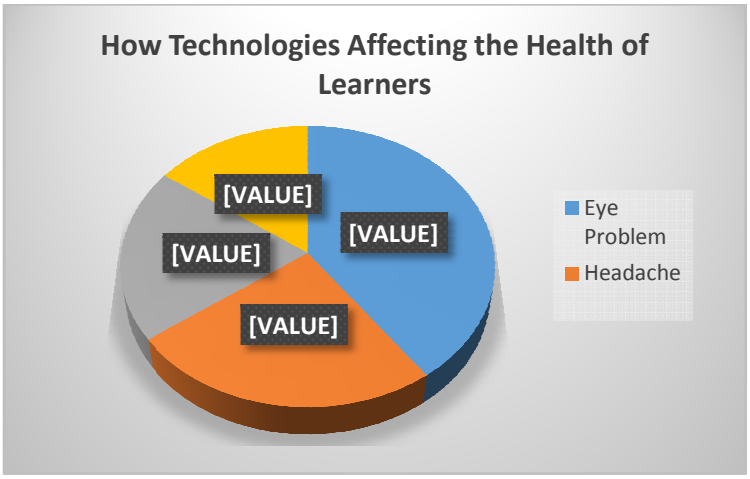

Figure 4: Illustrates the Health Problems of Learners in their Education Using Modern Technologies.

3.5. Data Analysis:

The survey used to assess the data defined the problems addressed in this research, as well as the methods employed to determine the samples. It is easy to identify the analysis' outcomes after evaluating the data and also how modern technologies affecting the education system. From the Figure 2 out of 200 respondents (Students and educators) 56% of learners are agree and 44% learners are disagreeing from technologies-based education. According to the Figure 3, 30% learners said that implementing technology based education saves their time in comparison to simplest education, 20% of learners said that it provide easy learning methods, 20% of students said that their grades are improving with the help of technologies because they get appropriate solutions and answers related to their problems, 18% of students said that it is easy to access as well as 12% of learners are declared that technology based education is cost effective in comparison to simplest form of education. Figure 4 depicts that by using technologies in education out of 200 respondents (Students and educators) 40% of learners from different age groups are facing eye problems, 25% of learners are facing headache, 20% are facing hand pain and 15% of learners are facing neck pain.

4. RESULTS AND DISCUSSION

Due to the rapid growth of learning in our society, educators face a major difficulty. Teachers must learn how to utilize modern technologies in their teaching as well as teaching in order to evolve with the times. As a result, these emerging technologies enhance the training requirements for educators. The attitudes of teachers towards computers are important to the effective use of Technology in teaching. The impact of modern technologies in education system are observed in the above research after analyzing the several results which is based on different data. The primary data is existing study is used to conduct the research i.e., Google forms, magazines etc., and these data are based on different eight questions.

The gathering of the data on the basis of responses through the respondents (students and educators).Learners and the educators can have quick access to information, learn faster, and practice whatever they've acquired in an engaging way with the help of technology. After analyzing the data from the above figures, the author observes major data that is 56% of learners are agree with modern technology in their education, 30% learners said that implementing technology-based education saves their time and 40% of learners from different age groups are facing eye problems. The below Table 1 illustrates the responses

from the students and educators who answers "Yes" or "No" to utilizing modern technologies in their learning and whether or not it is beneficial and helpful for them.

Table 1: Represents the Responses from the Students and Educators who Answers Yes

Questions	Yes	No
Are modern technologies in education system are beneficial?	64%	36%
Are your institutions introducing technologies in education system?	85%	15%
Are modern technologies is changing the educational system?	80%	20%
Is it cost-effective to use technology in education?	65%	35%

or No to Utilizing Modern Technologies in their Learning.

From the above Table the author has seen that after asking the questions from 200 respondents 64% of respondents said yes that modern technologies are really beneficial for the education system and 36% are against with this. After that 85% learners accept that their institutions introduce technologies for their education where 15% are not. Furthermore, out of 200 respondents 80% peoples believe that modern technologies really change the face of education system on the other hand 20% peoples are not. Lastly, when the question was asked to the 200 respondents is it cost-effective to use technology in their education, 65% of them said that yes using modern technologies in learning reduce the costs on either side 35% are believe that it doesn't cost effective for their learning.

5. CONCLUSION

Technologies plays a significance role in education system whether in the form of devices, media, or the internet, technology makes a major difference in making education system far better than now. Modern technology introduces the variety of functions in education system through which learners can get their solution from wherever they are. There is no dependency on the institute or teacher having technology-based education and learners can understand anytime from the comfort in their homes. Students can also benefit from E-learning by having easy access to all relevant information related to their subject of study. Technology has a greater impacton education, by making it more interactive, time saving and allowing students with disabilities to accomplish their goals. Peoples also believe that technology is a gift of God because technology makes our life easier and using modern technology in education learners get several benefits on the basis of their education and learning. The future of education will be shaped in large portion by the utilization of technological advancements in the learning.

REFERENCES

[1] R. Raja and P. C. Nagasubramani, "Impact of modern technology in education," *J. Appl. Adv. Res.*, 2018, doi: 10.21839/jaar.2018.v3is1.165.

[2] N. M. Stukalenko, B. B. Zhakhina, A. K. Kukubaeva, N. K. Smagulov, and G. K. Kazhibaeva, "Studying innovation technologies in modern education," *Int. J. Environ. Sci. Educ.*, 2016.

[3] I. A. Kuvshinova, E. L. Mitsan, E. M. Razumova, and E. I. Shuleva, "Modern technologies of inclusive higher education," *Vyss. Obraz. v Ross.*, 2019, doi: 10.31992/0869-3617-2019-28-6-138-148.

[4] A. A. Korostelev *et al.*, "Modern information and communication technologies in the advanced education of children," *Int. J. Innov. Technol. Explor. Eng.*, 2019, doi: 10.35940/ijitee.i8939.078919.

[5] S. Shukla, A. Lakhmani, and A. K. Agarwal, "A review on integrating ICT based education system in rural areas in India," 2017, doi: 10.1109/SYSMART.2016.7894531.

[6] J. Rai, R. C. Tripathi, and N. Gulati, "A comparative study of implementing innovation in education sector due to COVID-19," 2020, doi: 10.1109/SMART50582.2020.9337148.

[7] M. M. Gupta, S. Jankie, S. S. Pancholi, D. Talukdar, P. K. Sahu, and B. Sa, "Asynchronous environment assessment: A pertinent option for medical and allied health profession education during the covid-19 pandemic," *Education Sciences*. 2020, doi: 10.3390/educsci10120352.

[8] R. K. Mittal, N. Garg, and S. K. Yadav, "Quality assessment framework for educational institutions in technical education: a literature survey," *On the Horizon*. 2018, doi: 10.1108/OTH-08-2017-0066.

[9] A. Gupta, B. Gupta, and K. K. Gola, "Blockchain technology for security and privacy issues in internet of things," *Int. J. Sci. Technol. Res.*, 2020, doi: 10.1007/978-3-319-95037-2_5.

[10] V. Jain, S. Arya, and R. Gupta, "An experimental evaluation of e-commerce in supply chain management among indian online pharmacy companies," *Int. J. Recent Technol. Eng.*, 2019, doi: 10.35940/ijrte.C1092.1083S19.

[11] N. Agrawal, A. Jain, and A. Agarwal, "Simulation of network on chip for 3D router architecture," *Int. J. Recent Technol. Eng.*, 2019.

[12] S. M. Mian and R. Kumar, "Review on Intend Adaptive Algorithms for Time Critical Applications in Underwater Wireless Sensor Auditory and Multipath Network," 2019, doi: 10.1109/ICACTM.2019.8776782.

[13] A. Walia, N. Singhal, and A. K. Sharma, "A novel e-learning approach to add more cognition to semantic web," 2015, doi: 10.1109/CICT.2015.15.

[14] N. Mangal, "Transfer Learning Based Activity Recognition using ResNet 101 C-RNN Model," *Int. J. Adv. Trends Comput. Sci. Eng.*, 2020, doi: 10.30534/ijatcse/2020/199942020.

[15] G. Goswami and P. K. Goswami, "Self-adaptive learning based controller to mitigate PQ issues in internet of things devices," *Int. Trans. Electr. Energy Syst.*, 2021, doi: 10.1002/2050-7038.12888.

[16] D. Nadrljanski, M. Nadrljanski, and V. Domitrovic, "The Importance of information technology education for the future," *31st Int. Sci. Conf. Econ. Soc. Dev.*, 2018.

[17] G. R. Paudyal, "Online Classes as a Paradigm Shift in Teaching and Learning Culture," *Prithvi Acad. J.*, 2020, doi: 10.3126/paj.v3i1.31285.

[18] F. Mikre, "The Roles of Information Communication Technologies in Education," *Ethiop. J. Educ. Sci.*, 2011.

[19] U. F. Abdurahimovna, "The Role of Digital Technologies in the Education System," *J. La Edusci*, 2020, doi: 10.37899/journallaedusci.v1i6.258.

CHAPTER 2

RENEWABLE ENERGY HARVESTING USING PIEZOELECTRIC INSTALL AT RAILWAY PLATFORM WITH ARTIFICIAL INTELLIGENCE

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ABSTRACT*:*Piezoelectric energy is generated by mechanical stress exerted on piezoelectric discs that produce the electrical charge. Multiple countries are consumed large amounts of power cutting-edge several forms of renewable energy similar tidal power, thermal energy, besides wind power. Since piezoelectric power remains a significant issue in the progress of any country because piezoelectric energy generators have no need for conventional and non-conventional fuel for electricity generation, it can be produced power by human foots which employing pressure on piezoelectric discs. This study is focused on piezoelectric energy generation at railway platforms where the electric load (Fan, light etc.) of the platforms are controlled by artificial intelligence (AI) module. Herein this study, the data are collected from two railways platform where the piezoelectric energy generating units are employed. The piezoelectric energy generation units at platform A is generated more power compared to Platform B because a lot of people are moving at platform A. The electricity demand is increasing day by day, so a major gap is created between the demand and supply of electricity. The piezoelectricity power generation will compensate for the major gap in electric supply and distribution.

KEYWORDS*:*ArtificialIntelligence, Electric Charge, Piezoelectric energy, Renewable Energy, Transducer

1. INTRODUCTION

Renewable energy is energy derived from renewable resources that do not harm the environment. For electricity generation, a variety of renewable energy sources are accessible, including sunlight, rain, tides, and waves, as well as geothermal heat. Renewable energy generation is reliant on renewable resources and challenging to manage because of the high voltage and power generated. The renewable energy generating station takes up a lot of extra space, while the piezoelectric power generating station doesn't because piezoelectric discs are placed on the surface. The vehicles and people's feet are affected by the gravitational force of the Earth, which exerts pressure on the piezoelectric material due to external pressure deformation in the paving material[1]. The technology of piezoelectric energy harnessing has major advantages over renewable energy generation [2].A piezoelectric sensor is the most common type of transducer found in many devices, and it is a device that measures temperature, strain, pressure, and acceleration through the piezoelectric effect. A piezoelectric transducer is an electronic device that transforms power from single form to additional by altering external force into an electrical charge. Automation, control systems, electrical charge creation, and power monitoring are all common uses for transducers. Mechanical and electrical transducers are two most common forms of transducers. Mechanical transducers, such as thermometers, pressure sensors, microphones, and antennas, respond to changes in physical or mechanical quantities, while electrical transducers, such as thermometers, pressure sensors, microphones, and antennas, respond to changes in electrical signals.

1.1. piezoelectric Transducer and Effect:

Piezoelectric materials remain materials that change mechanical power into electrical power due to external pressure applied. Piezoelectric means the electricity generated due to pressure, a single piezoelectric crystal located amid 2 metal plates initially,the device remains cutting-edge faultless equilibrium and is not conducting an electric charge [3]-[4]. When an external force is employed to the piezoelectric materials besides the impact of external force is caused by deformation in the dimension of piezoelectric material that is produced an electric charge as well as their effect is known as piezoelectric effects, an electric charge is generated from the charge-collection plate in a piezoelectric as shown in Figure 1.

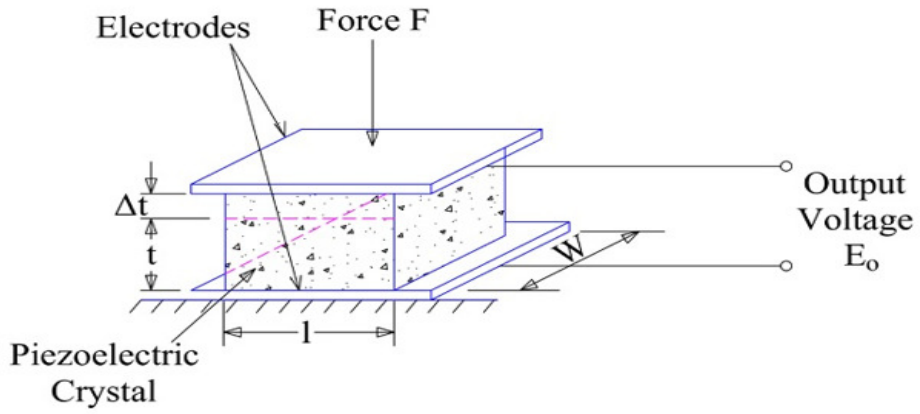

Figure 1: Illustration of charge generation due to external force applied on Piezoelectric Material[5]**.**

1.2. Classification of Piezoelectric Material:

Piezoelectric materials are utilized for making an electrical device that converts mechanical power into electrical power. Piezoelectric materials are ferroelectric structures and their strong arrangements, which are made by the union of a combination of various oxides, carbonates, and salts of metals. The piezoelectric materials are classified on basis of different characteristics of piezoelectric materials such as high strain constant, permittivity, high Curie temperature, and coupling constants as well as a low mechanical quality feature. The classification of piezoelectric materials remain shown in Figure 2.

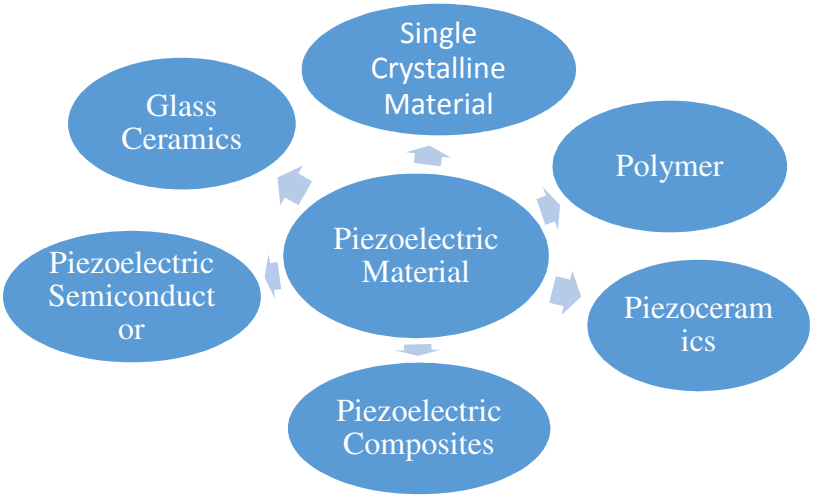

Figure 2: Illustrating the classification of the piezoelectric materials for renewable power generation[6]

1.2.1. Single-Crystalline Material:

The single-crystal material has excellent piezoelectric properties and has been applied for various sensor and actuators applications. The piezoelectric single crystal is used for ultrasonic transducer applications[6]-[7]. Ultrasonic transducers are operated based on converse effects of pyroelectrics materials that are produced vibration due to potential differences.

1.2.2. Glass Ceramics:

Glass-ceramics remain partly crystallized spectacles that are the composition of a combination of an amorphous glass phase and crystalline stage. Glass-ceramics are widely used for various applications because of their thermal and mechanical properties[8]. The compact glass-ceramic consumes physical possessions greater to parent glass the numbers of crystalline phases are varied over a wide range[9].

1.2.3. Piezoelectric Semiconductor:

Piezoelectric materials are used as dielectric or semiconductors, the piezoelectric semiconductor is applied to make acoustics wave devices. New piezoelectric semiconductor nanostructures have been developed such as tubes, Zinc oxide (ZnO) fibers, belts, films, and spirals in the past two decades [10]-[11]. The piezoelectric semiconductors have been utilized to generate electricity.

1.2.4. Piezoelectric Composites:

Piezoelectric compound materials remain specially used aimed at underwater sonar as well as medicinal diagnostic ultrasonic transducer implementations. The piezoelectric composites are an alternative to standard piezo materials for specific applications.

1.2.5. Piezoceramics:

Piezoceramics are an important class of piezoelectric ingredients and piezoceramics remain known as ferroelectric ingredients with polycrystalline structures such as Perovskite, tetragonal or rhombohedral crystals [12]. The most significant piezoceramics are lead zirconate titanate (PZT), lithium titanate ($LiTaO_3$), sodium tungstate (Na_2WO_3), barium titanate ($BaTiO_3$), lead titanate ($PbTiO_3$), zinc oxide (ZnO), lithium niobate ($LiNbO_3$), as well as potassium niobate ($KNbO_3$) [13].

1.2.6. Polymer;

Piezoelectric polymers are a polymer that are generating electric charges on the surface due to pressure, and thus can convert mechanical power into electrical power. Polyvinylidene fluoride (PVDF) remains the most significant piezoelectric polymer that sutures have found to be very common in tensile breaking forces [14]. The study focussed on piezoelectric energy generation at Railway platforms by applying foot's pressure to piezoelectric discs, where the electric fan loads are regulated by an artificial intelligence (AI) module. The present study is divided into multiple sections, the first is an introduction and the second section discussed the prior review regarding this renewable power generation by piezoelectric materials and the third is the methodology used for the current study], after that, the result and discussion regarding this study and the next conclusion of this study.

2. LITERATURE REVIEW

Mohamed A. Shabara et al. discussed comprehensive piezoelectric material application problems on power harvesting aimed at artificial intelligence systems [15]. The author had desired to develop renewable, reliable, sustainable as well as local electricity generator-based self-powered AI systems installed in the city. Piezoelectric Energy Harvesting (PEH) technology was used to convert vibration/motion mechanical energy into electrical energy with the help of the AI Base Self Power System. When mechanical force or stress was exerted on a piezoelectric material, generated electrical energy. The author said that the Application of piezoelectric ingredients-founded energy harvesting was impressive in the upcoming future. Herein author discussed major piezoelectric materials and devices classification.

Vikram Puri et al. discussed a hybrid artificial intelligence as well as Internet of things model aimed at the production of renewable resources of power [16]. The author said that numerous investigators strained to produce electricity from renewable sources gathered through the sensor for home applications as well as in Industrial areas. This research was based on Internet of Things (IoT) for the production of electrical energy from numerous sensors aimed at an electrical converter. The solar panel was utilized to connect the energy storing circuit aimed at the production of electricity. There were 2 dissimilar Artificial Intelligence (AI) based models for example Adaptive Network-founded Fussy Interfere System (ANFIS), and Artificial Neural Network (ANN) utilized for power generation from renewable energy resources. There were developed four models from the real-time that was gathered dataset as well as verified then skilled by ANFIS as well as ANN by statistical parameters specifically root mean square error (RMSE) as well as correlation factor (R2). According to the author, there were three input modules for example solar energy, piezoelectric, besides body to warmth power that were recognized to forecast the entire outcomes energy production as output cutting-edge the AI models. This study was favourable for forecasting energy production from renewable resources.

D Vatansever et al. discussed an investigation of power harvesting from Renewable sources with polyvinylidene fluoride(PVDF) and lead zirconate titanate [17]. The author said that piezoelectricity had gained a significant position cutting-edge research as well as growth to extract power from the atmosphere. According to the author's research the voltage replies of ceramic were founded on piezoelectric fiber compound structure (PFCs) and polymer-founded piezoelectric strips and PVDF. There were two easy ways to generate electricity, such as wind and water. Natural renewable power bases aimed at use cutting-edge low-energy electronic equipment.As the above literatures have provided information regarding piezoelectric power harnessing by the implementation of piezoelectric power generating units, therefore this current study shows piezoelectricity harnessing as well as electrical load is carried by piezoelectric power using AI, Piezoelectric materials can generate electricity to complete the electricity demand for lighting, LED display, and Fan at the platform. This study is demonstrated that the generation of energy due to external pressure applied to piezoelectric materials and the piezoelectricity is used cutting-edge low-power electronic devices cutting-edge outdoor implementations such as railway platforms which is possible through the use of flexible polymers based on piezoelectric structures.

Research question:

- How to compensate for electricity demand?
- How to generate piezoelectricity at the railway platform?

3. METHODOLOGY

3.1. Design:

In this research, electrical energy is generated through applying an external force to a piezoelectric material. This external force is exerted by the feet of the human due to the movement of people on the railway platform. By using the piezoelectric technique waste energy of feet (pressure due to gravitational force) is converted into electrical energy and generated electricity as per the requirement of the platform.Initially, the output power is generated in the form of Alternating Current (AC) from piezoelectric materials and the AC supply is converted into Direct Current (DC) supply through a converter. The load & artificial intelligence (AI) is connected with a battery that is controlled the energy distribution and maintains supply when voltage fluctuation occurs as shown in Figure 3.

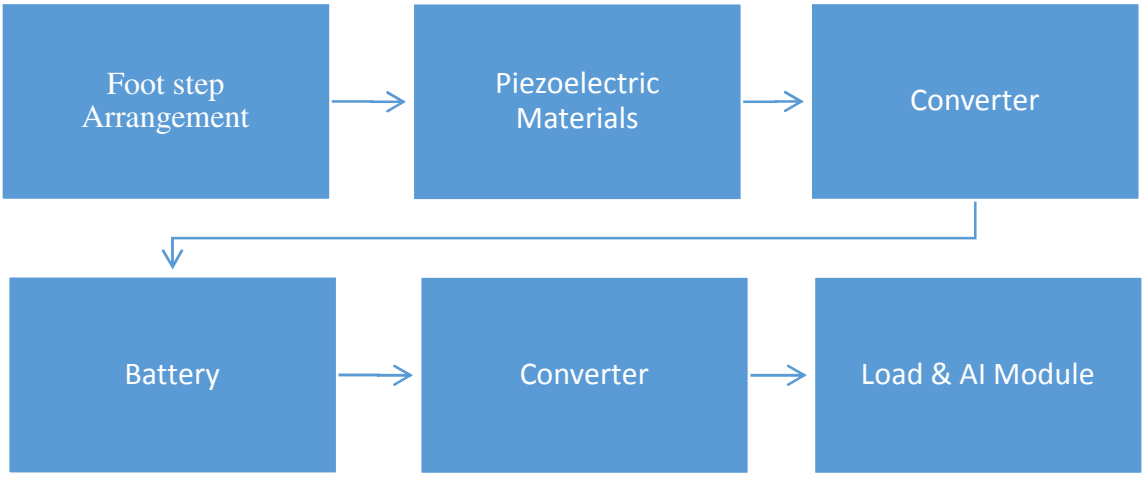

Figure 3: Represents the block diagram of power generation by exerting footstep pressure on Piezoelectric Materials.

3.2. Instruments:

In this research paper, various components are used for renewable power generation which is applicable to compensate for the requirement of electricity at the Railways platform with the utilization of feet energy (during the walk on the platform). These are the following components.

3.2.1. Footstep Arrangement:

The Footstep arrangements are employed at both platform A and Platform B that is generated energy when external pressures are applied by foots of people. The piezoelectric material has deformed from its original shape which is the cause of piezoelectric energy generation.

3.2.2. converter:

The converter is an electronic component that is used to convert the A.C power into D.C power, while at the same time regulating the frequency, current, and voltage of the power supply [18]. In this project, an inverter is used one times for converting the D.C supply into A.C supply.

3.2.3. Battery:

A battery remains a device that supplies electrical energy cutting-edge form of chemical power, whenever people are moved on a platform then multiple rechargeable batteries are started to store D.C charge. The rechargeable battery has carried a 15-ampere current and it's completely charging in a 10hour, 12-volt DC supply, and 1.8 kVA energy storage capacity.

The battery is connected with a converter, as well as batteries, are connected in the series form to each other for increasing DC voltage [20]-[22].When no one is moving on the platform, the battery's storage power is continuously delivered to the electric load on the platform.

3.2.4. Artificial Intelligence:

Artificial intelligence (AI) has the ability of a robot or computer system controlled by a microprocessor of a computer to perform tasks that are commonly completed by a human with the possibility of error but AI has completed a task without error. Here in this project, AI is used for monitoring and regulating the supply voltage as well as distribution of electricity[21].

3.3. Data collection:

The AC unbalanced voltage is generated by the piezoelectric material after pressurizing the footstep arrangement during the movement of people on the platform. The output AC discrete voltage is converted into DC discrete voltage by the converter and this DC discrete voltage is converted into pure DC voltage after rectification by the converter. The converter is connected to the battery that is stored in the DC supply. The pure DC supply is converted into pure AC supply by the converter and further supplied to the platform's load. The entire electrical loads are monitored by the AI module. Herein study data are collected from two different platforms (A, B) and the complete arrangement of platform A are shown in Table 1 and Table 2.

Table 1: This table illustrates the data collected from platform A, which are No of Footsteps, Time interval of a running Fan, Energy/ steps, Pressure Exerting/step as well as Total energy generation.

No. of Footsteps	Time interval of a Running Fan(80W) in second	Energy/ step (Jules)	Total Energy generation (kWatt)	Pressure Exerting/step in (Newton/(square meter))
50	4	2.8	0.560	47
100	8	2.8	2.240	47
120	9.6	2.8	3.225	47
144	11.4	2.8	4.596	47

Table 2: This table represents the data of Platform B, which are No of Footsteps, Time interval of a running Fan, Energy/ steps, Pressure Exerting/step as well as Total energy generation.

No. of Footsteps	Time interval of a Running	Energy/ step (Jules)	Total Energy generation	Pressure Exerting/step in

	Fan(80W) in second		**(Watt)**	**(Newton/(square meter))**
60	3	2.8	0.504	47
110	5.5	2.8	1.694	47
150	7.5	2.8	3.150	47
180	9	2.8	4.536	47

3.4. Data analysis;

When mechanical pressure is applied to the material, and pressure is generated electric charges due to the deformation of pyroelectric's materials, the diameter of the piezoelectric disc is 26 mm, and the regular thickness is 0.33 mm.The ratio of the electric field intensity and pressure is known as the voltage sensitivity of the disc, and the voltage sensitivity of the piezoelectric disc is 0.86 V/g.

The output voltage of the piezoelectric crystal may be calculated by utilizing the formula.

E= V/d

Where V remains Voltage as well as d plate separation inside the electric field

V = P×G× T

Where P remains the pressure applied cutting-edge N/ (sq.m)

G remains the sensitivity of the material

T remains the width of the material

V remains an outcome voltage

Thus, Voltage generated by piezo disc of Platform A is

P = 50, G = 0.86, T = 0.33

V_A = 47×0.86× 0.33

=13.3386 V

Total energy generated at platform A by employed pressure by people's foots

E_A= (No. of Footsteps) x (Time interval of a Running Fan (80W) in second) x (Energy/ step in Jule)

E_{A1}=50×4×2.8 = 0.560 kWatt

E_{A2} = 2.240 kWatt , E_{A3} = 3.225 kWatt, E_{A4} = 4.596 kWatt

Thus, Voltage is generated by piezo disc of Platform B is

P = 47, G = 0.86, T = 0.33

V_B = 47×0.86× 0.33

= 13.3386 V

E_B = (No. of Footsteps) x (Time interval of a Running Fan (80W) in second) x (Energy/ step in Jule)

E_{B1} =60×3×2.7 =0.504 kWatt

E_{B2} = 1.694 kWatt , E_{B3} = 3.150 kWatt, E_{B4} = 4.536 kWatt

This project is analyzing the data that has been collected from two platforms A and B. Renewable energy is generated by the piezoelectric disc, having the thickness and diameter of the disc are sequentially 0.33 mm and 26 mm, as well as the voltage sensitivity of the piezoelectric disc is 0.86V/g. According to Table 1, 50 footsteps are applied pressure on the piezo discs, and energy per footstep (2.8 j) generates total energy of 0.560 kW in 4 seconds. Another 100 footsteps are exerted pressure [47 N/ (sq .m)] on the piezo disc, and energy per footstep generate total energy of 2.240 kW pressure in 8 seconds. 120 footsteps are applied pressure on the piezo disc, and energy per footstep generates total energy of 3.225 kW by pressure in 9.6 seconds. 144 footsteps are applied pressure on the piezo disc, and energy per footstep generates total energy of 4.596 kW by 47N/ (sq .m) in 11.4 seconds. Voltage generation at Platform A is 13.3386 V by a single piezoelectric disc.According to table 2, The piezo disc is pressurized 60 footsteps [47N/(sqm)], producing 2.8 J of energy per step and a total energy of 0.504 kW in 3 seconds. 110 footsteps are the pressure acting on the piezo disc which generates a total energy of 1.694 kW in 5.5 seconds. A pressure of 150 footsteps is applied to the piezo disc which generates a total energy of 3.150 kW in 7.5 seconds. Another 180 footsteps are the pressure acting on the piezo disc which generates 2.8 J of energy per foot and a total of 4.536 kW of energy is generated in 9 seconds. The voltage output by a piezoelectric disc at platform B is 13.3386 V.

4. RESULTS AND DISCUSSION

The various techniques are capable to generate renewable power generation but renewable power generation is dependent on renewable sources such as water, sun, wind, tide, etc. Renewable power generation by piezoelectric disc is a different technique of power generation that is not dependent on the renewable source. The footsteps pressure is applied to the piezoelectric disc that is converted mechanical energy into electrical energy. The electrical energy originating from a piezoelectric disc is in discontinuous alternating current (AC) form. The discrete AC supply is converted into a pure AC supply through a converter and the pure AC supply is converted into a Pure DC supply by a converter. The pure DC supply is not appropriate for applications such as Fan, Light, and LED displays. Therefore the DC supply has converted into pure AC supply by converter and the pure AC supply is connected with the load and AI module. The power distribution is monitored by artificial intelligence (AI) and AI is employed for the Measurement of Voltage, Current as well as Power. Herein this study, data on renewable power generation through piezoelectric material is collected from two different railway platforms such as Platform A and Platform B. Various dissimilar data are obtained from platform A such as voltage, power, and energy/ steps. The total energy obtained at platform A that are sequentially E_{A1}=0.560kWatt, EA_2 = 2.240 kWatt , E_{A3} = 3.225 kWatt, E_{A4} = 4.596 kWatt as well as total energy obtained from platform B are sequentially E_{B1} =0.504 kWatt,E_{B2} = 1.694 kWatt , E_{B3} = 3.150 kWatt, E_{B4} = 4.536 kWatt. The output energy of the platform A is more than platform B. both platforms are generating different voltage through the piezoelectric disc.

4.1.Advantages of piezoelectric energy utility:

- No need of conventional and non-conventional fuel
- Protect the environment without releasing harmful gas, particles, and heat.
- To convert the waste energy of legs (during a walk at the piezoelectric device) into electrical energy.
- It could be easy to handle due to its small size and dimension.

4.2.Application of piezoelectric energy:

- It can be used in various prospective such as lighting bulbs, LED displays, and fans.
- It can be applicable for both supply AC and DC.
- It can be installed on railways platform, metro as well as Airport.
- Piezoelectric power generating Modules can be installed in universities, colleges, and rural and urban areas.
- It can be supplied power to the power grid due to an unbalanced load.

5. CONCLUSION

The world utilizes huge amounts of power cutting-edge numerous forms, including electrical and mechanical power. Because the demand for electrical power remains growing by the day, numerous power generation techniques are being used to fulfill the demands. Both conventional and non-conventional fuels are used in the generation of electric power. The conventional source of energy generation, such as coal power generation, produces a large amount of polluted gas, dust particles, and heat, all of which have an impact on nature. Renewable energy generation is an expensive way to generate energy without damaging the environment. Renewable energy production is dependent on non-conventional energy sources, while piezoelectric power generation is free from both conventional and non-conventional energy sources. When external pressure is applied to the piezoelectric disc, the piezoelectric generator converts mechanical energy into electrical energy. In this study, the output voltage is obtained in AC form by using piezoelectric unit plates.The converter is used to convert AC discrete supply to DC discontinuous supply. The converter converts the unregulated DC supply into a pure AC supply, which is connected across the load. The whole process of load distribution is controlled by artificial intelligence. In this paper, 13.3386 V AC discrete supply has been obtained from platform A and platform B of the piezoelectric disc. The total energy produced on platform A is more than the energy received on platform B. The power generation figures have been calculated by AI. The voltage of platform A is higher than platform B which is monitored by AI. The research aims to address the power shortage for railway platform equipment. Piezoelectric power will be used in various electronics applications like mobile charging, LED display, etc.

REFERENCES

[1] A. M. Levenda, I. Behrsin, and F. Disano, “Renewable energy for whom? A global systematic review of the environmental justice implications of renewable energy technologies,” *Energy Research and Social Science*. 2021, doi: 10.1016/j.erss.2020.101837.

[2] M. Zafar, S. Kumar, S. Kumar, A. K. Dhiman, and H. S. Park, “Maintenance-energy-dependent dynamics of growth and poly(3-Hydroxybutyrate) [p(3hb)] production by azohydromonas lata mtcc 2311 using simple and renewable carbon substrates,” *Brazilian J. Chem. Eng.*, 2014, doi: 10.1590/0104-6632.20140312s00002434.

[3] X. Xu, D. Cao, H. Yang, and M. He, “Application of piezoelectric transducer in energy harvesting in pavement,” *Int. J. Pavement Res. Technol.*, 2018, doi: 10.1016/j.ijprt.2017.09.011.

[4] “2018 5th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering, UPCON 2018,” *2018 5th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering, UPCON 2018*. 2018.

[5] Electrical Concepts, "Piezoelectric Transducer," 2020, [Online]. Available: https://electricalbaba.com/piezoelectric-transducer/.

[6] Science Dirrect, "Piezoelectric Material," 2015, [Online]. Available: https://www.sciencedirect.com/topics/engineering/piezoelectric-material#:~:text=Piezoelectric materials can be classified,piezoelectric composites%2C and (6).

[7] S. Sarkar, U. Ray, D. Roy, D. Banerjee, and K. Kumar Chattopadhyay, "Synthesis of silicon nanowire and crystalline carbon quantum dots heterostructure and study of photo response and photoluminescence property," *Mater. Lett.*, 2021, doi: 10.1016/j.matlet.2021.130493.

[8] E. Leighton, "Advances in Applied Ceramics: Editorial," *Advances in Applied Ceramics*. 2011, doi: 10.1179/174367611X13032991389880.

[9] "2016 5th International Symposium on Next-Generation Electronics, ISNE 2016," *2016 5th International Symposium on Next-Generation Electronics, ISNE 2016*. 2016.

[10] M. Wang, B. Wang, F. Huang, and Z. Lin, "Enabling PIEZOpotential in PIEZOelectric Semiconductors for Enhanced Catalytic Activities," *Angewandte Chemie - International Edition*. 2019, doi: 10.1002/anie.201811709.

[11] D. D. donno and L. T. G. Monti, F. Congedo, "Progress In Electromagnetics Research C, Vol. 31, 109–121, 2012," *Prog. Electromagn. Res. C*, 2012.

[12] C. H. Hong *et al.*, "Lead-free piezoceramics – Where to move on?," *Journal of Materiomics*. 2016, doi: 10.1016/j.jmat.2015.12.002.

[13] "(Crystal Research and Technology 4/2021)," *Cryst. Res. Technol.*, 2021, doi: 10.1002/crat.202170016.

[14] K. W. D. Ledingham and W. Galster, "Laser-driven particle and photon beams and some applications," *New J. Phys.*, 2010, doi: 10.1088/1367-2630/12/4/045005.

[15] M. A. Shabara, A. R. Badawi, and T. B. Xu, "Comprehensive piezoelectric material application issues on energy harvesting for artificial intelligence systems," *AIAA Scitech 2020 Forum*, vol. 1 PartF, no. January, pp. 1–24, 2020, doi: 10.2514/6.2020-1862.

[16] V. Puri, R. Kumar, I. Priyadarshini, and L. E. Hoang, "A Hybrid Artificial Intelligence and Internet of Things Model for Generation of Renewable Resource of Energy," 2019, doi: 10.1109/ACCESS.2019.2934228.

[17] D. Vatansever, R. L. Hadimani, T. Shah, and E. Siores, "An investigation of energy harvesting from renewable sources with PVDF and PZT," *Smart Mater. Struct.*, vol. 20, no. 5, 2011, doi: 10.1088/0964-1726/20/5/055019.

[18] "International Conference on Electrical, Electronics, Signals, Communication and Optimization, EESCO 2015," *International Conference on Electrical, Electronics, Signals, Communication and Optimization, EESCO 2015*. 2015.

[20] S. Duan, J. Wu, J. Xia, and W. Lei, "Innovation strategy selection facilitates high-performance flexible piezoelectric sensors," *Sensors (Switzerland)*. 2020, doi: 10.3390/s20102820.

[21] G. Goswami and P. K. Goswami, "Artificial Intelligence based PV-Fed Shunt Active Power Filter for IOT Applications," 2020, doi: 10.1109/SMART50582.2020.9337063.

[22] M. Jayalakshmi and K. Balasubramanian, "Simple capacitors to supercapacitors - An overview," *International Journal of Electrochemical Science*. 2008.

CHAPTER 3

USE OF ARTIFICIAL INTELLIGENCE AND MICROCONTROLLERS IN SOLAR-WIND HYBRID POWER GENERATION SYSTEM

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ABSTRACT: ***The use of artificial intelligence and microcontroller in solar-wind hybrid power generation systems without producing hazards in the environment and is also monitored by artificial intelligence. The energy produced by the whole system is pollution-free and eco-friendly and energy is produced by solar and wind, which increased rapidly day by day with the increase in energy demands. The energy generated from fossil fuels such as coal, oil, and natural gas is limited in nature and will vanish in the future. The problem arises due to the use of fossil fuels which generates a lot of environmental pollution and also responsible for global warming. To overcome these problems author generates the energy production system with a hybrid system and this system control and monitor by artificial intelligence. In this paper, the method used for a hybrid power generation system is controlled with a microcontroller with the help of artificial intelligence. As a result, the overall power generated with the hybrid is 240kwh/day which is sufficient to cover the electrical consumption of the house. In the future, this hybrid system helps to cover the shortage of electricity as well as also maintain the continuous supply of electricity.***

KEYWORDS: ***Artificial Intelligence, Hybrid Energy, Renewable Energy, Solar Energy, Wind Energy.***

1. INTRODUCTION

1.1. Benefits of Solar Energy:

There are a few reasons why energy based on sunlight is so valuable. Sunlight-based receive various monetary benefits, such as lower service bills spent on investment funds. There are several additional perks and advantages such as some folks just appreciating the concept of being greener and more self-sufficient in terms of energy [1]. They like not having to rely as heavily on the system for their energy consumption. However, one of the main benefits of solar-powered energy is its impact on the climate**.** There are 5 benefits of solar energy are:

- Decrease Air pollution

Pollutants are produced by fossil fuels.If anyone has ever visited foreign country or any other region with mountains and valleys, it has seen what dirty air looks like. Smog and polluted air are dreadful for the climate, harmful to wellbeing, and terrible for our appearance [2]. At the point when impurities become consumed in the air, everything seems to fade. Solar panels add to the decrease of air contamination as well as create clean energy that doesn't dirty the climate.

- Reduce Water Consumption

If our source of energy does not use fossil fuels, it is almost certainly powered by water. To produce electricity, both hydroelectric and nuclear energy usage a plenty of water.To manage water flow and create electricity, a dam is frequently required. Reservoirs have a considerable impact on the local ecosystem, which is an issue.

- Lowers Reliance on non - Renewable Energy Sources (RES)

Certain people are drawn to solar energy because they desire to be environmentally conscious and self-sufficient. Solar energy, on the other hand, has the potential to help us lessen our reliance on non - renewable energy sources such as fossil fuels [3]. This is excellent for a number of reasons. First and primarily, non-renewable energy fuels make a significant contribution to the toxins that harm our air quality [4]. Non-renewable resources, on the other hand, are non-renewable because they diminish over time. The earlier and more effectively that can switch to renewable power, the better it would be for the Earth and our species.

- Aids in Climate Change Protection

Finally, there's the issue of climate change, which means that continuing to discharge pollutants and carbon dioxide into the atmosphere is harmful to our biosphere. It impacts the ecosystem's ability to clean the air more difficult. As even the carbon level rises, our ability to retain energy from the sun will decline [5].These shifting air conditions will likely have an impact on many nations, warming some of it and cooling others while also making weather systems more unpredictable and volatile around the world. One way to try to alleviate the effects of climate change is to use solar energy. Reducing carbon dioxide emissions and releasing fewer pollutants into the atmosphere which all help to combat climate change.

1.2. Benefits of wind energy:

Wind energy is a technologically developed energy source with huge potential. It takes up less area since it expands vertically, requires minimum upkeep, and interacts nicely also with the circular economy model, making it incredibly attractive.Many of the advantages of wind energy are shared by other renewables. The first is its role in combating climate change: using wind power reduces the use of fossil energy, lowering co2 emissions, fine particles, and other climate-altering elements that cause the greenhouse effect [2]. Furthermore, wind power may help countries attain energy self-sufficiency by providing indisputable economic advantages besides being a step toward environmental sustainability because it is free once the wind turbine is constructed [3]. Furthermore, the wind is a plentiful form of energy that is both infinite and limitless in time and is available on much of the Earth's surface.One of the unique characteristics of wind power that makes it such a potential source of green energy is the ability to combine it with solar power. In contrast to functioning at the same facility, the two types of energy share various complementing characteristics.

- There is Wind Nearly Everywhere

Not only is wind prevalent practically everywhere on Earth, but we also know where it blows the most regularly and forcefully. It's a matter of availability: because we know in which the wind blows the hardest, we can construct wind turbines based on our extensive knowledge of the local circumstances [4]. The windier a region, the more energy it may create, balancing the initial investment expenditures.

- Wind Power is Ideal for Faraway Places

Wind power, like many other renewable energy sources, is beneficial in that it may be used via micro-grid solutions even in areas in which there is no connectivity to the electricity grid. This presents a major potential in more remote places far from towns or cities since it can result in large savings from not having to develop costly infrastructure. Wind, unlike geothermal or hydroelectric electricity, may be used on a worldwide scale, except a few regions where installing wind turbines is not advantageous.

- The Wind Remains Stable over the Medium and Long Term

One of the limitations of wind power is the intermittent nature of the wind from one moment to the next or from a day to the next. However, there is another side to this coin, just as there is with solar power: the wind does not typically depend on precise times of the day or the alternating of day and night, but it does have a seasonal or yearly rhythm [5]. Overall, it's a resource that, in the medium to long term, provides great assurance of consistency, separating itself from fluctuation which does not follow the very same pattern as the sun's electricity.

- The Environmental Damage is Negligible

Even though the visual element and low rate of sound pollution created by turbine blade rotation are continuing work process in addition to making wind farms even more ecologically friendly, it is worth mentioning that the real impact today is, however, extremely limited [6]. Wind power is, in reality, the greenest source with the least total impact since any pollutants and resources consumption are restricted only to the plant's development, transportation, and installation [7]. Furthermore, many nations need certificates before commencing construction on a wind power installation to guarantee that any collateral impacts on fauna and flora are kept to a minimal [8].Although wind turbines are often erected on mountains, hills, or at ocean, when they are positioned in meadows or on moderate inclines, the area may still be utilised for agricultural cultivation or animal grazing without interfering with either activity [9].

1.3. Photo-voltaic Cell (PVs):

The PV (Photovoltaic) cells are prepared by semiconductor materials like silicon, which is the furthermost extensively utilized element right now in the semiconductor industry. Mainly, a portion of the semiconductor material absorbs the light that strikes the cell. When it comes to energy in which the electrons particles are loosely packed and easy to flow in the semiconductor [10]. Photo-voltaic cells are made up of one more electric cell.The attraction of the arenas light causes the illuminated electrons to move in a particular path. Electrons flow to produce current, and metal contacts are inserted on the top and bottom of the circuit board to form that current can be drawn off and used externally by a PV cell. The voltage is a result of the electric field that is integrated into the device[11].

1.4. *Artificial Intelligence*:

Artificial intelligence (AI) is a term to describe is entirely automated using big data technologies and combines the advantage of hybrid systems, resulting in the monitoring of all measured value and data respectively without great initial effort [12]. Any machine that demonstrates brain characteristics such as real concern and learning is referred to as a humanoid machine [13].The present study focuses on electricity generation by the solar-wind hybrid power generation system with artificial intelligence which reduce the harmful effect of the chemical by producing a clean energy source. This hybrid power generation system is monitored with a microcontroller and artificial intelligence to give more reliability and stableness. This research is characterized into several sections where the first is an introduction and the second section is a literature review of previous studies. Furthermore, the methodological section of this study is mentioned where the data is examined in the different sub-sections. After that, the results and discussion part are discussed where the results are compared with the existing data followed by the methods applied in this research. Lastly, the conclusion of this research is declared where the research gives outcomes as well as future scopes.

2. LITERATURE REVIEW

Bharat Raj Singh and Bal Krishna Dubey explained the energy generation by the solar-wind hybrid power generation as a combination of a solar plant and a wind energy plant. In that paper, the method was used as solar equation as well as the wind equation to calculate the energy generation cost for electricity. In that paper, the outcomes have helped reduce the dependency on a single source and make the system more consistent. In comparison to non-renewable energy resources, the developed hybrid system is the most appropriate and effective alternative for producing electricity. It not only less costly but is also does not affect the environment.

According to the authors it may be used to generate electricity in hilly places where traditional transmission techniques are challenging [14].

Rajashekhar P. Mandi, explained the energy production by the hybrid model of a solar energy system that uses the sun and winds renewable energies to generate power. The comparison of their distinct ways of generation, the hybrid system relies mostly on microcontrollers and allows for the most efficient use of resources, hence increase in the efficiency.

The authors used hybrid model for power generation which was created using the following method such as wind energy conversion systems, solar energy conversion systems, and solar-wind hybrid energy systems are all examples of energy conversion systems. In those papers, the results have helped to improve reliability and lessen reliance on a single source. It can be used to produce energy for companies as well as for household uses [15].

K. Boopathi explained the electricity generation by wind-solar hybrid energy production. In that paper, author compared to their single technique of generation, the results have helped to boost efficiency. It can be used in both industrial and home settings energy sources. The author takes the various wind potential sites based on the met-masts installed in different areas and examines the graph, pie-chart where the wind power range with seasonal trend difference.

As a result, combining various renewable sources through hybrid power systems is beneficial in lowering power demand and ensuring a continuous supply of renewable energy to the grid [16].

Research Questions:

- How to generate electricity from solar-wind power generation?
- How to generate an eco-friendly and clean source of energy?

3. METHODOLOGY

3.1. Research Design:

In this research Hybrid system is used to generate the electricity which is a mix of solar and wind power, as shown in Figure 2 in which the output generated from the system is used to charge batteries, this stored energy can be transferred to the inverter which converts DC to AC voltage, and these devices are not generating any kind of power because power is generated from the DC source. The microcontroller is attached to the battery which is used to command the signal. The AI is used to monitor the microcontroller command according to the system requirements. Load is connected with an inverter that receives AC voltages.

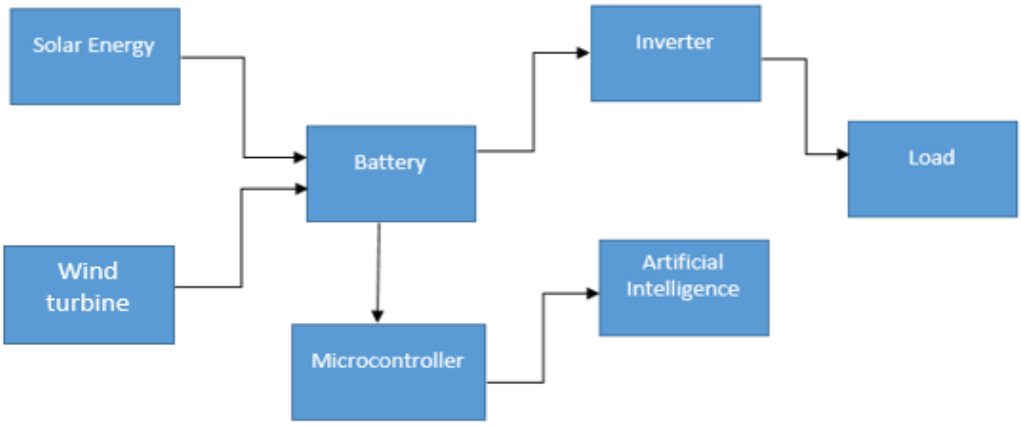

Figure 2: Diagrammatic Representation of block diagram of hybrid System with Artificial Intelligence.

3.2. Instrument:

- *Wind Turbine:*

A wind turbine converts the kinetic energy contained in the wind into electricity. The energy is converted with help of a generator, which is attached to the shaft of the blade in which electrical energy is converted from mechanical energy. The wind turbine is made up of steel and the first is based on the blades rotating axis, while the second is based on the rotating axis of the blades. Wind turbines are divided into two categories: horizontal and vertical axis. The turbine output is determined by the wind speed. The turbine generates varying amounts of power which are to provide a constant supply of electricity, the electricity is first stored in a battery unit before being transmitted to the load.

- *Batteries:*

Batteries are used to accumulate power generated by wind and solar sources. Battery capacity varies based on the scope of the solar power plant as well as the wind turbine. Battery maintenance should be minimal, and charge loss should be minimal. When all of these factors are taken into account, the free discharge type is the best option.To get the desired effect, multiple batteries can be linked in both series and parallel configurations. Depending on the output from the hybrid systems, raise or decrease the battery capacity.

- *Inverter:*

With the help of an inverter, the battery's DC output will be transformed into AC form at the required frequency and voltage output, which will then be distributed to the loads. This device never generates any kind of power because the power is generated by the dc source. Overvoltage protection, reverse protection, reverse polarity protection, and short circuit protection are all required on the inverter.

- *Micro-controller:*

The microcontroller's role is to compare the inputs from both power systems and then relay to charges the battery after the DC voltage that was used in the test with the help of an inverter, inverter voltage is converted into AC voltage which is fed into the battery. To be used in a center-tapped transformer's secondary coil there is a MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor) attached. To make the current in the pipe flow a MOSFET is triggered by a main winding alternate in nature.

- *Artificial Intelligence:*

In general, an AI model is a computer program that has been trained to perform specific tasks, such as identifying patterns, using a set of data. Artificial intelligence uses training and decision-making algorithms to learn from data, then apply what they have learned to achieve pre-determined objectives.

3.3. Data Collection:

In the data collection various component are taken which are used in the generation of the electricity are, PV panels having range from between 25kw-30kw, the battery is range from between 90Ah-100Ah, inverters are range from between 25kw-30kw, and wind turbines are range from between 25kw-30kw.

3.3.1. Solar Power system

Let us consider 1st 30kw PV panel, 30kw inverter, and battery of 100Ah. As a 30kw PV panel generates 120 units per day so this system should be used for loading conditions of 120kw/h day as presented in Table 1.

Table 1: Illustrating the Equipment and their Rating Detail which is used for Solar Power System.

Equipment	Rating	Lifetime(Years)
Battery	100Ah	2
PV	30kw	22
Inverter	30kw	25

3.3.2. Wind Power System

Let us consider 1st 30kw PV wind turbine, a battery of 100Ah. As a 30kw wind turbine generates 120 units per day so this system should be used for loading conditions of 120 kWh/day as presented in Table 2.

Table 2: Illustrating the Equipment and their Rating Detail which is used for Wind Power System.

Equipment	Rating	Lifetime(Years)
Battery	100Ah	2
Wind Turbine	30kw	20

3.3.3. Solar-Wind Hybrid Power System

Let us consider 1st 30kw PV, 30kw wind turbine, 30kw inverter, and a battery of 100Ah. As a 30kw PV panel generates 120 units per day and a 30kw wind turbine generates 120 units per day so this system should be used for loading conditions of 240 kWh/day as shown in Table 3.

Table 3: Illustrating the Equipment and Rating Detail of Solar-Wind Hybrid Power System.

Equipment	Rating	Lifetime(Years)
PV	30kw	22
Wind Turbine	30kw	20
Battery	100Ah	2
Inverter	30kw	25

The DC power energy generated by the hybrid power system is collected in a battery. The battery is monitored with the microcontroller and controlled with artificial intelligence automatically, after the DC voltage is converted into ac voltage by the inverter and then transfer to the load.

3.4. Data Analysis:

In the data analysis at first, we calculate separately the wind energy after that calculate separately the solar energy, at the end combine both equations as a result hybrid power is generated and the flow chart of hybrid system as shown in Figure 3. The use of hybrid system is the combination of two system such as wind and solar which produce electricity and both solar radiation as well as differ throughout the day thereafter battery is connected which used to store power generated through solar and wind thereafter microcontroller with AI which is used for monitoring and form automatically according to the system thereafter inverter is connected to battery which is used for dc output will be transformed into AC form at the required frequency and voltage output thereafter load is received converted voltages. The generated power is more as compared to the individual energy source which helped to reduce the dependence on a single source

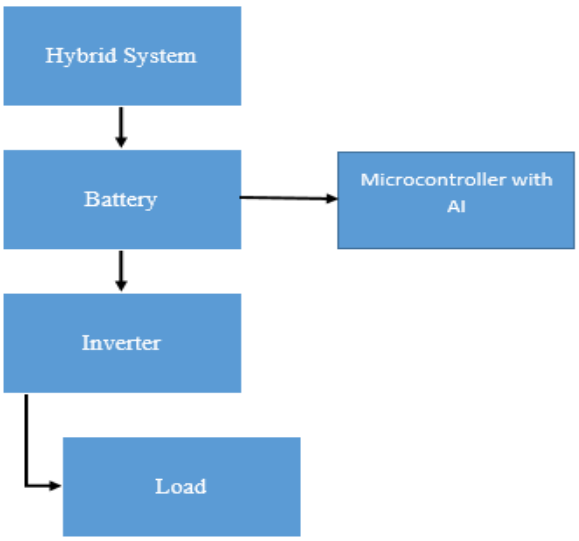

Figure 3: Flow Diagram of Hybrid Management System Which Monitoring with Microcontroller and Artificial Intelligence.

The use of artificial intelligence and microcontroller in solar-wind hybrid power generation system based is entirely automated using big data technologies and combines the advantage of hybrid systems, resulting in the monitoring of all measured value and data respectively without great initial effort. The above equation is generating more energy because it combined solar and wind power to give a hybrid power generation system.

4. RESULTS AND DISCUSSION

The wind power system generates power of 120kwh/day, and solar power generates the power of 120kwh/day overall power generated with the hybrid system is 240kwh/day. The power is sufficient to cover the electrical consumption for own house.A photovoltaic solar plus wind turbine hybrid system is ideal for climates with different seasons in wind and sun. As everyone all know that the wind doesn't blow throughout the day and the sun does not rise throughout the day. A hybrid system that harnesses the power of both the sun and wind and saves it in a battery could be a far more realistic and stable power source. Even when there is no wind or sun, the load can still be powered using the energy stored in the battery. Hybrid systems with artificial intelligence are usually built to plan systems with maximum reliability and the lowest possible cost.

Wind power and solar system are becoming increasingly popular which implies reversing the situation. A hybrid power system is made up of several different types of energy solar panels, wind turbines, and other RES, etc. charge batteries and supply electricity to meet the demands considering the local geography and energy needs other information about the installation site. These kinds of systems aren't also employed in stand-alone applications and can run on their own independently and consistently the most appropriate applications for this system are found in remote locations, such as rural areas, telecommunications, villages, and so on. The significance of hybrid systems has increased in popularity since they appear to be the best solution.The advantage of a hybrid system is providing continuous power supply power continuously,with no inconvenience.So, whenever electricity is interrupted,the battery's stored energy is utilized to solve the problem of electricity shortages.It has low maintenance cost, unlike older generators that run on diesel, these newer generators run on electricity. It has also high efficiency as compared with traditional generators which under specific circumstances, the fuel should be thrown away.

5. CONCLUSION

The use of artificial intelligence and microcontroller in solar-wind hybrid power generation system has been implemented so that the energy generating by the hybrid power generation system is more as compared to a single source. In this study that the energy produced by the system helps in decreasing on depending a single source and is more reliable, which is monitored by the microcontroller and controlled with artificial intelligence. Developing a hybrid system with artificial intelligence is one the most effective solution and convenient for generating electricity as compared to non-renewable energy.A hybrid power generation system has the advantage of a never-ending oil source. Naturally renewable sources of combining energy include sunshine, wind, water, biomass, and even geothermal (bottom) heat. The fact that renewable energy produces zero emissions and there are no greenhouse gases or other impurities throughout the process is probably the most significant advantage.Solar panels and wind turbines do not emit carbon dioxide while coal power plants emit carbon dioxide for each kWh of electricity (kWh) generated.Coal power plants generate significant amounts of carbon dioxide and nitrous oxide, two of the greatest greenhouse gases, directly into the environment. Mercury, lead, sulphur dioxide, particulates, and hazardous metals are also emitted, posing health risks ranging from shortness of breath to

early death. In the coming year, it can be used to generate electricity in the upper hill areas where normal transmission is challenging. It just requires some high initial investment. Not only is it expensive, but it also does not harm the environment.

REFERENCES

[1] vivintsolar, “benefits of solar energy to the environment”.

[2] D. Zhang *et al.*, “Research on the configuration and operation effect of the hybrid solar-wind-battery power generation system based on NSGA-II,” *Energy*, 2019, doi: 10.1016/j.energy.2019.116121.

[3] enelgreenpower, “All the benefits of wind power”.

[4] B. Xu, J. Zhang, M. Egusquiza, J. Zhang, D. Chen, and E. Egusquiza, “Exploring the regulation reliability of a pumped storage power plant in a wind–solar hybrid power generation system,” *Water (Switzerland)*, 2021, doi: 10.3390/w13182548.

[5] R. Zhu, A. L. Zhao, G. C. Wang, X. Xia, and Y. Yang, “An energy storage performance improvement model for grid-connected wind-solar hybrid energy storage system,” *Comput. Intell. Neurosci.*, 2020, doi: 10.1155/2020/8887227.

[6] Y. Du, L. Wang, and F. Wang, “Design and implementation of a wind solar hybrid power generation system,” in *E3S Web of Conferences*, 2019. doi: 10.1051/e3sconf/201911802024.

[7] M. M. Y. M. Al-Asbahi and L. Y. San, “Development of Vertical Axis Wind Turbines and Solar Power Generation Hybrid System,” *Int. J. Comput. Digit. Syst.*, 2020, doi: 10.12785/ijcds/090410.

[8] J.-H. Park and J.-D. Kim, “A Basic Study on the Airflow inside the Tower of Solar/Wind Hybrid Power Generation System,” *J. Power Syst. Eng.*, 2021, doi: 10.9726/kspse.2021.25.1.043.

[9] S. Rehman, “Hybrid power systems – Sizes, efficiencies, and economics,” *Energy Exploration and Exploitation*. 2021. doi: 10.1177/0144598720965022.

[10] Y. Yang, S. Guo, D. Liu, R. Li, and Y. Chu, “Operation optimization strategy for wind-concentrated solar power hybrid power generation system,” *Energy Convers. Manag.*, 2018, doi: 10.1016/j.enconman.2018.01.040.

[11] M.V.P. Geetha Udayakanthi, “Design of a Wind-Solar Hybrid Power Generation System in Sri Lanka,” 2015.

[12] W. Ghai, S. Kumar, and V. A. Athavale, “Using gaussian mixtures on triphone acoustic modelling-based punjabi continuous speech recognition,” in *Advances in Intelligent Systems and Computing*, 2021. doi: 10.1007/978-981-15-1275-9_32.

[13] JAKE FRANKENFIELD, “Artificial Intelligence (AI),” 2021.

[14] B. K. D. Bharat Raj Singh1, “SOLAR-WIND HYBRID POWER GENERATION SYSTEM,” 2018.

[15] R. P. Mandi, “A Hybrid Model of Solar – Wind Power Generation System,” 2016.

[16] K.Boopathi, “WIND - SOLAR HYBRID ENERGY PRODUCTION ANALYSIS REPORT,” 2016.

CHAPTER 4

PROTECTION SYSTEM FOR UNIVERSAL MOTOR USING INTERNET OF THINGS

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ABSTRACT: ***Universal motor is a special kind of electric motor that is operated with both supply alternating current (AC) as well as direct current (DC). It has a series of wound winding that allowed them to produce high torque for rotation of the rotor. The universal motor is operated at a higher speed on DC supply compare to AC supply because the reactance loss occurs only in the AC supply. Prevention of Universal motor from unbalanced supply and overload is a very complex issue. The Universal motor could be protected by manually disconnecting the supply but this has a high risk. This study is focused on the protection of universal motor using the internet of things (IoT) that can employ unbalanced supply occurrence. Herein the study the data are collected from the running universal motor and analysing the obtained data for the protection of the universal motor. The back electromagnetic force (EMF) is induced the torque for rotation of the shaft of the motor.The future demand for IoT is unlimited as it will be applicable for industrial advancement which will enhance network agility, as well as protect the security system of industries. The demand for protection systems for the motor is increasing day by day, so the security system using IoT is increasing together. There is a vast scope of research in the field of Universal Motor Protection systems through the innovation of new technology in the operational use of the universal motor protection system.***

KEYWORD: ***AC Supply, Back EMF, DC Supply, Universal Motor, Voltage.***

1. INTRODUCTION

A universal motor remains a superior kind of motor that operates on both alternating current (AC) besides direct current (DC) power supplies. The universal motor has series-wound winding which means the field windings and armature are in series. The series connection remains allowed them to produce high torque. Therefore, the universal motor is normally constructed into the device they remain destined to drive. Most universal motors have meant to function at speeds as high as 3500 revolutions per minute (rpm) [1]. The universal motor operates at an upper speed on a Direct current (DC) supply than an AC supply of a similar voltage. Because of the reactance voltage drip that remains to exist only cutting-edge AC supply, as well as reactance voltage drip, do not occur in DC supply. The field pole is connected to the stator, and the field coils remain coiled through the outfield pole in the universal motor. Mutually the armature and stator field circuit of a universal motor remain coated for reduction of the eddy currents that are produced while working on AC supply. A universal motor rotary armature is composed of straight or oblique slots to which the commutator and brushes are attached [2]-[3]. Armature coil on AC has poor commutation as compared to DC due to induced current being state-of-the-art. Whenever a Universal motor remains associated with a direct current (DC) supply, it performs like a DC series motor.

Therefore, whenever current is flowed by the field winding, it generates an electromagnetic field. The identical current drifts in the armature electrodes, as well as the current-carrying electrode, remains employed in cutting-edge a magnetic field, and the conductor experiences a mechanical power. This mechanical power is caused for the rotation of the rotor [4]-[5]. The unidirectional torque is generated by the AC power supply in the universal motor. This

happened due to the field winding besides armature winding remaining aligned with cutting-edge series and similar phrases. When the polarity of the AC supply is changed then the direction of the current cutting-edge armature besides field winding is changed concurrently [6]-[7]. Therefore, the direction of force employed on armature conductors remains identical. Hence, the Universal motor is performed on the same principle that DC series motors perform. The universal motor failed to operate due to fluctuation of electric supply, overcurrent, overload, and low or high voltage supply [8]-[9]. Therefore, the universal motor is protected through applying protection procedures.

1.1. Type of Universal Motor Protection:

Motor protection remains rummage-sale to avoid damage to an internal part of the universal motor. Also, external conditions whenever it is linked to abnormal energy supply then protection system is triggered to prevent the universal motor, the protection relay delivered main protection to the motor that can be used Circuit breaker. Various protection systems are used to protect the universal motor as shown in Figure 1.

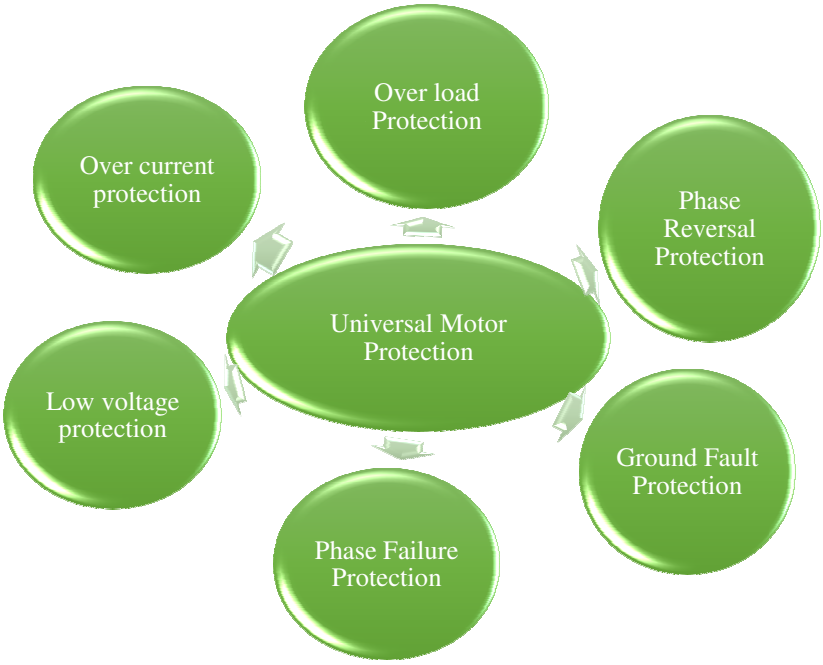

Figure 1: The above Block Diagram represents several types of protection systems for universal motor[10]**.**

- *Overload protection:*

Overload protection is a special type of protection that is opposed the mechanical overload. The overload conditions may happen in the universal motor when the motor is in running condition. The overload condition can result in the temperature of the motor than can damage the motor [11]-[12]. The protection unit is used to disconnect the motor in an overload situation from the main power supply.

- *Overcurrent protection:*

When an extreme amount of current flowed by the universal motor then the protection units trip. Fuses and circuit breakers are used as protection units for the protection of universal motor as well as overcurrent protection units may defend personnel from electric shock [13].

- *Low voltage protection:*

When the voltage is decreased to below the rated value for running the motor then a protection unit is applied to separate the motor from the supply voltage. The protection units may be reset to balance when the voltage steadied to the rated value and the motor is activated again when the supply voltage is a balance to the normal value [14].

- *Phase Failure protection:*

Phase failure protection is employed for the safety of the motor in case of any phase failure during the running condition of the motor. It is generally engaged with 3-phase motors and keeps on running even if the phase failed in the circuit which may burn the universal motor or affect the task of the motor [15].

- *Phase Reversal protection:*

Protection technology is utilized to protect the motor from phase reversal conditions. Phase reversal inside a universal motor could occur due to several reasons which are a reason of safety and operational problems. If two out of the three connections of the motor are reversed then the motor operates rotating in the opposite direction. When detecting reverse rotation of the motor, the protection unit is separated the motor from the supply [16].

- *Ground Fault protection:*

A ground fault is occurred due to several short circuit conditions as well as an extreme number of current flows in the motor that is the cause of the short circuit. Ground fault protection is used to separate the motor in the situation of ground fault occurrence.

2. LITERATURE REVIEW

Jérôme Cros et al. [17], discussed a novel structure of universal motor utilizing soft magnetic composites. According to the author,In addition to the concentrated winding technique, a novel universal motor fabrication was based on the effective use of the isotropic magnetic properties of the soft magnetic mixture. The author demonstrated the comparison between classical universal motor structures and new structure universal motor with closely matching performance and the total volume of the classical universal motor was 200% more than the new structure universal motor. The study held that the new structure of the universal motor had a minor numeral of poles for minimizing the magnetic damages besides a upper numeral of coils/winding path was used for improving the commutation performance that would be more beneficial for cutting-edge high-speed range.

Gregor Papa et al. [18], discussed the improvement of universal motor efficiency used by evolutionary optimization. The author presented a novel design process for improvement in the efficacy of universal motor that was rummage-sale cutting-edge home appliances as well as power tools. The main objective of the study remained to detect the self-governing geometrical parameter of the rotor besides the stator to decrease the motor's energy wounded that occurred iron losses and copper losses in the universal motor. The author said that the iron and copper losses were reduced by 20% through a genetic algorithm (GA) and the running time of the universal motor was increased.

Barbara Seljak and Gregor Papa [19], discussed the efficiency development of the universal motor through an approach of Artificial Intelligence. The study presented a project approach aimed at improving the efficacy of a universal motor. The main objective of optimization remained to analyse the optimum standards of the self-governing geometrical parameter of

the rotor besides the stator of the universal motor which had the aim to decrease the energy losses that occurred in the cutting-edge universal motor. The developing software was linked with a genetic algorithm (GA) that optimized the geometry of the rotor as well as the stator of the universal motor. The procedure of loss reduction was founded on a genetic algorithm GA through using it, besides the efficacy of universal motor was improved.

Marius D. Marco et al. discussed the universal Motor protection system Founded on Microcontroller embedded Algorithm [20]. The author said that industrial issues in verifying, analysing, besides regulatory aggregates powered through DC motors remains to protect in contradiction of dissimilarities above the machines' nominal operational limits. The current paper suggests an optimized technical solution aimed at low voltage, overvoltage, and overload protection in an extensive range of incessant present motors. A microcontroller circuit is used to protect the motor via a relay founded on the data obtained from the sensors. The microcontroller unit (MCU) is an integral part of the overall control system. Using an MCU, one can develop various algorithms that organize the movement of different components more efficiently, reduce the power consumption, shorten control algorithms and increase the accuracy of control processes.The application-specific code C package also includes all of the initialization routines as well as the main application kernel. As a result, the software structure is as robust as possible.As the above literature has inappropriate information on the implementation of a protection system for Universal motors using the internet of things. This study is better than the earlier study on the protection system of universal motor. The microcontroller is communicated to the universal motor through the Internet of things (IoT). This study also demonstrated the protection of the universal motor.

Research question:

- How to protect the universal motor from an unbalanced supply?
- How to implement the Internet of things in the protection system of the universal motor?

3. METHODOLOGY

3.1 Design:

In this research, the universal motor is protected through Pulse with modulation (PWM) chopper using the Internet of Things. In the present study, AC main supply is associated with a bridge rectifier that is used to rectify the AC supply and it is converted the AC supply into a DC supply.

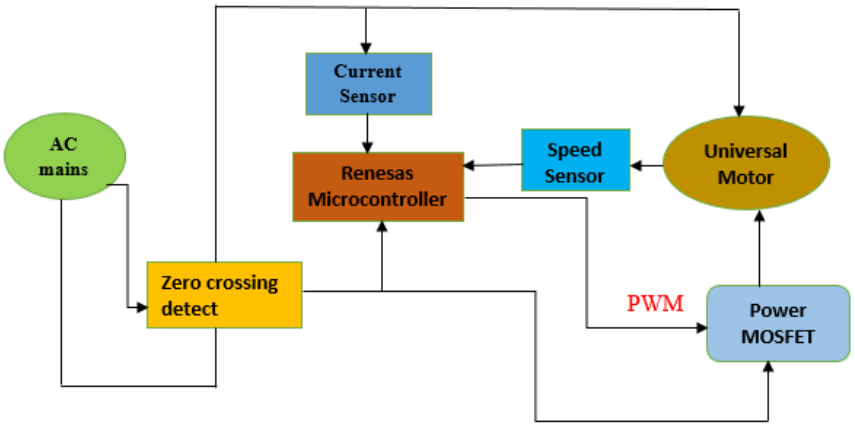

Figure 2: The above Block Diagram represents the Protection system of Universal Motor by the Internet of things

The bridge rectifier is connected with the Current sensor, Renesas microcontroller, and electric energy metal-oxide-semiconductor field-effect transistor (MOSFET). When the overcurrent is flowing in the universal motor then overcurrent flow is detected by the current sensor and generates a signal to the microcontroller to protect the universal motor overcurrent flow. The speed sensor remains utilized to sense the speed of the universal motor and generates a signal to the microcontroller for the safety of the universal motor. The power MOSFET is used to handle the high power which is delivered from the bridge rectifier. The entire process for the protection of the universal motor is shown in Figure 2.

3.2. Instrument:

In this research paper, various components are employed to the protection of universal motor from an unbalanced supply using the internet of things (IoT) that are applicable to decrease the damage inside the motor. There are the following components that are used for the protection of the universal motor.

- *Current Sensor:*

The current sensor is employed for current measurement and alternating current is converted to an effortlessly measurable voltage by the current sensor that remains proportional to the current by the measurable path. The current sensor is recognized as a current to voltage converter.

- *Renesas Microcontroller:*

Renesas Microcontroller remains associated with Speed Sensor, Current sensor, Bridge rectifier, and Power MOSFET. The Microcontroller has received a signal from the Current sensor, speed sensor, power MOSFET, and bridge rectifier, and generates the command signal for the protection of the universal motor which is already programmed in the microcontroller.

- *Speed Sensor:*

The speed sensor stays used for detecting the shaft speed of the universal motor and the direction of spin. The speed sensor is associated with the microcontroller and has delivered the signal regarding the speed of the universal motor to the microcontroller.

- *Bridge Rectifier:*

The Bridge rectifier remains directly connected with AC main supply that delivers the full-wave rectification by converting AC discrete supply into a Pure DC supply. The bridge rectifier remains also allied with Renesas Microcontroller and current sensor.

- *Power MOSFET:*

Power MOSFET is applied to handle high power that is delivered from the Bridge rectifier and can perform better in comparison with other normal MOSFETs. Power MOSFET is coupled with Renesas Microcontroller and provides the signal for controlling the high DC power supply from Bridge Rectifier to Microcontroller.

3.3. Data Collection:

The unbalance supply is caused by the damage to the universal motor. AC main Supply is connected with a bridge rectifier that is used to convert the AC supply into pure DC supply. The power MOSFET is associated with DC supply and (PWM) MOSFET protection system using IoT is a progressive solution aimed at protecting the angular velocity of Universal

motor. Cutting-edge this research rectified AC line voltage remains switched at a high frequency through power an energy MOSFET to produce time variable voltage for the motor. Herein study data are collected from a universal motor that is operated with overload as shown in Table 1.

Table 1: This table illustrates the data collected from the Universal motor's active overload, which are Field winding current in Ampere, Running Time of Universal Motor, and Angular velocity of Universal motor.

The field winding Current (*if*) in Ampere	Running Time (T) of Universal Motor in (second)	Angular velocity (ω) of Universal motor (radian/second)
0.05	2	360
0.07	3	540
0.09	4	720
0.11	5	900
0.13	6	1080

3.4. Data Analysis:

When the unbalance supply is connected with the Universal motor and extreme field winding current is induced in the magnetic coil of the universal motor it affected the speed of the universal motor. The magnetic field cutting-edge the motor generates the back emf *Vb* cutting-edge the armature of universal motor.

$Vb = L_{af} * if * \omega$

Where *Laf* remains a constant of proportionality, *if* remains field winding current and ω is the angular velocity.

$If_1 = 0.05$, $\omega_1 = 360$, $Laf = 1$

$Vb_1 = Laf * If_1 * \omega_1 = 1 * 0.05 * 360 = 18$ volt

$Vb_2 = 37.80$ volt, $Vb_3 = 64.80$ volt, $Vb_4 = 99$ volt, $Vb_5 = 140.40$ volt

The mechanical power remains equal to the power responded through the back EMF:

$P = vb * if = L_{af} * if^2 \omega$

Speed of universal motor $Us = \omega/6$

$Us_1 = \omega_1 / 6 = 360/6 = 60$ rpm,

$Us_2 = 540/6 = 90$ rpm, $Us_3 = 720/6 = 120$ rpm, $Us_4 = 150$ rpm, $Us_5 = 180$ rpm

The project is analyzing data that has been collected from the universal motor that is connected with AC unbalanced supply. The AC unbalance supply is converted into DC supply by rectifier and DC unbalance voltage has flowed in universal motor that is caused by

overvoltage fault occurrence. According to Table 1, 0.05 ampere (A) field winding current and 360 rad/second angular velocity are induced at 18 volts back emf in the universal motor, as well as the speed of the motor, is 60 rpm. Another field winding current 0.07 A and 540 rad/ sec angular velocity generates the 37.8V back emf including the speed of motor 90 rpm. The angular velocity (720 rad/ sec) and field current (0.09) of the motor are produced by the back EMF 64.8 volt and the speed of the rotor is 120 rpm. 99 volt back EMF is generated by the field winding current (0.11) and angular velocity (900) of the motor and back emf generate 150 rpm speed of the motor. The back EMF (140.4 volts) is induced through a 0.13A field winding current and 1080 rad/sec angular velocity, as well as the speed of a motor, is 180 rpm. Table 2 represents the data of Universal motor, which are back emf Voltage, Running time of universal, and Speed of Universal motor active overvoltage.

Table 2: This table represents the data of Universal motor, which are back emf Voltage, Running time of universal, and Speed of Universal motor active overvoltage.

Back emf Voltage (Vb) in volt	**Running Time of Universal motor (second)**	**Speed of Universal motor (rpm)**
18	2	60
37.80	3	90
64.80	4	120
99	5	150
140.40	6	180

4. RESULTS AND DISCUSSION

The universal motor remains a special kind of motor that can be activated on both electric supply AC and DC energy as well as usages an electromagnet as its stator to produce the magnetic field. The universal motor shaft is wrapped with the laminated coil that is a commutated series-wound motor where the field coils of the stator remain related cutting-edge series with the coil of the rotor by the commutator. The universal motor remains very close to DC series motor cutting-edge construction. Therefore, a slight modification of the DC motor could be operated with an AC supply. The universal motor is generated high torque and can run at high speed as well as has a compact and lightweight structure. The DC supply associated with the universal motor is generated high torque compare to the AC supply because of AC supply is produced reactive loss in the universal motor, but the DC supply is not produced any reactive losses inside the core of the universal motor.

In the previous research, the authors present a universal motor structure that makes effective use of the soft magnetic composites' isotropic magnetic properties and the concentrated winding technique.The previous study optimization's goal was to find the independent geometrical parameters of the rotor and stator in order to reduce the motor's power losses, which occur in iron and copper.The previous study's procedure is based on a genetic algorithm (GA), and it was able to significantly improve the motor's efficiency by using this procedure.it was able to reduce the iron and copper losses of an initial Universal motor by at least 20% by using the GA, and we were able to boost the GA running time or set its

parameters more appropriately by using the GA. The use of a microcontroller in the digital control and regulation of electric motors proved to be very effective, lessening work in designing the traditional protection. But the present study is based on a universal motor protection system using IoT, the microcontroller interacts with a universal motor whenever an electric fault is detected which protects the universal motor from an electrical hazard that happened infrequently of the second.

The prevention of universal motor from unbalanced supply and overload is a huge challenge in front of industrial appliances as well as commercial appliances. Herein the study, the data are collected from the Universal motor's active overload that is influenced by the angular velocity (360, 540, 720, 900,1080 in rad/sec) of the universal motor due to the field winding current (0.05, 0.07,0.09,0.11,0.13 in Ampere). The back EMF is induced in the magnetic coil of the universal motor that is exerted torque for rotation of the rotor. The back EMFs are induced corresponding 18, 37.8 volts, 64.8, 99, and 140.40 volts. The back EMF is caused by torque applied on the rotor's shaft that is generated at the speed corresponding to 60, 90, 120, 150, and 180 rpm as shown in Figure 3.

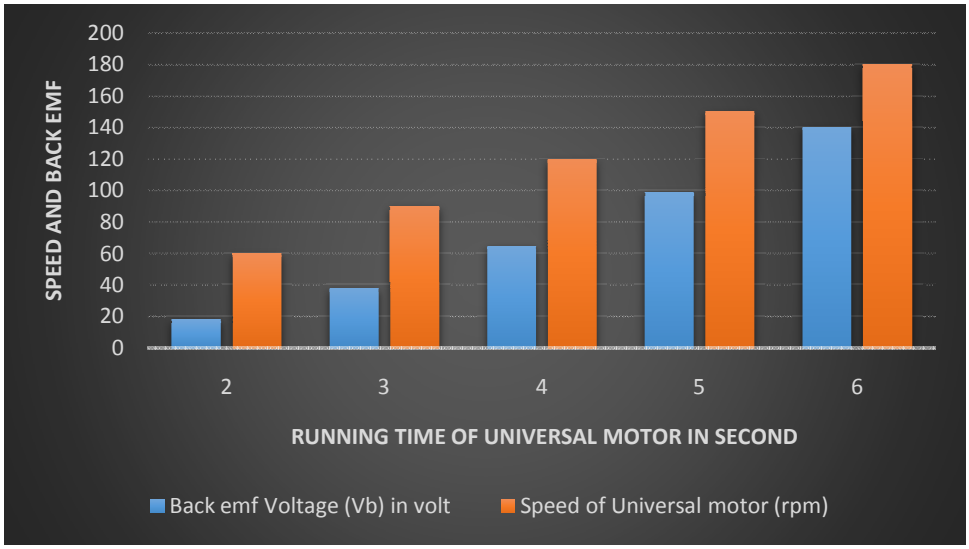

Figure 3: The above graph represents the Back EMF, Speed of the Universal motor, and running time of the Universal motor.

5. CONCLUSION

The universal motor stands an exceptional motor that may be functioned with both supply AC and DC and the DC series motor is similar to the Universal motor in its construction. In the construction of a universal motor, if the slight change in its construction can be operated with an AC supply. The universal motor is protected from unbalanced supply and overload through a protection system using the Internet of Things. The Internet of things is used to compensate for the communication gap between the microcontroller to other protection system components such as power MOSFET, current sensor, and speed sensor. The back EMF is induced due to the armature current flow in an electromagnetic coil of the motor such as 18, 37.8, 64.8, 99, 140.40 volts, and the speed of the motor (60, 90,120, 150, 180 in rpm) is generated due to back EMF. The future demand for IoT is unlimited as it will be applicable for industrial advancement which will enhance network agility, as well as protect the security system of industries. Also, the use of IoT will help in reducing operating costs and improve the quality of service. The protection system of the universal motor will be employed in various industrial and commercial appliances as well as household appliances.

REFERENCES

[1] Byju's, "Univeral motor".

[2] H. Qi, L. Ling, C. Jichao, and X. Wei, "Design and research of deep slot universal motor for electric power tools," *J. Power Electron.*, 2020, doi: 10.1007/s43236-020-00131-6.

[3] V. Anand, "Photovoltaic actuated induction motor for driving electric vehicle," *Int. J. Eng. Adv. Technol.*, 2019, doi: 10.35940/ijeat.F1298.0986S319.

[4] N. Kishore and S. Singh, "Torque ripples control and speed regulation of Permanent magnet Brushless dc Motor Drive using Artificial Neural Network," in *2014 Recent Advances in Engineering and Computational Sciences, RAECS 2014*, 2014. doi: 10.1109/RAECS.2014.6799498.

[5] M. N. Jyothi, D. V. Rai, and R. Nagesh babu, "Identification and Characterization of High Temperature Stress Responsive Novel miRNAs in French Bean (Phaseolus vulgaris)," *Appl. Biochem. Biotechnol.*, 2015, doi: 10.1007/s12010-015-1614-2.

[6] B. K. Singh, N. Trivedi, A. Agarwal, and A. Gupta, "Current challenges in clinical trials in India," *Pharma Res.*, 2013.

[7] G. Goswami and P. K. Goswami, "ANFIS Supervised PID Controlled SAPF for Harmonic Current Compensation at Nonlinear Loads," *IETE J. Res.*, 2020, doi: 10.1080/03772063.2020.1770134.

[8] O. A. Imran, W. N. al-din Abed, and A. N. Jbarah, "Speed control of universal motor," *Int. J. Power Electron. Drive Syst.*, 2019, doi: 10.11591/ijpeds.v10.i1.pp41-47.

[9] P. K. Gupta and S. Gupta, "Generation of green electricity with pedal generator," in *Proceedings of the 2018 International Conference on System Modeling and Advancement in Research Trends, SMART 2018*, 2018. doi: 10.1109/SYSMART.2018.8746927.

[10] ELECT GO, "Motor Protection," 2019.

[11] S. Jain and A. K. Saxena, "A survey of load balancing challenges in cloud environment," in *Proceedings of the 5th International Conference on System Modeling and Advancement in Research Trends, SMART 2016*, 2017. doi: 10.1109/SYSMART.2016.7894537.

[12] K. G. Verma, B. K. Kaushik, and R. Singh, "Propagation Delay Variation due to Process Induced Threshold Voltage Variation," in *Communications in Computer and Information Science*, 2010. doi: 10.1007/978-3-642-15766-0_87.

[13] R. Vaddi, R. P. Agarwal, S. Dasgupta, and T. T. Kim, "Design and analysis of double-gate MOSFETs for ultra-low power radio frequency identification (RFID): Device and circuit co-design," *J. Low Power Electron. Appl.*, 2011, doi: 10.3390/jlpea1020277.

[14] R. Vaddi, S. Dasgupta, and R. P. Agarwal, "Robustness comparison of DG FinFETs with symmetric, asymmetric, tied and independent gate options with circuit co-design for ultra low power subthreshold logic," *Microelectronics J.*, 2010, doi: 10.1016/j.mejo.2010.02.003.

[15] K. Sharma and L. Goswami, "RFID based Smart Railway Pantograph Control in a Different Phase of Power Line," in *Proceedings of the 2nd International Conference on Inventive Research in Computing Applications, ICIRCA 2020*, 2020. doi: 10.1109/ICIRCA48905.2020.9183202.

[16] N. Kumar, N. Verma, O. Songh, N. Joshi, and K. G. Singh, "Estimation of atenolol by reverse phase high performance liquid chromatography," *E-Journal Chem.*, 2010, doi: 10.1155/2010/601650.

[17] J. Cros, P. Viarouge, Y. Chalifour, and J. Figueroa, "A new structure of universal motor using soft magnetic composites," *IEEE Trans. Ind. Appl.*, vol. 40, no. 2, pp. 550–557, 2004, doi: 10.1109/TIA.2004.824491.

[18] G. Papa, B. Koroušić-Seljak, B. Benedičič, and T. Kmecl, "Universal motor efficiency improvement using evolutionary optimization," *IEEE Trans. Ind. Electron.*, vol. 50, no. 3, pp. 602–611, 2003, doi: 10.1109/TIE.2003.812455.

[19] G. Papa and B. Koroušić-Seljak, "An artificial intelligence approach to the efficiency improvement of a universal motor," *Eng. Appl. Artif. Intell.*, vol. 18, no. 1, pp. 47–55, 2005, doi: 10.1016/j.engappai.2004.09.003.

[20] M. D. Marcu, R. I. Slusariuc, F. G. Popescu, and L. B. Samoila, "Universal DC Motor Protection System Based on Microcontroller Embedded Algorithm," *2018 Int. Symp. Fundam. Electr. Eng. ISFEE 2018*, no. 20, 2018, doi: 10.1109/ISFEE.2018.8742423.

CHAPTER 5

MICRO HYDROPOWER GENERATION AND DISTRIBUTION USING ARTIFICIAL INTELLIGENCE

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ABSTRACT*: *One of the most important pillars for correct modelling of the difficult optimization of cutting-edge Micro Hydropower Plants (MHP) is the hydropower production structure.Emerging countries that need resources must undertake stress cracking to stabilize the power system.The stream rate of aquatic cutting-edge release gates remains an appropriate interest aimed at problem optimization because it is based on the relationship between the reservoir's water height and the capability of the micro hydro-turbine cutting-edge the tank. This study is focused on Micro hydropower generation as well as distribution using Artificial intelligence.A micro hydropower generating unit, for instance, has a small dam or water reservoir, turbine, and generator, as well as a power distributing unit that comprises a step-up transformer, electric utility, and artificial intelligence.The execution of micro-hydro schemes with novel cost-effective designs is expected to result from cutting-edge local industry expansion, which will lead to general economic growth in developing countries, and also social development. There is a wide scope of research in the field of micro-hydropower generation, other research is the possibility of a developed novel method for micro hydro-power generation.

KEYWORDS*: *Artificial Intelligence, Micro Hydropower, Reservoir, Transformer, Turbine.

1. INTRODUCTION

Hydroelectricity generation was a golden period of cutting-edge the 1st half of the 20th century earlier oil was regulated on the power of overriding cutting-edge the delivery of vigor. Numerous developing countries began to convert out oil and coal based on coal, oil besides natural gas as oil prices rose, fossil fuel costs rose, thermal pollution rose, and the global energy crisis increased, allowing renewable hydro plants to take their place. In recent times, the energy demand is increasing day by day, requiring more electric energy generating resources and dissimilar power grid constructions. The emerging countries that require obtaining resources must accomplish load cracking that can stabilize the power scheme. The generators that remain connected to a hydro-turbine grow slowly as the load grows, causing the output to be influenced by lowering the rate of electrical energy. As a result, the whole scheme would go up, resulting in a cascaded or blackout failure [1]. For most dependability annotations of generation schemes, the energy reserve aimed at power output is assumed to be available at all times. This indicates that the electrical generation portion of the power plant's general failure is the only single cause of the energy manufacturing deficit. An abundance of energy generation defeats the instruction of water stream rate when the lake remains enough to ensure power, showing that this model remains correct [2].

The stream rate of aquatic cutting-edge release gates remains an appropriate optimal aimed at problem optimization since it is based on the relationship between the reservoir's water height and the capability of the micro hydro-turbine. One of the most important pillars for correct modelling of the difficult optimization cutting-edge Micro Hydropower Plants (MHP) is the hydropower production construction. Let's examine how the construction of micro-hydropower relates to the hydropower system, as well as how the water may easily get into the entire detail of micro-hydroplane discharge [3]-[4]. In hydro-turbine power production optimization, relying on unit numbers in operation, the connection between water flow rate

and power production is difficult and nonlinear. It has become more complex because the system's overall loss is decided by entire units released cutting-edge the plant. When a single of the generation path solutions remains an assorted integer with a linear programming model, the success of linear programming influences the behaviour and situation of the nonlinearity method [5]-[6].

The flowing water strikes a hydro turbine, that mechanically converts it to rotational power, and the turbine's rotating shaft is hooked to an electric generator. The efficiency of a turbine is largely controlled by the turbine's power, type, the water flow rate [7]. Kaplan turbine can be analyzed that its efficacy remains to achieve to the highest worth aimed at numerous run rates of water, indicating that these types of turbines are desirable for a river with a changing water flow rate regime Ground acceleration, water flow rate, water drop height, and general efficiency are the four factors that make it up a hydropower plant's unit of generating electricity [8]-[9]. There are 3 kinds of micro-hydro power amenities such as diversion micro-hydropower units, impoundment micro-hydropower units, and micro pumped storage.

1.1. Impoundment micro- hydropower generating unit:

The impoundment facility, Micro-hydropower remains a small hydropower scheme that usages a dam to stock aquatic cutting-edge a reservoir. The flowing water remains stroked to the blades of the turbine, and the turbine converts its rotational energy. The rotating shaft of the turbine is coupled with an electric generator that is produced electricity [10]-[11]. The aquatic might be discharged to content altering electricity demands, plus other needs such as recreation, fish passage, and flood control besides other ecological and aquatic quality problems.

1.2. Diversion micro- hydropower generating unit:

The channel section of a river through a canal diverts flowing water for hydroelectric power generation that utilizes the natural inclined of river bend evaluation to produce the electrical energy. The flow of water remains controlled through gates, and valves, besides turbines in a penstock, which remains a closed conduit that channels aquatic to turbines; hence, the dam may not be obligatory aimed at a diversion [12]. Water is realized by gates as per the requirement for electricity that strikes to turbine’s blade and produces electricity.

1.3. Pumped Storage micro- hydropower generating unit:

Storage of Pumps Pumping aquatic from the lower lake to the upper reservoir enables the Micro-Hydropower Generating Unit to store energy. Water storage is used to produce electricity whenever there is a high electricity demand, water is released to strike the blades of the turbine, and the rotating shaft of the turbine remains attached to an electric generator. The induction generator is used as a backup source of energy production for synchronous generator micro-hydropower, a definition of low production costs [13]. When compared to synchronous generators, induction generators have a lower rate per unit of electric power [14]-[15]. Electricity is generated from an electric generator that is transmitted through the power grid. The electric generator of the micro-turbine has produced the electricity in alternating current (AC) form. The AC supply is converted into a direct current (DC) supply through an “AC to DC converter” and then the DC supply is transmitted through the power grid to the sub-station. For long transmission AC supply must be used to convert in DC Supply because DC supply is not produced eddy current loss as well as Hysteresis loss, therefore DC supply is used for long supply instead of AC supply.

Micro-hydro power generation and distribution of electricity using artificial intelligence are the main focus of this current study. The present study is divided into multiple sections, the first is an introduction and second is a prior review regarding this Micro-hydropower generation and distribution as well as the third is the methodology of the current study. After that, the result and discussion regarding this study and the next conclusion of this study.

2. LITERATURE REVIEW

Yanlai Zhou et al. discussed Small-hydropower installation settled upon optimal aquatic. Distribution and taking action to stimulate synergies of the aquatic-food-vigor nexus [16]. This study suggested that a complete scheme-extensive solution compelled through aquatic resources perspectives encountering micro-hydroelectric power production by artificial intelligence (AI) techniques to control the interactions of the aquatic-food-energy (AFE) Nexus. The suggested 3-faceted methodology was investigated deliberately by enhancing several-sectoral aquatic distribution, expanding the establishment of little hydropower turbines lined up with the acquired ideal several-sectoral water allotment, as well as elevating the synergistic advantages of the WFE (Water, Fuel, Energy) Nexus controlled through the ideal aquatic designation besides micro hydropower establishment. The author's analysis of M-5 execution principal curves imitation like the benchmark and comparative results obtained have illustrated the several-year combined optimization below the association of water distribution beside micro- hydropower installation. The average yearly food production was raised by approximately 10.6% as well as annual hydro production was improved by about 7.5 %. This study not only unlocks new prospective for clean energy generation as well as care about production benefit.

Krishna Kumar and R.P Saini demonstrated the application of Artificial Intelligence for optimal hydropower energy production [17]. Both authors said that Hydropower generation is a special promising source of renewable power generation that had delivered an impact on the environment clean and pollution-free. The authors suggested to the analysis feasibility study, itemized project report readiness, development arranging, and ideal implementation of work remain the significant exercises of a hydropower plant. Energy generation cutting-edge hydropower plants chiefly rely upon release and head. Along these lines, an exact assessment of release and head is vital to choosing the plant limit. Disintegration, cavitation, activity, and upkeep are critical difficulties in the hydropower energy age. Man-made consciousness artificial intelligence (AI) has developed well known, which may be used aimed at site determination as well as parameters assessment and timely execution of work. This study showed the implementation of artificial Intelligence for hydropower generation that had identified the future potential areas of hydropower plants.

Ali Thaeer Hammid et al. demonstrated the forecast of a small hydropower plant cutting-edge Himreen Lake dam through Artificial Intelligence [18]. According to the author, the developing countries had less capacity to develop electricity as per demand inside the countries. Hence, a small hydropower plant (SHP) included a Kaplan turbine remained specified to discover its relevance. This study emphasized on implementation of Artificial Neural Networks (ANNs) and back-propagation was built on activity prediction of waterpower plants. Stream rate of aquatic besides influence creation that information accumulated throughout an examination north of a long-term period. The model investigated the vulnerabilities of data sources and result activity and there was planning to organize design and afterward prepared through the whole of 3570 trial and noticed information. Besides, ANN offers a breaking down and diagnosed instrument actually to demonstrate the execution of the nonlinear plant. The study proposed that the ANN might analyze the activities of plants and predict the output power generation.

Guo-ping Liao et.al explained hydroelectric producing units' Fault diagnosis through a one-D conventional Neural Network as well as a gated recurrent unit in small hydropower generation [19]. According to the statement of the authors, the Machine learning algorithm was founded on hand-made topographies that demonstrated the actual result of cutting-edge the hydropower generating unit (HGU) error diagnosed in current years. The author said that the methodology of hydropower generation led to specific data loss cutting-edge representing the vibration indication, and a gated recurrent unit (GRU) founded on continuous data was proposed. The performance of Hydropower energy was suggested to verify through likening with the outcomes of additional machine learning techniques.

As the above literature has inappropriate information regarding the Micro Hydropower Generation and Distribution using AI. This study is better than the earlier study on the power generation and distribution from Hydropower generation. The distribution of electric power is monitored by an energy meter comprised of AI. This study also demonstrated the distribution of hydropower Monitored through the energy meter comprised with AI.

Research question:

- How the AI-powered energy meter monitors power distribution?
- How to implement micro hydel power generation units equipped with AI for power distribution monitoring system?

3. METHODOLOGY

3.1. Design:

The micro hydropower generating unit especially consists small Dam or water Reservoir, turbine, and generator as well as a power distributing unit comprised of a step-up transformer, Electric Utility, and Artificial intelligence. The water is flowed through the penstock from a reservoir to the turbine and flowing water hits to blades of the turbine transforming hydraulic power into mechanical power. The governor of micro-hydro power has controlled the water flow in the turbine as well as the main function of the governor remains to regulate the generator turn, therefore the rate of the generator has not varied through the supply of water. The generator is associated with a turbine, and the generator is converted mechanical energy into electrical energy. The step-up transformer is connected with a generator that converts the low voltage to high voltage as well as electrical Utility (power grid) is controlled the electric power distribution to another electric sub-station. The distribution of electric power is monitored through an energy meter using artificial intelligence (AI) and also the amount of producing electric power has been calculated through artificial intelligence as shown in Figure 1.

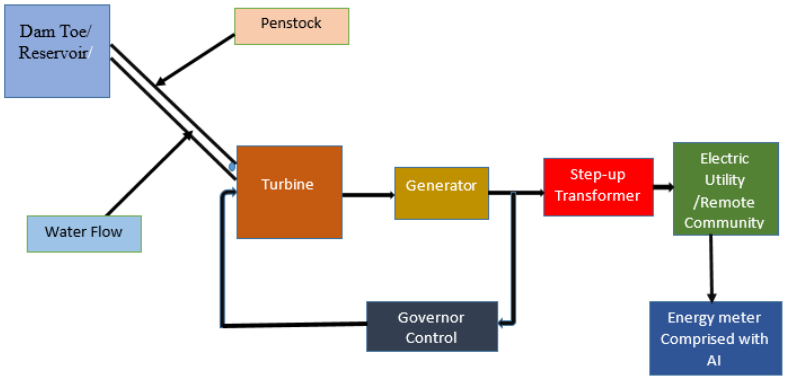

Figure 1: Illustrates the Block Diagram of Micro Hydropower Generation comprised with Artificial Intelligence.

3.2. Instrument:

In this research paper, numerous components are used for micro-hydro power generation which is applicable to compensate for the requirement of electricity in the Rural and urban areas with the utilization of renewable energy. These are the following various components for micro-hydro power generation as discussed below.

- *Reservoir:*

A micro-hydroelectric reservoir is a small pond behind a hydroelectric dam that generates electricity by utilizing the potential power of water. The dam holds back most of the water, therefore a small amount remains allowed to flow down the dams found to generate electricity when it's desirable. These reservoirs are a sort of water storage that is particularly important for hydropower. The water in the micro-reservoir of a hydroelectric facility is at a higher elevation on one side of the dam than on the other. The hydraulic head is the height with which this water flows.

- *Turbine:*

The Kaplan turbine is 30m apart from the height of the reservoir that obtains the physically hydro force strikes to the blades of the Turbine and converted into rotational power. The rotating shaft of the Turbine is coupled with an electric power generator. Kaplan turbine has been observed that efficiency of the turbine is achieved to the highest value aimed at numerous stream rate of water and flow of water is controlled by penstock as well as Kaplan turbine has high shaft speed.

- *Generator:*

The induction generator is used instead of a synchronous generator to generate electricity in microsystems. As a result, of induction generators, the cost per unit of electricity is reduced. The electric induction generator is coupled with the rotating shaft of the Kaplan turbine that converts the mechanical power into electrical power. Induction generators are more efficient, with a simple starter and control mechanism, as well as fault protection. Instead of single-phase induction generators, 3-phase induction generators are used, which convert 3 -phase power into single-phase energy and then supply it to single-phase loads.

- *Step-up-Transformer:*

Step-up-Transformer is connected with a 3-phase induction generator that is used to increase the voltage from primary to secondary. The 10 KVA step-up transformer has a 240-volt yield and a current capability of 41.670 amperes (10,000 watts / 240 volts equal to (=) 41.67 amperes). Step-up-transformer is associated with electric utility units as well as 3-phase step-up transformer are designed to be compatible with current infrastructure and equipment. They could keep the power grid safe, lower the chance of power failures, and help generators run more efficiently.

- *Energy meter Comprised with Artificial Intelligence:*

The energy meter comprised of (AI) is linked with the Electric Utility units that are used to monitor power generation as well as power distribution. AI Energy meter has been used to forecast the yield of hydropower plants in terms of net turbine head, power generation as well as water flow rate. To simulate the nonlinear plant output, it delivers an actual instrument for analysis besides diagnosis. The AI energy meter could forecast plant presentation and the

coefficient of correlation amid the forecast besides detected output variables is higher than 0.960, per the results.

3.3. Data collection:

The most widely used renewable energy source in the world is micro hydropower plants. It produces 18.99 percent of the world's electricity. On a broad scale, the micro hydropower potential has been exploited in almost every corner of the planet. However, its small-scale potential has yet to be exploited, Micro-hydro energy may be found in almost every nation on this planet as shown in Figure 2. The data on micro-hydro power generation has been collected from several countries that are sharing India's border and the capacity of micro-hydropower generation of these countries (Shrilanka, Nepal, Bhutan, Bangladesh, and India) has been demonstrated on basis of natural resources, financial capability, and technical strength for micro-hydro power generation unit implementation in various part of the country.

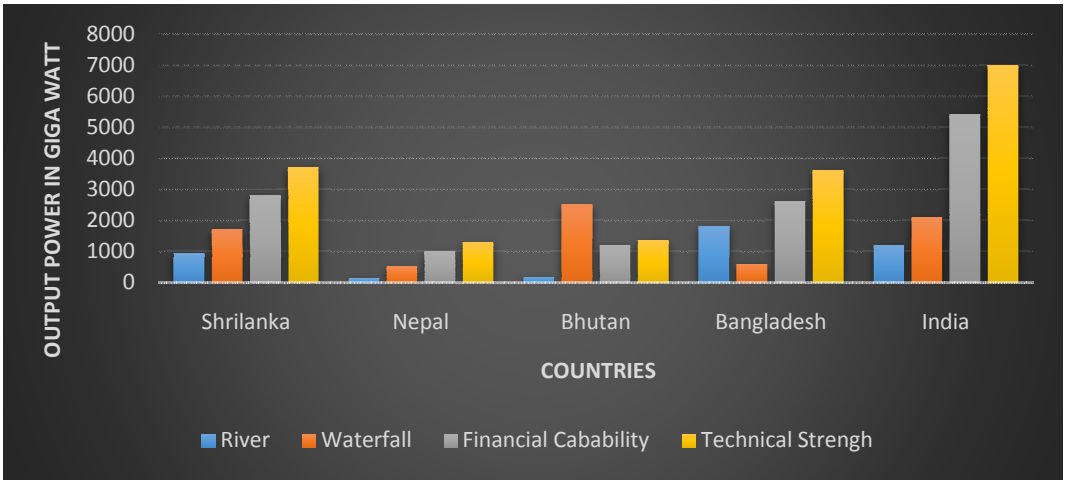

Figure 2: The above Graph represents the Micro Hydropower Generation capacity of several countries surrounding India.

The various resource of renewable power generation such as Tidal energy, Geothermal Energy, Micro hydropower, wind energy, solar energy, Biomass electricity as well as Large Hydroelectricity has important proportions in supplying electricity demand as illustrated in Figure 3.

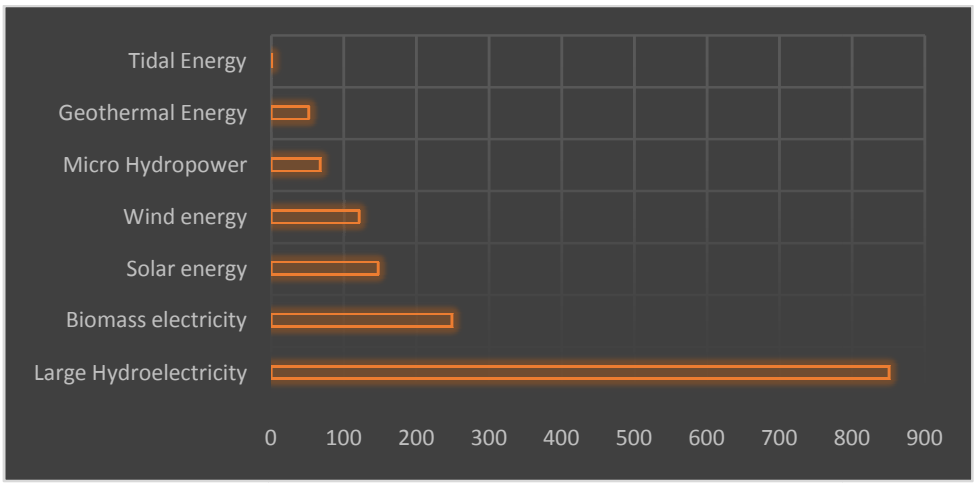

Figure 3: The above graph shows the Renewal power generation across the world in Gigawatt (GW).

3.4. Data Analysis:

The water is flowed from the Dam to the lake and the lake to the turbine using the penstock. Whenever aquatic fall to the blade of the turbine that changes hydraulic power into rotational power, the hydraulic turbine convert function remains specified for the determination of mechanical output power.

$$\frac{\Delta Pm}{\Delta G} = \frac{1 - TwS}{1 + 0.5TwS}$$

Where delta Pm represents turbine mechanical outcome power cutting-edge per unit,

Delta G represents gate inaugural of turbine cutting-edge per unit besides

T_w is the aquatic initial period of a turbine.

The servo motor is used to control through Gate position, it adjusts the flow rate of water for the production of electricity permitting to load. The conversion function aimed at the relay valve beside the gate servomotor remains specified.

$$\frac{g}{b} = (Ks)/\{s(1 + s * Tp)\}$$

Where servo gain is Ks and pilot value or servo meter time constant is represented as Tp.

The electric generator is coupled with the rotating shaft of the turbine, and electrical energy is obtained. The rotating shaft is produced mechanical power

P = □ x s x g x Q x H

Where □ remains hydraulic turbine efficiency, P remains to produce mechanical power

s remains the solidity of aquatic,

g remains acceleration because of gravity

Q remains stream rate of aquatic,

H remains aquatic head.

4. RESULTS AND DISCUSSION

As oil prices rose, fossil fuel costs grew, thermal pollution rose, and the global energy crisis worsened. Several developing countries began to generate electric power by using natural sources of oil, coal, and natural gas, after those renewable hydro plants took their place for electric power generation. The micro-hydro power plants have not been completely used aimed at electrical power generation because of the high wealth cost. The high cost remains owing mostly to the operational expenses. Reduced costs of these plants are made to fulfil the fast upsurge in energy demand. The spare of conventional equipment with fee substitute equipment besides an induction generator is one method to reduce corners. The micro-hydroelectricity is generated by several and power is monitored by artificial Intelligence. Several countries are producing electricity as 40% of power is generated by china, and 15% of micro-hydropower is generated by India. Italy has produced hydropower of about 3% as well as Brazil generates 3% micro hydropower as illustrated in Figure 4. United States America (USA) and Japan have produced hydroelectricity sequentially at 8% and 11%.

The entire cost of micro-hydro power generation remains divided into four parts. The most expensive part is the construction of Dam that is 40% of the entire cost, and the cost of the

turbine remains 16% of the total price as shown in Figure 5. The cost of the management system and controlling units are sequentially 8% and 12% as well as electricity distributing unit's cost is 24 % of the total cost.

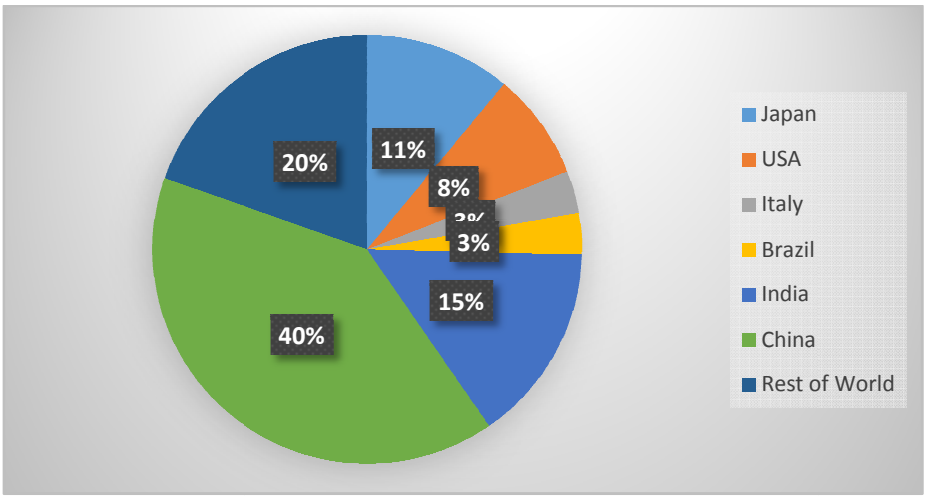

Figure 4: The above graph represents the Micro hydro-power generation by Japan, the USA, Italy, Brazil, India, China, and the Rest of the world.

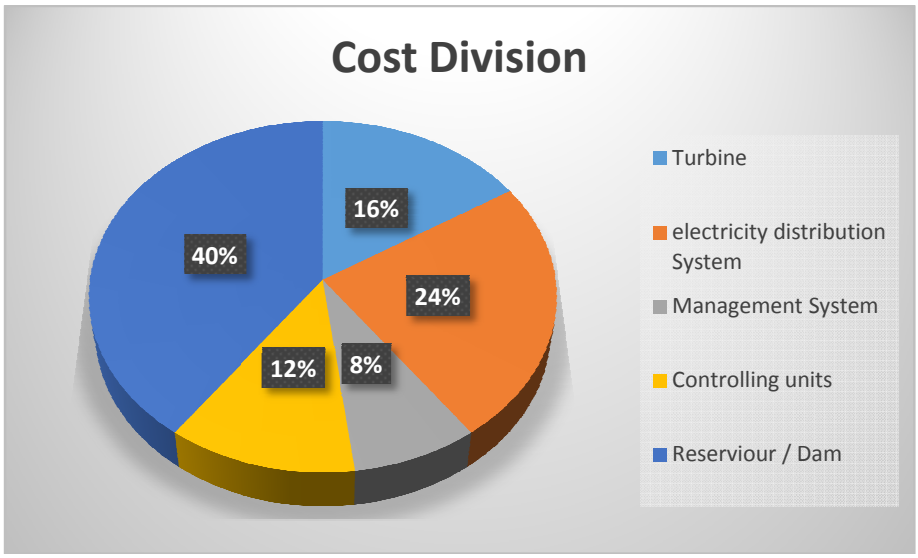

Figure 5: The above graph represents the cost Division of Micro- Hydropower generation.

The cost-benefit effectiveness of this form of energy is analyzed in terms of installed costs, annual benefits, and recoverability period. It is found that installing 81 Kaplan turbines with a entire installed capacity of 405 kW (=81 * 5 kW) besides 12 Vortex turbines with a entire installed capacity of 336 kW (=12 * 28 kW) could lead to an average annual hydropower advantage limitation amid 246 thousand USD (=3600 MWh * 65.57 USD/MWh) besides 348 thousand USD (=5220 MWh * 65.57 USD/MWh).The proposed model of hydropower generation has a 96% efficiency of power generation which is comparatively higher than the previous model of power generation. A micro-hydroelectric power system can generate a steady supply of electricity at a relatively low cost when compared to many other renewable sources of energy. For example, an average site in the Fraser River Basin has an installed cost of about $15 000 per kW capacity, and Micro-hydropower installed costs could be recovered

in two or three years after the start of energy production in this scenario based on current energy price structures.

5. CONCLUSION

The hydropower production construction remains regarded as one of the most essential pillars for correct modelling of the difficult optimization cutting-edge micro-Hydropower plants. Several developing countries started to shift away from oil and coal in favour of oil, coal, and natural gas, allowing renewable hydroelectric plants to take their place. In cutting-edge terms of water flow rate, net turbine head besides energy generation, artificial intelligence has been used to predict the output of hydropower plants. To simulate the output of a nonlinear plant, Micro hydropower plants remain the most extensively rummage-sale renewable energy source in the world.Micro Hydropower is installed with 81 Kaplan Turbines with a full power generation capacity of 405 kW and the annual hydropower generation unit gets a profit of USD 246 thousand to 348 thousand. Micro hydropower generation unit has 96% efficiency which is comparatively higher than the earlier model of micro-hydropower generation.There is a wide scope of research in the field of micro-hydropower generation, other research is possible to develop the innovative method developed for micro-hydro power generation.

REFERENCES

[1] J. A. Laghari, H. Mokhlis, A. H. A. Bakar, and H. Mohammad, "A comprehensive overview of new designs in the hydraulic, electrical equipment and controllers of mini hydro power plants making it cost effective technology," *Renew. Sustain. Energy Rev.*, vol. 20, pp. 279–293, 2013, doi: 10.1016/j.rser.2012.12.002.

[2] G. Goswami and P. K. Goswami, "Power quality improvement at nonlinear loads using transformer-less shunt active power filter with adaptive neural fuzzy interface system supervised PID controllers," *Int. Trans. Electr. Energy Syst.*, 2020, doi: 10.1002/2050-7038.12415.

[3] A. Kumar and A. Jain, "Image smog restoration using oblique gradient profile prior and energy minimization," *Front. Comput. Sci.*, 2021, doi: 10.1007/s11704-020-9305-8.

[4] S. Tripathi, P. K. Verma, and G. Goswami, "A review on SMART GRID power system network," 2020. doi: 10.1109/SMART50582.2020.9337067.

[5] G. Khan, K. K. Gola, and W. Ali, "Energy Efficient Routing Algorithm for UWSN - A Clustering Approach," 2015. doi: 10.1109/ICACCE.2015.42.

[6] G. Goswami and P. K. Goswami, "Transient Specifications and Reactive Power Compensation Using ShAPF for Non-Linear Load Applications," 2020. doi: 10.1109/SMART46866.2019.9117326.

[7] J. K. Rajput, T. K. Pathak, and L. P. Purohit, "Impact of Sputtering Power on Properties of CdO:ZnO Thin Films Synthesized by Composite Method for Oxygen Gas Sensing Application," *J. Electron. Mater.*, 2019, doi: 10.1007/s11664-019-07464-4.

[8] D. Yadav, T. K. Sharma, V. Sharma, and O. P. Verma, "Optimizing the energy efficiency of multiple effect evaporator house using metaheuristic approaches," *Int. J. Syst. Assur. Eng. Manag.*, 2021, doi: 10.1007/s13198-021-01429-9.

[9] V. S. Rana, J. K. Rajput, T. K. Pathak, P. K. Pal, and L. P. Purohit, "Impact of RF Sputtering Power on AZO Thin Films for Flexible Electro-Optical Applications," *Cryst. Res. Technol.*, 2021, doi: 10.1002/crat.202000144.

[10] P. K. Gupta and S. Gupta, "Generation of green electricity with pedal generator," 2018. doi: 10.1109/SYSMART.2018.8746927.

[11] K. Chaturvadi, G. Goswami, and D. Chauhan, "Synchronous Link Converter based Scheme of Harmonic Filtration for Non-Linear Load," 2020. doi: 10.1109/SMART46866.2019.9117272.

[12] M. M. Gupta, S. Jankie, S. S. Pancholi, D. Talukdar, P. K. Sahu, and B. Sa, "Asynchronous environment assessment: A pertinent option for medical and allied health profession education during the covid-19 pandemic," *Education Sciences*. 2020. doi: 10.3390/educsci10120352.

[13] G. Goswami and P. K. Goswami, "Artificial Intelligence based PV-Fed Shunt Active Power Filter for IOT Applications," 2020. doi: 10.1109/SMART50582.2020.9337063.

[14] P. Rosha, H. Ibrahim, A. K. Nanda, S. K. Mohapatra, S. K. Mahla, and A. Dhir, "Effect of hydrogen-enriched biogas induction on combustion, performance, and emission characteristics of dual-fuel compression ignition engine," *Asia-Pacific J. Chem. Eng.*, 2020, doi: 10.1002/apj.2435.

[15] V. Anand, "Photovoltaic actuated induction motor for driving electric vehicle," *Int. J. Eng. Adv. Technol.*, 2019, doi: 10.35940/ijeat.F1298.0986S319.

[16] Y. Zhou, L. C. Chang, T. S. Uen, S. Guo, C. Y. Xu, and F. J. Chang, "Prospect for small-hydropower installation settled upon optimal water allocation: An action to stimulate synergies of water-food-energy nexus," *Appl. Energy*, vol. 238, no. October 2018, pp. 668–682, 2019, doi: 10.1016/j.apenergy.2019.01.069.

[17] K. Kumar and R. P. Saini, "Application of Artificial Intelligence for the Optimization of Hydropower Energy Generation," *EAI Endorsed Trans. Ind. Networks Intell. Syst.*, vol. 8, no. 28, pp. 1–12, 2021, doi: 10.4108/EAI.6-8-2021.170560.

[18] A. T. Hammid, M. H. Bin Sulaiman, and A. N. Abdalla, "Prediction of small hydropower plant power production in Himreen Lake dam (HLD) using artificial neural network," *Alexandria Eng. J.*, vol. 57, no. 1, pp. 211–221, 2018, doi: 10.1016/j.aej.2016.12.011.

[19] G. Liao, W. Gao, G. Yang, and M. Guo, "Using 1-D Convolutional Neural Network and Gated Recurrent Unit in Small Hydro," no. July 2019, 2020, doi: 10.1109/JSEN.2019.2926095.

CHAPTER 6

MICROCONTROLLER BASED ELECTRICAL POWER THEFT MONITORING SYSTEM

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ABSTRACT*:*Electricity theft remains a major concern in a country with such a large population. Electricity theft in India's households and industrial power supply is increasing every year. Due to power theft, many power generation companies have gone bankrupt or are not able to sustain electricity generation. The power theft monitoring system can trace the exact location of the power theft as well as generate a message to the nearest sub-station, transmitting the power theft data wirelessly through a microcontroller connected to the Internet of Things (IoT). The objective of this study is to reduce the theft of electricity and protect the power transmission line as well as benefit the power generation companies. In this study, whenever there is unauthorized tapping on the load side, the data of the electric power load is transmitted through the load side energy meter and this data is received by the receiver of the energy meter at the pole. This received data is compared by a pre-programmed microcontroller. After comparing the data, the obtained dataset is transmitted to the consumer as well as the nearest electrical substation.In the future, there is a maximum probability to develop new technology for detecting power theft in three-phase transmission lines as well as load side transmission lines. Microcontroller-based electrical power theft monitoring systems can identify power thefts in transmission systems, allowing power generating companies to reduce power losses and maintain economic stability.

KEYWORDS: ***Electricity Theft, Electrical Power, Microcontroller, Transmission Line, Unauthorized Tapping.***

1. INTRODUCTION

Power theft remains an actual common issue in the world, where the world's population is very high. Also, the use of electricity is ultimately unreliable. In India, the number of electricity thefts in domestic electricity connections as well as industrial power supplies is increasing every year.Due to this, there is a loss of energy for the power company, apart from this, the urban and rural areas are facing the constant loss of load shedding to meet the power requirement of the entire state. In addition to this, the habits used to commit theft are countless, so how the theft happened can never be tracked, and this problem needs to be addressed as quickly as possible. This summary, suggests an electricity theft detection system to identify theft which remains made through the most common technique of theft besides which remains to bypass the meter by utilizing a piece of wire, people just use electricity [1]. Bypass the meter. Including the current unit in addition to the meter reading unit by the first wiring. The suggested system remains hidden in such meter besides as soon as an attempt remains made burglary, it is sending a message to the control unit of the electric power board. In this arrangement, a single current transformer is used to place on the input side of the post line. Another current transformer is used to place at the supply point of the home lines [2].

The outcomes power of a current transformer (CT) remains transferred to the programmable interface controller (PIC) as an input supply to the microcontroller, converting the analog input signal into a digital signal. The input current, as well as the same output current, are compared by the PIC. If the likened outcome has negative values then this specific post remains recognized as a power theft point [3]. This comparison value remains conveyed to the power board, this value is displayed in the Light Crystal Diode (LCD) display. The

information remains processed quickly through the microcontroller as well as a message is transferred through GSM (Global System for Mobile Communication) technology.

The power theft monitoring system consists of a wireless communication system of energy meters that is used in conjunction with ZigBee, General Packet Radio Service (GPRS), and Relay. The cryptography method is used to protect the communication channel. Also, ZigBee is used aimed at data transmission in a serial process. The negative point of this procedure is to gather the reading of the energy meter whenever going in a specific range of areas, as well as the power supply is disconnected manually if needed. Energy theft comprises the illegal exploitation of electricity from a feeder, grounding the neutral wire as it does not measure the readings apart from avoiding the payment of bills. In the primary system, there was no theft detection device on the line so that anyone could access the electricity without getting it. Electricity remains single of the most basic requirements, particularly aimed at persons who work in industries that rely on electricity as their primary source of energy [4]-[5]. At present moment, the prepaid and post-paid electricity measuring equipment still has a flaw, as there remain still numerous examples of electricity theft performed through numerous elements using various theft modes. This remains because each customer's residence is equipped with an electric measurement instrument. At present moment, power supply companies still utilize an antiquated way to identify incidents of power theft, which involves reviewing the pattern of electricity bills collected by manual recording through officers. Detecting electricity theft, of course, comes at a high expense. Various research has looked into ways to avoid electrical theft [6].

1.1. Energy meter:

The reduced energy costs besides recovering power efficiency on machines as well as electrical possessions, one must be aware of energy consumption. Energy meters allow owners, facility managers, and users to identify areas for improvement and generate profit. They make it possible to run better buildings with less money and energy. Because Mild Intellectual Disability (MID) certification can also split utility costs between multiple homes using an energy meter. Sub-metering delivers an accurate picture of power ingesting as well as usage [7]-[8].

1.1.1. Electromechanical Induction Energy Meter:

The electromechanical Induction Energy meter contains a revolving aluminum disc mounted on a spindle amid 2 electromagnets. The rotational speed of the disc remains relative to the energy besides this electric energy remains combined through the usage of a counter mechanism as well as gear trains. The electromechanical Induction energy meter consists of two silicon steel coated with electromagnets that are a series magnet and shunt.The coil is a series magnet consisting of a few turns of thick wire associated with cutting-edge series with the line. The flux generated through the series magnet remains comparative to the flux [9]. The flux generated through the shunt magnet remains comparative to the voltage as it carries a coil with several turns of thin wire associated with the supply. Due to their inductive nature, these two fluxes are 90 degrees apart. The interaction of these 2 fields causes an eddy current cutting-edge the disc, which exerts a force comparative to the product of their immediate current, voltage as well as phase angle [10]-[11]. This kind of meter is easy to construct and the accuracy of electricity measurement is less because of creeping as well as external fields.

1.1.2. Digital Electronic Energy Meter:

The earlier electro-mechanical meters are replaced by a novel digital electronic meter which is more accurate for showing a reading. The advanced electronic energy meter is founded on

Digital microtechnology as well as usage of no moving parts. Therefore digital energy meter is recognized as a Static Energy meter [12]-[13]. The electronic energy meter is provided an efficient and accurate reading of power supply because it has an integrated circuit (IC) that is specially designed for controlling accuracy functioning, and the design IC is known as Application specified integrated circuit (ASIC).

1.1.3. Smart Electric Power Measuring Meters:

A smart electric power measuring meter is excellent metering technology that is involved to transfer metering data to read as well as receiving feedback data from customers regarding the power supply. It is capable to measure energy utilization, automatically turning ON and turning OFF switch for supply to customers as well as automatically controlling the maximum electricity utilization. For improved presentation, smart metering schemes use current metering substructure scheme technology [14]. They are capable of bidirectional communication. They can provide data to utilities such as energy consumption, parameter values, alerts, and other necessary messages, and they can also receive data from uses for example automatic meter reading systems, re-join/separate instructions, meter software upgrades, besides other important messages. The study focussed on a microcontroller-based electrical power theft monitoring systemwhere the electric power supply is regulated without any electricity larceny.

The present study is divided into several sections, the first section is the introduction of the electric power theft monitoring system, with the second section is a prior review of the current study. The third section implementation is the working of a microcontroller-based power theft monitoring system. Results and discussion are the next part of the study, the last section is the conclusion of the study.

2. LITERATURE REVIEW

Sagar Patil et al. discussed electrical power theft identification as well as wireless meter reading [15]. The author stated that the unauthorized tapping was detected utilizing a power theft detection system from the distribution line. This tapping system was implemented in the distribution network of the electric power supply, the system detected the fault in the distribution system. According to the author, wireless receiving and transmitting technology was used which was linked to wireless meter reading. This power theft detection device was safe for the power distribution system.

M.Dinesh Sundar and R. Rathika discussed the development of electricity theft recognition using the smart meter cutting-edge energy distribution networks founded on wireless technology. The author realized that power burglary happened frequently in dissimilar spots. Therefore, the author suggested a framework that utilized the power theft sensor accommodated with a ceaseless screen. The sensor esteems were continuously analyzed, and power burglary had recognized, an alarm message was provided to the client utilizing the Global system for mobile communication (GSM) Module. Whenever power burglary happened then the alarm message provided real-time power burglary [16].

A Tjahjono et al. discussed consumer power forecast founded on a neural network aimed at electrical theft detection [17]. The author said that state electricity enterprise monitored the active energy of consumers through recording meters besides was still prone to electricity theft. The location of the theft was detected by an electricity measuring device that was placed at every consumer of electricity. In this research, the author has proposed an electric theft detection device accommodated with Advanced RISC Machines (ARM) microcontroller that was located centrally on the corner of the distribution transformer panel to measure the

active energy cutting-edge of each consumer. The entire distributed active energy was predicted to total active energy of the entire customer throughout the neural network technique. The entire active energy of distributing transformer was compared with the entire active power of customers, and this device was capable to detect the electrical theft through error predicated value of active power on the Istituto Europeo Di Design (IED) master.

Ram K. Kanhe et al. explained Electrical Theft detection using GSM, Author said that Electricity was compulsory for our daily life with a growing energy theft was also increasing, and power theft was an issue that continued to plague the energy subdivision across the entire country. This study aimed to design a scheme that was an attempt to decrease the illegal use of electricity as well as decrease the opportunities for electricity theft [18]. According to the author, electronic companies faced the electric theft issue in recent times as well as electricity theft directly affects the profit made by electricity companies, prevention, and detection of electricity theft was compulsory.

Research Question:

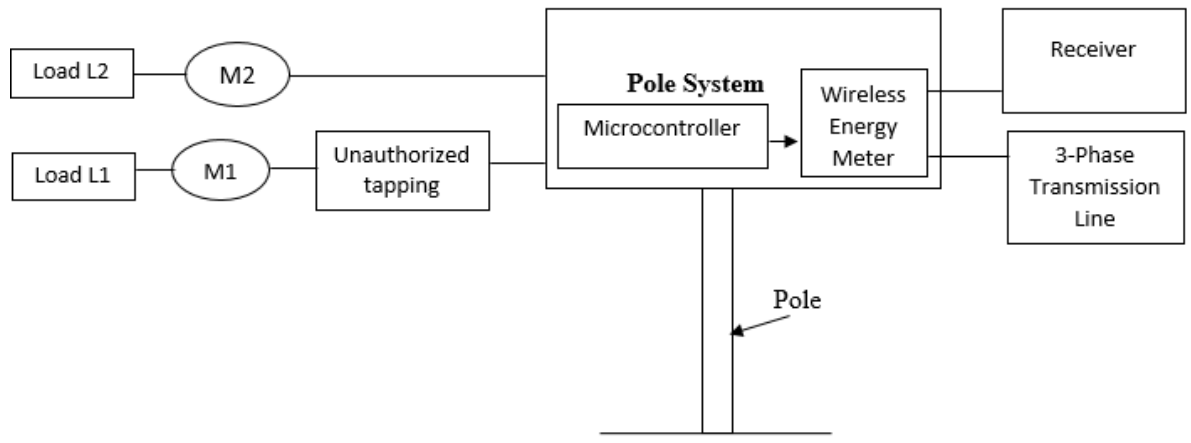
- How to meet the demand for electricity without a power shortage?
- How do employ a microcontroller to detect power theft in transmission lines?

3. METHODOLOGY

3.1. Design:

The electrical power theft monitoring systemconsists of a 3-A phase electricity distribution supply, this supply is connected with different 2 single-phase loads L1 as well as L2. There remain two energy meters M1 and M2 that are used to measure the power consumed through loads, load side meters have an additional feature of transmitting data to the receiver at the electric pole, the receiver passes the signal to the microcontroller.

Microcontroller based system have been install to find out power theft. The pole side energy meter is used to detect electric energy transmitted through every single-phase line associated with the pole. Whenever unauthorized tapping of electricity happens from the load side, then wireless data transmitting units at the load side meter is transmitted a signal to a receiver, and the receiver provides data to the microcontroller as shown in Figure 1. The microcontroller is compared to the data of the energy meter at the pole as well as the electric meter at the load side, if unauthorized tapping happens on the load side, then the microcontroller is transmitted data to the electric sub-station.



Load side Energy Meter (M1, M2)

Figure 1: The above Block Diagram represents the Pole base Theft Protection system

3.2.Instrument:

This study has been done on a three-phase transmission line installed between power generations to power consumption. In thisstudy, three energy meters are used, two energy meters are used on either side of the load as well as one wireless energy meter mounted on a pole. Receiving power consumption data from the load side and comparing the total power transmission is done by the microcontroller. The microcontroller is already programmed for comparing data, herein some following basic equipment for data collection.

3.2.1. Load side Energy Meter (M1, M2):

The digital electric load meters are measured the consume electricity through loads (L1, L2) over an interval of time. The load meter consists of wireless data transmitting units that have transmitted data to a receiver on a pole, and the receiver is transmitted data to the microcontroller. The load-side energy meter has a digital display and data storage memory, the digital display shows the reading of power consumption, and memory storage units have stored the data of power consumption on the load side.

3.2.2. PIC16F877A Microcontroller:

The microcontroller used to compare load-side energy meter data with pole-mounted wireless energy meter data, some will have tolerance if the value measured at the pole is comparatively higher than the value sent to the load-side energy meter which means the energy is stolen. In addition, the microcontroller has generated a theft signal and transmitted the theft signal to the substation by the wireless commutation system.

3.2.2.1. Special Features of Microcontroller:

- Electricity-saving Sleep mode
- In-Circuit Debug via two pins
- Ten-bit, eight-channel analog to digital Converter
- Brown-Out Reset
- Analog Comparator module
- Data “SRAM: 368 bytes”
- Data “EEPROM: 256 bytes”
- Self-reprogrammable under software control
- Cutting-edge-Circuit Serial Programming via 2 pins (5V)
- Watchdog Timer with on-chip “RC oscillator”
- Programmable code shield

3.2.3. Wireless Energy Meter on pole:

The wireless energy meter has been performed as the same rule of wireless data transmitting unit that remains utilized to find out energy larceny detection. The wireless energy meter is installed on the pole of the 3-phase transmission line that has a wireless data receiver associated with a microcontroller or display. The receiver of the wireless energy meter is received the data from the load side meter, then it has transmitted the data to the microcontroller.

3.3. Data Collection:

The gathered data has illustrated in tables that outcome information about power consumption by two loads (L1 and L2), 3-Phase electricity distribution supply, and this supply is connected with different two single-phase loads L1 and L2. The power consumption of electric load L1 is measured by load-side energy meter M1, and load-side energy meter M2 is measured by the power consumption of electric load L2. Based on this data further Data analysis regarding theft detection in 3- phase transmission lines.

Table 1: Specified below data based on the power consumption of the load side (L1), Total power transmission, and transmission loss.

Month	**Total Power Transmission (kW)**	**Consumption of Power (kW)**	**Transmission Loss of power (kW)**
January	110	90	20
February	220	190	30
March	210	180	20
April	205	190	15
May	222	202	20

Table 2: Demonstrated below data based on power consumption on the Load side (L2), Total power transmission, and transmission loss.

Month	**Total Power Transmission (kW)**	**Consumption of Power (kW)**	**Transmission Loss of power (kW)**
January	120	95	15
February	230	195	25
March	240	191	39
April	211	192	15
May	223	193	17

3.4. Data Analysis:

When the input alternative current (AC) supply remains transitory from the AC power supplier to the receiver, at that time if the entire quantity of electrical supply remains not obtained through the receiver, then there remains a maximum likelihood of energy theft.

$$\sum Power\ transmission = \sum Power\ consumed + transmission\ loss \ldots\ldots\ldots No\ Theft\ Happen$$

$$\sum Power\ transmission \neq \sum Power\ consumed + transmission\ loss \ldots\ldots Theft\ Occur$$

Here, Power transmission = Electric energy measured through Pole side energy meter

Energy Consumed = Load electricity measured through a load-side energy meter

- *Mathematical calculation*:

According to Table 1,

(Total transmission power) = (Power consumed by load side L1) + (Transmission loss)

T_P = Pc1 + Ts1, where T_P = Total transmission power in kW, Pc1 = Power consumed (kW) by load side L1, Ts1= Transmission loss in kW

T_P (January) = Pc1 (January) + Ts1 (January)

= 90 + 20

= 110 kW

Sequentially total transmission power for February, March, April and May are T_P (February) = 220 kW, T_P (March) = 210 kW, T_P (April) = 205 kW, T_P (May) = 222 kW

According to Table 2,

(Total transmission power) = (Power consumed by load side L1) + (Transmission loss)

T_P = Pc2 + Ts2, where T_P = Total transmission power in kW, Pc2 = Power consumed (kW) by load side L2, Ts2= Transmission loss in kW

T_P (January) = Pc2 (January) + Ts2 (January)

= 95 + 15

= 110 kW

Sequentially total transmission power for February, March, April and May are T_P (February) = 220kW, T_P (March) = 230kW, T_P (April) = 207 kW, T_P (May) = 210 kW

This research is analyzing the data that has been collected from two dissimilar power consumption loads (L1, and L2), these loads are associated with single-phase supply. The electricity consumption is measured by the energy meter (M1, M2) on the load side. In the data collection Table1, shows the monthly report of electricity consumption, Total AC power transmission, as well as transmission losses. According to Table 1, In January total power transmission is 110 kW and power consumption is 90 kW on the load side and transmission loss of power is 20 kW. Total transmission power, power consumption, and transmission loss are sequentially 220 kW, 190 kW, and 30 kW in February. In the march, total transmission power, power consumption, and transmission loss are sequentially 210 kW, 180 kW, and 20 kW. The power consumption is 190, the total power transmission is 205 kW, and transmission loss is 15 kW in April. In May, Total Transmission power, Consumption power on the Load side (L1), and transmission loss in May are sequentially 222 kW, 202 kW, and 20 kW.

According to Table 2, In January total power transmission is 120 kW and power consumption is 95 kW on the load side and transmission loss of power is 15 kW. Total transmission power, power consumption, and transmission loss are sequentially 230 kW, 195 kW, and 25 kW in February. In the march, total transmission power, power consumption, and transmission loss are sequentially 240 kW, 191 kW, and 39 kW. The power consumption is 192 kW, total power transmission is 211 kW, and transmission loss is 15 kW in April. In May, Total Transmission power, Consumption power on the Load side (L1), and transmission loss in May are sequentially 223 kW, 193 kW, and 17 kW.

4. RESULTS AND DISCUSSION

In a society with such a large population, power theft continues to be a serious problem. Electricity larceny is increased unreliable, every year, the number of electrical thefts in India's home and industrial power supplies rises. There is a loss of energy for the power company as a result of this, and the urban and rural areas are constantly experiencing load shedding to meet the state's power requirements. The electrical power theft monitoring system is made up of a three-phase energy distribution supply that is connected to 2 single-phase loads, L1 as well as L2. There remain two energy meters, M1 besides M2 that is used to measure the power consumed by loads. Load side meters also have the capability of transmitting data to a receiver at the electric pole, which then sends the signal to a microcontroller. A microcontroller-based system has been installed to detect power theft.The microcontroller is compared with the data from the energy meter at the pole as well as the power meter at the load side, if unauthorized tapping occurs on the load side the microcontroller transmits the data to the electric sub-station. Herein this study). The data in Table 1 shows that Total electrical transmission power is equal to the sum of transmission loss and power consumption at L1. Therefore, no unauthorized tapping is happed in load side L1. According to Table 2, Total transmission power is not equal to the sum of transmission loss and Power consumed by load L2 which shows the unauthorized tapping of electricity has happened on the load side (L1). The wireless power meter protects the electricity transmission system from larceny of electricity as well as electricity board or company will get the benefit without any economic problem. Because of this wireless energy meter has a microcontroller that is capable to analyse the data of electricity transmission as well as sending the data to the sub-station (Table 3).

When there is a difference between the predicted value from active power on Intelligent Electronics Device (IED) Master at 58th seconds and real active power on (IED) Master at the same time, and when there is a difference between the value of total active power from 2 pieces IED slave at 58th seconds and real active power on IED master, which is representing power usage in that group at 58th seconds for electricity theft detection parameter test.

Table 3: Represents the below data is collected from the Wireless energy meter attached to Microcontroller.

Month	Powder Measure by Wireless meter (kW)	Power of IED Master (kW)	Entire Power IED Slave (kW)	Microcontroller Signal	Error in IED Master (%)	Error in the IED Master and IED slave (%)
January	402.93	403.01	403.02	Normal	0.21	0.22

February	402.2	402.19	402.18	Normal	0.19	0.17
March	403.4	403.9	403.7	Normal	0.06	0.05
April	405.9	400.2	410.7	Theft detection	7.45	5.45
May	1220.6	1200.7	1296.7	Theft detection	20.65	19.89
January	1296.8	1297	1296.9	Normal	0.18	0.05

The percentage of error between values obtained by summing active power from two portions of IED Slave (reality) with active power measured on the IED Master (transformer power) is in the range of 14.99%. And the percentage of errors between the predicted value of active power on IED Master (forecast) as well as the measured value of active power on IED Master (power transformer) is in the range of 14.99%. The parameter test for electricity theft detection reflects violations committed by bypassing the measurement phase or changing the electric measuring device design.

5. CONCLUSION

Electricity theft remains a major concern in a country with such a large population. In the long run, the power is also unreliable. Incidents of power theft in India's domestic and industrial power supplies increase every year. Serval Electricity Generation Company has gone bankrupt due to loss in power generation, apart from this there is a continuous loss of power load-shedding in rural and urban areas. The study aims to reduce the theft of electricity and protect the power transmission line as well as benefit the power generation companies. In this research data is collected from two unequal electric loads (L1, and L2). There is no power theft on the load side (L1), so there is power theft at the L2 electric load side. The receiver receives data from the load side (L1 & L2), and this received data is compared by the microcontroller. The microcontroller compares the received data with the previously programmed data. The power theft data is transmitted through a microcontroller which is connected to the energy meter on the pole. The microcontroller remains capable of passing the electric power bill to the electricity sub-station as well as the consumers. The microcontroller-based electrical power theft monitoring system is capable of detecting power theft in transmission systems and will be able to improve power shortages and create economic stability for power generation companies.

REFERENCES

[1] International Journal Of Engineering Research & Technology (IJERT), "Power Theft Detection using GSM," 2019, [Online]. Available: https://www.ijert.org/Power-Theft-Detection-using-GSM.

[2] P. Bhardwaj, D. V. Rai, M. L. Garg, and B. P. Mohanty, "Potential of electrical impedance spectroscopy to differentiate between healthy and osteopenic bone," *Clin. Biomech.*, 2018, doi: 10.1016/j.clinbiomech.2018.05.014.

[3] M. V. Ramesh and P. Sowjanya, "IoT based energy meter with theft detect," *Int. J. Recent Technol. Eng.*, 2019, doi: 10.35940/ijrte.B1075.0982S1019.

[4] "Power System Automation with CAS Using Wireless Sensor Network (ZIGBEE)," *Int. J. Sci. Res.*, 2016, doi: 10.21275/v5i2.10021601.

[5] G. Khan, K. K. Gola, and M. Dhingra, "Efficient techniques for data aggregation in underwater sensor networks," *J. Electr. Syst.*, 2020.

[6] J. Kaur, A. Kumar, D. V. Rai, and S. K. Tripathi, "Electrical study of ultra high molecular weight polyethylene/multi wall carbon nanotubes (UHMWPE/MWCNT) nanocomposite," 2011, doi: 10.1063/1.3653706.

[7] M. K. Jangid, S. S. Sharma, D. Mathur, and Y. C. Sharma, "Optical, electrical and structural study of Mg/Ti bilayer thin film for hydrogen storage applications," *Mater. Lett. X*, 2021, doi: 10.1016/j.mlblux.2021.100076.

[8] G. Khan, K. K. Gola, and W. Ali, "Energy Efficient Routing Algorithm for UWSN - A Clustering Approach," 2015, doi: 10.1109/ICACCE.2015.42.

[9] H. Sharma and Y. C. Sharma, "Experimental investigation of electrical properties of bismuth selenide thin films," *Chalcogenide Lett.*, 2020.

[10] Electrical India, "Types of Energy Meter," 2018, [Online]. Available: https://www.electricalindia.in/glimpse-of-energy-meters/.

[11] A. Kumar and A. Jain, "Image smog restoration using oblique gradient profile prior and energy minimization," *Front. Comput. Sci.*, 2021, doi: 10.1007/s11704-020-9305-8.

[12] D. K. Gupta, M. Verma, R. Gopal, N. D. Jasuja, K. B. Sharma, and N. S. Saxena, "Synthesis, characterization and electrical properties of GO/PANI/NPs (NPs = CdSe, CdSe/CdS, CdSe/ZnS) nanocomposites," *Indian J. Pure Appl. Phys.*, 2018.

[13] R. Kumar and P. Ailawalia, "Moving load response in micropolar thermoelastic medium without energy dissipation possessing cubic symmetry," *Int. J. Solids Struct.*, 2007, doi: 10.1016/j.ijsolstr.2006.11.008.

[14] A. U. Kumar and A. Sachar, "Evaluation of correlation's between Cbr using Dcp with laboratory Cbr at varying energy levels," *Int. J. Adv. Sci. Technol.*, 2020.

[15] S. Patil, G. Pawaskar, and K. Patil, "Electrical Power Theft Detection and Wireless Meter Reading," *Int. J. Innov. Res. Sci. Eng. Technol.*, vol. 2, no. 4, pp. 1114–1119, 2013, [Online]. Available: http://www.doaj.org/doaj?func=fulltext&aId=1489660.

[16] M. DineshSundar and R. Rathika, "Development of electricity theft detection using smart meter in power distribution network based on wireless technology," *Technology*, no. 2, pp. 25–33, 2020, [Online]. Available: https://www.malayajournal.org/articles/MJM0S200664.pdf.

[17] A. Tjahjono, S. Raziqurrahman, and R. N. Wardhani, "Consumer power prediction based on neural network for electricity theft detection," *J. Phys. Conf. Ser.*, vol. 1450, no. 1, 2020, doi: 10.1088/1742-6596/1450/1/012048.

[18] R. S. Z. Ram K. Kanhe* and Amol L. Bhandare, Sunayna S. Mane, "Electricity Theft Detection Using Gsm and Gps," vol. 05, no. 12, pp. 448–452, 2018.

CHAPTER 7

MICROCONTROLLER-BASED SUBSTATION MONITORING AND CONTROL WITH ARTIFICIAL INTELLIGENCE

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ABSTRACT: ***Microcontroller-based substation motoring and control with artificial intelligence are used to monitor the operation of the substation through a microcontroller which is commanded the signal with the help of artificial intelligence to send electrical parameters such as current, voltage, and temperature via the microcontroller and artificial intelligence. The problem that arises in substation motoring is due to which lack of supporting service, lack of independent monitoring function, poor linkage performance, the high error rate in a complex environment, and some functions overlap. Hence to overcome all these this problem substation motoring and control based on a microcontroller with artificial intelligence are introduced. The result shows that the unit time of information acceptance on traditional manual acceptance is approximately 6 minutes, but with artificial intelligence receiving, the unit time of information acceptance is just 2 seconds. It concluded that with the continuous development of the electric utility grid, there will be a need to modernize the substations to suit the diverse needs of people's lives. In future by incorporating new components such as General Packet Radio Service (GPRS) technology, which allows for the transmission of monitored and regulated data to any location on the planet.***

KEYWORDS: ***Artificial Intelligence, Microcontroller, Power Plants, Substation Monitoring, Transmission.***

1. INTRODUCTION

In our modern capitalist society, electricity is a practical and convenient source of energy that is growing increasingly significant. The power systems are extraordinarily vast, nonlinear, and dynamic networks[1]. For cost-effective benefits, such electric power systems are consolidated.They have some of the utmost essential aspects of both nationwide and worldwide arrangement, and their let-down has massive potential economic as well as public safety consequences. The part of a power network such as transformers, loads, switches pipes, generators, and compensators[2].Modern electrical systems are made up of a variety of sources of energy and charges. Distribution and transmission are the two substations that make up the electrical power system [3]. A transmission system's role is to transfer electricity from electrical generators to customer locations, whereas a distribution network's primary purpose is to transfer power from an electrical generator to a nearby consumer location, which is the perfect connection between high-voltage and low-voltage systems [4].Provides customer services and transmission systems after using transformers, the voltage is reduced. Electrical energy is provided from the transmission grid to the distribution substations by dielectric power distribution systems in which the voltage is normally reduced to 10kV and then supplied to commercial, housing, and industrialized clients [5].Shorter supply connections assist industrial users and modern electric power systems like power transmission and distribution grids are among a huge number of distributed, separately functioned capital rigorous effects. Such properties include equipment for protection, transformers, power plants, and transmission lines [5].

Both the transmission and distribution systems use electric utility substations, and they produce electricity separately [6]. Hundreds of Kilometres of transmission lines transfer the

power generated at the major stations until it reaches the substations. Several projects involving uninterrupted monitoring of unit concentrations, analyst movements at various periods, and monitoring of frequency, power, current, and voltage variations in distribution transformers at sub-stations have been completed in recent years with the help of microprocessors and controllers [7].When the temperature of the distribution transformers rises the values of the current may change inadequate way and the power provided to the consumer may be insufficient.

The motoring of voltage and other parameters on the side of distribution will aid in improving the output voltage and the quality of power delivered to customers [8].It can also detect breakdowns caused by heat, such as when the temperature rises above the desired temperature, to protect the distribution transformer from which the control equipment can shut down the unit.The biggest difficulty with the Electricity Board (EB) is the transformer repair. Transformers burn out during abnormal events due to overloads and short circuits in their windings. The temperature rise in internal oil is due to the variation of current[9].As a result, the distribution transformer's power, frequency, or temperatures quickly changes. Consider the limits of voltage, current, and temperature in mechanization as the transformer demonstrates its maximum responsiveness for almost the same [10].As a result, let's build a microcontroller-based machine that manages the transformer in real-time. The transformer present at the sub-station side is turned off by the micro-controller activity.

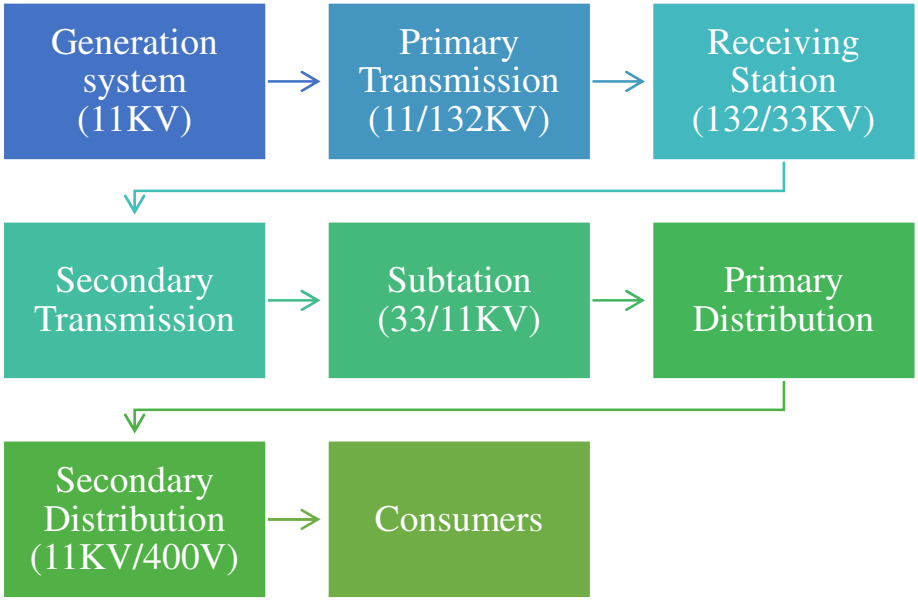

Figure 1: Single Line Diagram of Alternating Current (AC) Power Transmission and Distribution System.

Electric power generation is generally generated in 11 kilo-voltage (kV) at a substation in some circumstances, generation power may be greater or lesser in India and Europe. Some large manufacturers offer generating machines with voltages ranging from 6 to 25 kV for use in power plants. It is mentioned in Figure 1, the generating voltage is then increased to 132 kV, 220 kV, 400 kV, 765 kV, and so on. The stepping up of a current level is determined by the power transmission distance [11]. If the distance is long and moving forward the voltage level is high andthe power remains constant in proportion, so the I2R loss is decreased. This is known as the primary transmission [12]. At a receiving station, the voltage is stepped down to 33KV or 66kV. This receiving station has secondary transmission connections that connect substations nearby load centers. At a substation, the voltage is again reduced to 11kV and

these substations can directly provide 11kV to large industrial users.Feeders also come out of these substations. This is known as the primary distribution.

The present study focuses on substation monitoring and control based on a microcontroller with artificial intelligence to reduce human afford which works automatically as well as very quick to detect momentary irregularity of equipment and feedback to control in real times controls the transformer. This research is characterized into several sections where the first is an introduction and the second section is a literature review and suggestions of previous studies in terms of substation monitoring and control based on microcontrollers. Furthermore, the methodological section of this study is mentioned where the data is examined in the different sub-sections. After that, the results and discussion part are discussed where results are compared with the existing data followed by the methods applied in this research. Lastly, the conclusion of this research is declared where the research gives outcomes as well as future scopes.

2. LITERATURE REVIEW

A. Balamurugan [13] et al. explained that project utility companies will benefit from (Internet of Things) IOT-based substation control bydecreasing the duration of intensity incursions by confirming the near sub-station problems are rapidly revealed and linked to the main agencies. According to the author objective of the paper is to minimize substation labor costs and free up time. The microcontroller will work with the sensor installed at the neighbouring substation to complete the task as directed. The author concluded that improving the quality of power supply as well asthe safety of the substation and its equipment is ensured by real-time tracking of several parameters.

Emmanuel [14] et al. explained that a microcontroller-based parameter monitoring system acquires the remote electrical parameters like current, voltage, and apparent power as well as transmits those data in real-time “(Global System for Mobile Communication)” GSM over a system using GSM modern. According to the author objective of this paper was to help consumers monitor the energy usage of their electrical appliances, a real-time power monitoring system is used to inform consumers about the power consumption of the individual electrical appliance to avoid energy wastage. In this paper, the method was used of an on-board computer which is commonly termed a microcontroller, as well as the computer, can communicate effectively with the many sensors in use. As the result examined by the author such devices can be monitored utilizing GSM contemporary connected technology from anywhere in the world. It was concluded that each module's existence has been carefully considered and placed, resulting in the best possible functional unit. In the future scopecan be expanded through the use of GPRS technology, which allows monitoring and regulated data to be sent anywhere around the globe.

Kaxil Patel [15] has explained a review of efficient monitoring of substations using a microcontroller-based monitoring system on developing a system based on innovative design (Automatic Voltage Regulators) a microcontroller that monitors and protects a transmission system in a substation from increases in current, voltage, and temperature. According to the author objective of this review paper,is too constantly monitor the electrical performance to avoid the distributed energy transformer from combusting because of restraints are overheating, overcharging, and input voltage output. The author focuses on the Protection of distribution, the transformer can be switched off by using radio frequency communication to shut down the whole machine. This paper’s author concludedmonitors and controls such as current, voltage, and temperature of the transmission system by systems based on AVR

microcontrollers. In the future,the suggested system makes distribution more safe, dependable, and efficient.

Amit Sachan [16] has explained microcontroller-based substation monitoring and control system with Global System for Mobile Communication (GSM) modernist to use a GSM phone to collect external electrical properties are current, temperature, and voltage and communicate these in real-time through a GSM system, alongside with the temperature at the control station.In this project, the author employs an on-board computer, commonly referred to as a microcontroller, to efficiently communicate with the various sensors being employed. The main focus is to secure the circuit by activating an electromagnetic relay whenever the system parameters surpass the predetermined limits.As a result, that concept was created in such a way that the devices could be GSM-enabled mobile phones that could be used to view and operate the system from anywhere in the world.It was concluded that it had built-in integrated functions for all hardware devices used. In future scope,the technology is primarily intended for use with GSM-based smartphones to operate equipment such as lighting, fans, and motors.

From the research paper problem faced by the substation monitoring system obtains the remote parameters such as over-voltage, over-current and apparent power.In this study, the author researched the importance of substation monitoring and control based on a microcontroller with artificial intelligence which significantly minimizes the time it takes for substation information to be accepted.

Research Question:

- *How to Monitor and Control Substation Monitoring with AI?*
- *How to Solve Various Problems in Substations?*

3. METHODOLOGY

3.1. Research Design:

Unexpected increase in current, temperature, and voltage in an application transformer defines them. Accordingly, let's select the mechanization of the distribution transformer from the utility power supply of the substation. In the robotization process, the parameters are to be observed voltage, current, and temperature the transformer establishes its peak for a similar, consequence. Later, consider monitoring a mechanization background in a well-lit microcontroller with an AI controller that can very quickly and accurately detect momentary irregularity of equipment and feedback to control in real-time controls the transformer. Because of the micron roller, Artificial intelligence is used to turn off the transformer in the substation at the main station (Figure 2).

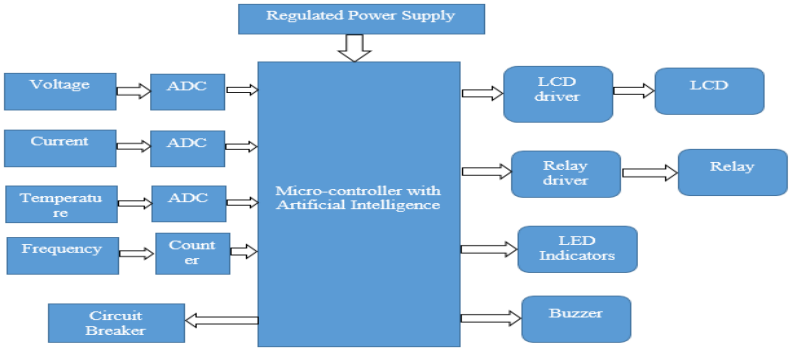

Figure 2: Substation motoring based on Microcontroller with Artificial Intelligence.

3.2. Instrument:

3.2.1.Voltage sensor:

It is a device that is used to compute and monitor voltage as well as to identify the voltage whether is to be alternating current or direct current.The sensor's input is voltage, and its outputs are analog voltage signals, switches, a current signal, or an audio signal as well as the sensor is a device that is used to recognize and respond to specific types of optical signals or electrical.

3.2.2.Current sensor:

It's a sensor that detects electric current in a wire and produces a signal that can be as simple as voltage or as complex as yield.The signal generated can subsequently be used to display the deliberate in an ammeter, stored in an information security system for further inquiry, or used for control.

3.2.3.Relay:

Many relays use an electromagnet to mechanically activate a switch, however other operational standards, such as strong state transfers, are also used.Relay is used when access to a circuit via a separate low-control signal is required, or when a single signal must control multiple circuits.The large exchanges were utilized as fixes in long separation display circuits, reconstructing and re-transmitting the flag rolled into it from one channel.

3.2.4.Microcontroller:

The microcontroller utilized is a PIC (Programmable Interface Controller), which can be used in a range of electronic devices such as computers, phones, control systems, alarm systems, embedded systems, and so on. This microcontroller circuit-wizard software was created using a computer. The PIC microcontroller architecture includes the CPU (central processor unit), I/O (inputs/outputs) channel, memory organization, A/D (analog to digital) conversion, timers/counters, interrupts, and serial connectivity, oscillator, and CCP (capture, compare and pulse width modulation). PIC is a microcontroller with RAM (random access memory), ROM (read-only memory), and DAC (digital to analog converter). The microcontroller used forHarvard architecture has been updated, and it now supports RISC (Reduced Instruction Set Computer). The pic microcontroller is faster than as compared to the other microcontroller.

3.2.5.LCD(Liquid Crystal Display):

A liquid crystal display (LCD) is a flat, electrical device that makes quiet and portable images and is commonly used as a screen in televisions, laptops, smartphones, and display signs.A tiny bright bulb is switched on or off electronically for each pixel on a plasma screen. The pixels are turned on or off automatically using liquid valuable stones to pivot enchanted light.

3.2.6.ADC (Analog to Digital Converter):

Analog to Digital Converter (ADC) changes analog impulses into binary information, permitting digital circuitry to interconnect with the outdoor world. ADC is allow microprocessor-controlled circuit Arduinos, Raspberry Pi, and to communicate with the outside environment, as well as other digital logic circuits. In everyday life,many digital systems detect analog signals from such transducers to interact with their surroundings.Analog signals have constantly changed values that come from a range of sources, such as sound, light, temperature, and movement sensors.

3.2.7.Digital to Analog Converter:

Any digital signal (a binary signal) is transformed into an analog signal via a digital signal converter (voltage as well as current). The digital signal present in binary numbers is 0's and 1's (high and low-level voltage). The binary digital data exists in the form of bits 1 and 0 representing its weight corresponding to its position as shown in Figure 3.The weight is measured in 2 powers of n, where n is the bit's right-hand position, hence it begins at 0.

3.2.8.Circuit Breaker:

A circuit breaker is a switching mechanism that could be used to protect and operate an electrical power supply both automatic and manual. Its primary function is to open and close electrical circuits, it protects the electrical system from damaged.It is a mechanical device that interrupts the flow of high-amplitude electricity while also switching.

3.3.Data collection:

The Power Grid business developed and executed a technical specification for a substation monitoring system, allowing power supply subdivisions in whole areas to substitute and improve the previous remote monitoring system year after year, and in compliance with the integrated deployment. Develop an understanding of the issues with microcontroller-based substation monitoring and control using artificial intelligence.

According to the study, questionnaires and field visits are used to analyze 360 substations in China. 360 questionnaires were distributed during the investigation, 356 of which were collected, as well as the effective rate, was 98.8% as mentioned in Table 1. The fundamental issue with China's substation monitoring system is thatseveral functionalities are overlapping, lack of independent monitoring function, a high error rate in a complex situation, poor connection presentation, and absence of supporting services.

Table 1: Illustratesthe Results of an Investigation into a Problem with the Operation of the Substation Monitoring System.

Difficulties	Percentage (%)
There are a lot of manufacturers, but not enough support services.	58.7
Absence of independent observing function.	65.6
Poor linkage performance.	75.2
The high inaccuracy ratio in complex environments.	80.9
Some functions overlap.	88.2

3.5 Data analysis:

The real simulation study is carried out in a specific area of 120kV in the design of substation monitoring control based on a microcontroller with AI-based needed information access automatic acceptance system.In a substation artificial intelligence monitoring system, the time consumed of accessing information automated acceptance job is characterized, as shown in Figure 3. The test result ofthe unit time of information acceptance in traditional manual acceptance is roughly 6 minutes.However, because of artificial intelligence, automatic receiving is now possible, Information acceptance takes only 2 seconds per unit time, and the closing, as well as each circuit breaker's opening cycle, can be precisely controlled for 42

seconds,The match level confirmation rate as high as 99 percent, lowering the time it takes to approve substation data significantly.

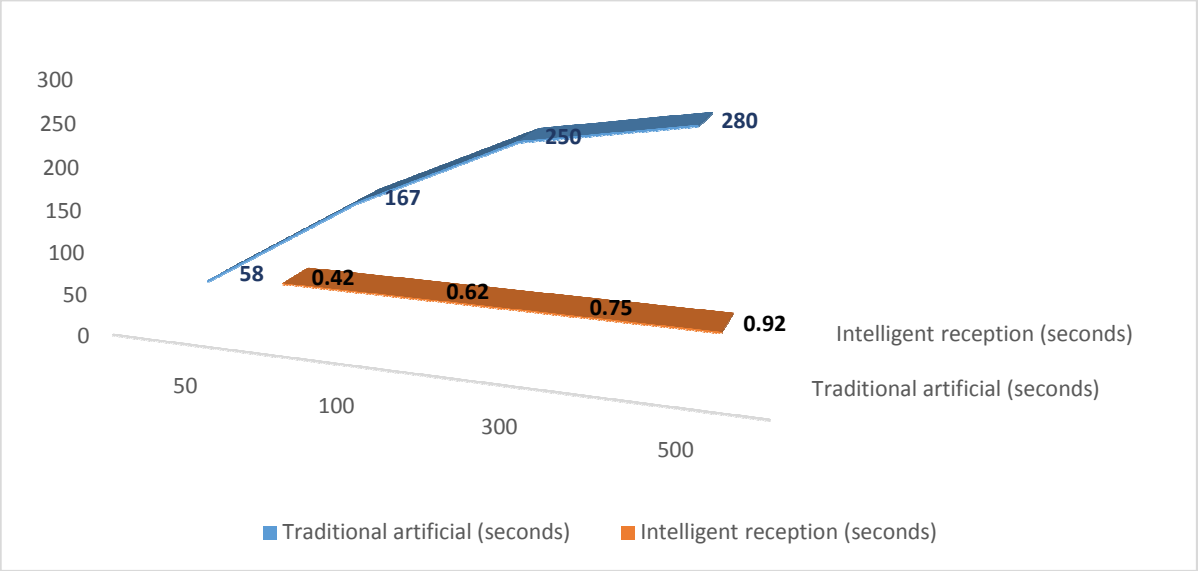

Figure 3:Investigation of Experimental Observations from a Time-Consuming Simulation Process on Details.

4. RESULTS AND DISCUSSION

According to this paper, questionnaires and field visits are used to analyze 360 substations in China.During the investigation, 360 surveys were circulated, 356 of which were collected, and the effective rate was 98.7%. The findings of an investigation into a problem with a substation monitoring system in proportion percentage are lack of supporting services 58.7%, Absence of independent observing function65.9%, poor linkage performance 75.2%, in a complex environment, there is a high error rate 80.6%, and some function overlap 88.2 %. The test result of the unit time of information acceptance in traditional manual acceptance is roughly 6 minutes.The unit time of information acceptance is merely 2s when artificial intelligence automatic reception is used.Each circuit breaker's shutting and the opening cycle can be precisely controlled for 42 seconds.

The degree matching verification percentage is as high as 99 percent. In this paper author show in the methodology section how the monitoring of substation with microcontroller and artificial intelligence in which various components are used such as voltage sensor, current sensor, relay, PIC microcontroller, liquid crystal display, analog to digital converter, digital to analog converter and circuit. Electrical energy is provided from the transmission grid to the distribution substations by dielectric power distribution systems in which the voltage is normally reduced to 11kV and then supplied to commercial, housing, and industrialized clients.Shorter supply connections assist industrial users and modern electric power systems like power transmission and distribution grids are among a huge number of distributed, separately functioned capital rigorous effects.

5. CONCLUSION

Substation, microcontroller-based substation monitoring and control with artificial intelligence are used to monitor the operation of substation through a microcontroller which commands the signal with help of artificial intelligence to obtaindistant electrical characteristics such as temperature, current, and voltage are submitted using artificial

intelligence and a microcontroller. It can see the full equipment from our personal computers utilizing GPRS and GPS technology by connecting wireless cameras in industries, factories, and other locations.The devices may be monitored and controlled from a personal computer, which we can employ to tackle a variety of scenarios.It asserts that the systems planned design renders the transmission system resistant to several serious power quality problems that result in excesses in voltage, current, or temperature. By connecting thermocouples, it is possible to obtain the temperature of dangerous areas in businesses; this eliminates the need to send workers into the field and the associated difficulties.It suggested that the device is built to shut down in order to stop more harm from occurring if the microcontroller notices any rise in voltage, current, or temperature values. The technology not only manages the substation's distributing transformer's breakdown but also shows the user these same values as they change for their reference. In the future will be used this proposed paper, by adding new components likeTemperature-controlling systems, as well asGPRS technology allows for the transmission of monitored and regulated information to any location in the world, such as coolants, which can similarly be used in situations where a constant temperature is required.

REFERENCES

[1] Y. Singh, A. L. Mathur, and D. D. Chauhan, "A Review on Substation Monitoring and control technologies and Problems," *Int. J. Trend Sci. Res. Dev.*, 2018, doi: 10.31142/ijtsrd11273.

[2] N. Matta, R. Rahim-Amoud, L. Merghem-Boulahia, and A. Jrad, "A wireless sensor network for substation monitoring and control in the smart grid," in *Proceedings - 2012 IEEE Int. Conf. on Green Computing and Communications, GreenCom 2012, Conf. on Internet of Things, iThings 2012 and Conf. on Cyber, Physical and Social Computing, CPSCom 2012*, 2012. doi: 10.1109/GreenCom.2012.39.

[3] K. Dhimar, "Substation Monitoring and Control Using Microcontroller & GSM Key Words□:," *Int. Res. J. Eng. Technol.*, 2017.

[4] P. M. Priya and E. S. Samundeeswari, "An Efficient routing method of wireless sensor network for transmission line monitoring in smart grid," *J. Comput. Theor. Nanosci.*, 2018, doi: 10.1166/jctn.2018.7623.

[5] O. Cortes-Robles, E. Barocio, A. Obushevs, P. Korba, and F. R. S. Sevilla, "Fast-training feedforward neural network for multi-scale power quality monitoring in power systems with distributed generation sources," *Meas. J. Int. Meas. Confed.*, 2021, doi: 10.1016/j.measurement.2020.108690.

[6] A. Mingotti, L. Peretto, and R. Tinarelli, "Low□impact current□based distributed monitoring system for medium voltage networks," *Energies*, 2021, doi: 10.3390/en14175308.

[7] D. I. Brandao, M. G. Simões, F. A. Farret, H. M. A. Antunes, and S. M. Silva, "Distributed Generation Systems: An Approach in Instrumentation and Monitoring," *Electr. Power Components Syst.*, 2018, doi: 10.1080/15325008.2018.1563954.

[8] M. Kezunovic, C. Guo, Y. Guan, and M. Ghavami, "New concept and solution for monitoring and control system for the 21 st century substation," in *2010 International Conference on Power System Technology: Technological Innovations Making Power Grid Smarter, POWERCON2010*, 2010. doi: 10.1109/POWERCON.2010.5666466.

[9] P. Cuffe and A. Keane, "Visualizing the electrical structure of power systems," *IEEE Systems Journal*. 2017. doi: 10.1109/JSYST.2015.2427994.

[10] M. Mahdavi, H. H. Alhelou, and P. Cuffe, "Test Distribution Systems: Network Parameters and Diagrams of Electrical Structural," *IEEE Open Access J. Power Energy*, 2021, doi: 10.1109/OAJPE.2021.3119183.

[11] electricialeasy.com, "Basics Of Electrical Power Transmission System".

[12] A. Ramelan, F. Adriyanto, B. A. . Hermanu, M. H. Ibrahim, J. S. Saputro, and O. Setiawan, "IoT Based Building Energy Monitoring and Controlling System Using LoRa Modulation and MQTT Protocol," *IOP Conf. Ser. Mater. Sci. Eng.*, 2021, doi: 10.1088/1757-899x/1096/1/012069.

[13] A. Balamurugan, R. Bhavya, K. Radhakrishnan, M. Kannan, and N. Lalitha, "Substation monitoring and control based on microcontroller using IOT," *Int. J. Recent Technol. Eng.*, 2019.

[14] E. Babu1, K.Krishnaprasad2, L. Lonappan3, N. Xavier4, and K.Sooraj, "Microcontroller based parameter monitoring system," 2014.

[15] K. Patel, “A Review on an Efficient Monitoring Of Substations Using Microcontroller Based Monitoring System,” *Int. J. Eng. Comput. Sci.*, 2016, doi: 10.18535/ijecs/v5i5.36.

[16] A. Sachan, “Microcontroller Based Substation Monitoring and Control System with Gsm Modem,” *IOSR J. Electr. Electron. Eng.*, 2012, doi: 10.9790/1676-0161321.

CHAPTER 8

DESIGN OF AN AUTOMATIC IRRIGATION SYSTEM USING SOIL MOISTURE CONTENT AND ARDUINO UNO MICROCONTROLLER

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ABSTRACT: ***The automatic irrigation system is useful for monitoring irrigation land and crops with the help of a microcontroller which reduces human efforts as well as saves time according to their requirement. There is a wide range of crops that have different requirements for water for the growth of crops. The problem arises in the irrigation system due to lack of moister content in the soil, lack of continuous monitoring of the irrigation land not possible for the farmer, and water waste occurs due to a deficiency of rain and unplanned use of water. Overcome this problem by Using the Arduino Uno Microcontroller to Create an Automatic Irrigation System Based on Soil Moisture Content. This research focused on the benefits of automatic irrigation systems such as sensing the soil moisture, continuous monitoring of the system of crops, used for saving time, and is to decrease human interference. For monitoring the soil moisture content an Arduino Uno microcontroller can also check how much water is required by different crops according to the season. The result of this system helps the farmer with an automatic irrigation system as well as fulfills the water requirement for a variety of crops. It concluded that a solution to increase the efficiency of the agricultural processes with the recent technological advancement of the irrigation system. In the future scope, it will save time and can be adjusted for automatic irrigation watering systems based on environmental circumstances.***

KEYWORDS: ***Agriculture, Automatic Irrigation System, Crops,Microcontroller, Soil Moisture Content, Water.***

1. INTRODUCTION

The ongoing increase in food demand requires the advancement of food-producing technology. Food production requires human monitoring of crops for irrigation. This continual human monitoring is not possible all of the time [1]. As a result, an autonomous irrigation system is a good option for irrigating crops without the need for human involvement [2]. This system will be constantly monitored to improve production.Agriculture is an important sector of India's economy, accounting for around 16 percent of the overall Gross Domestic Product (GDP) of the country.Farmers are vital to the survival of our varied communities because they offer food and fiber, which provide us with sustenance and clothing [3].The main reason for this is a shortage of rain and water in land reservoirs [4]. The repeated extraction of soil water lowers the water table, causing a large area of land to gradually become unirrigated. Another major contributor is unplanned water consumption, which wastes a lot of water.

1.1.Modern and Traditional Technology used in Irrigation System:

Irrigation is the process of applying water to plants artificially, and it has existed since people began to cultivate plants [4]. Previously, individuals had to water their plants using buckets. This method of irrigation is still in use, however, a new method has been discovered [2]. Check basin irrigation, furrow irrigation, strip irrigation, and basin irrigation are some of the methods utilized in traditional irrigation [5].Sprinkler irrigation, drip irrigation, and pot irrigation are some of the current methods employed in irrigation systems.

1.1.1 Check Basin method:

In this method, the whole area is divided into basins depending on water capacity. A small drain-like flow way having high earthen barriers on both sides, connects basins [6]. The input of water determines the size of the brain [8]. Drain width is influenced by a variety of factors including ground structure, slope, proportion and flow of water, and so on. The length of Dhora is determined by the slope of the fields and their formations.

1.1.2 Furrow Irrigation Method:

The method is employed in areas where the crop is grown in stalks, a dol is produced along the side of the rows of crops, and a furrow is formed across two such dols in which irrigation flows [9]. The amount of water flowing depends on the requirements for water by plants as well as the rate of infiltration.

1.1.3 Strip Irrigation Method:

Fields are separated into strips of varying sizes when using the strip irrigation method. The strips are separated by a line termed Med [7]. The slope determines how these strips are created. The source of water is at the maximum height in the field, and it supplies water to the entire region [8]. The width of the bars is determined by the amount of water used. If the strips are wider, there is more water waste. The elevation of the ground and its composition determine the length of the strip. It is also affected by the soil makeup.

1.1.4 Basin Irrigation Method:

This watering method is more beneficial to horticultural development a higher platform known as a Thanvla is erected around shrubs and trees that are connected by drains and water is flowing from one tree to the next in this method [12] is not good for crops.

1.2.Modern Techniques are used in Irrigation systems:

Water is in scarce supply everywhere under the current circumstances. As a result, we should use irrigation technologies that have proven to be effective in reducing the water scarcity situation through proper water management [9]. Only current irrigation systems will be discussed here.

1.2.1. Sprinkler Irrigation Method:

It is now the most straightforward form of irrigation in which water is delivered to the field via pipes from the source in this approach. This approach is used to maintain humidity in situations where there is a paucity of water or in high-temperature zones [10]. It is mostly employed on sandy loam and areas with uneven ground levels. Irrigation efficiency could increase from 60% to 90% with this strategy [11].Traditional irrigation methods leave 15 to 20% of land unoccupied in depres-sions and boundaries, making the entire field open for crop development. Because there are no depressions or barriers, modern technology can be used. In sandy soils with frequent watering, the level of pollution is higher [12].Sprinkler irrigation is, therefore, better suited to sandy soils. As a consequence, given the current expansion of water supplies, it is an adequate irrigation plan. Three approaches are used to install it in fields permanent, semi-permanent, and temporary.

1.2.2. Drip Irrigation Method:

In locations where water is scarce, a newly created irrigation technology known as drip irrigation or trickling irrigation, designed in Israel, is gaining popularity [18]. A small amount of water is delivered as droplets by perforations in plastic pipes or injectors connected to tubes spread across the soil to hydrate a limited region from all over the plant with this irrigation system [13].It is necessary to apply a specific level of liquid equivalent to the daily consumptive usage or the

depleted soil water [14]. During the crop growing season, the soil water can be kept at field capacity [15]. Deep infiltration loss can be avoided, and an increase in moisture content can be significantly minimized.

1.2.3. Pot Irrigation Method:

Pot irrigation is better suited to locations with little rainfall for pot irrigation is effective in saline locations where flow irrigation is ineffective [16]. This approach makes use of an earthen pitcher. The pitcher is buried up to its neck in the earth.The container is drilled with holes and filled with water so that water seeps through to the holes and keeps the soil adjacent moist. Those containers are filled at regular times with water [17]. This technique can be used as a substitute for drip irrigation.

The present study focuses on the automatic irrigation systems that irrigate the land by continuously monitoring soil moisture content and wirelessly controlling pipeline valves to open when the moisture level falls below the minimum threshold for the planted crop.This research is characterized into several sections where the first is an introduction and the second section is a literature review of previous studies. Furthermore, the methodological section of this study is mentioned where the data is examined in the different sub-sections. After that, the results and discussion part are discussed where the results are compared with the existing data followed by the methods applied in this research. Lastly, the conclusion of this research is declared where the research gives outcomes as well as future scopes.

2. LITERATURE REVIEW

Mon Arjay F. Malbog [18] et al. has explained to create an irrigation water delivery system that controls the amount and frequency of irrigated agriculture sprayed on the land and employs a low moisture sensor system that is similar to high-priced detectors on the market. The method used by the author isthe soil moisture sensor was also put through its paces in (60) sixty trials with diverse soils, with findings that were comparable to other moisture in soil monitoring systems on the market. As the results come out has proven that the soil moisture sensor-controlled automatic watering system works effectively and correctly. It concluded that low-budget tools for controlled soil moisture estimation become important for those who require autonomous irrigation as well as a system to help with farming issues.

Beza Negash Getu and Hussain A. attia [19] have to investigate based on the degree of moisture in the soil detection, the construction and modeling of an electrical system for automatic regulation of water motors use for farm areas or plant irrigation. In the method used by the author, a conditional comparator circuit processes the observed signal from the soil moisture sensor, which corresponds to varying degrees of actual soil moisture content. The result shows that the suggested solution eliminates the need for farmers or users to manually turn on or off irrigation or related watering system.It was concluded that by automating the system,is possible to obtain decent water management, conserve human energy, and boost crop or plant yields.

Abhishek Kumar and Magesh. S [20] have explainedautomating agricultural irrigation and soil moisture control with an Arduino, a moisture sensor, and an L293D module. The author describes, that whenever the electricity is turned on,the autonomous irrigation system senses soil moisture and activates the pump.The author's application is designed to preserve water, and automatic irrigation can be used to save time and energy. It concluded that when the appropriate moisture level is attained, the system will automatically stop and the water supply will be shut off. As a result, the entire system's operation has been tested extensively which is said to work well.

M. Priyadharshini [2] et al. has explained the automated irrigation system using soil moisture sensor, the data of the moisture content updated for regulating the water pump. The author has usedWireless sensor networks that have advanced to the point where they can detect moisture, temperature, and humidity. It concluded thatby upgrading the wireless sensor networks, the system may deduce various metrics such as nitrogen content and carbon dioxide level for many users.

The above review shows that the design of an irrigation water delivery system that controls the amount and regularity of irrigated agriculture spray on the ground, and uses a moderate sensor system to measure soil moisture content as well as the degree of moisture in the soil detection, the construction and modeling of an electrical system for automatic regulation of water motor use it for plant irrigation. In this research paper,the automatic irrigation system detects the soil moisture content with the help of a microcontroller, which helps in continuous monitoring of soil moisture and then starts the water pump to increase the output.

Research Question:

- *How to monitor an irrigation system with a microcontroller?*
- *How does the automatic irrigation system work?*

3. METHODOLOGY

3.1 Research Design:

An irrigation system works effectively and has a good impact on the environment in which it is implemented. Water distribution to crops and nurseries becomes simple once it is established in the agricultural area, and it does not require any human assistance to complete the tasks permanently. Automatic irrigation can also be done with the use of mechanical devices like clay pots or a bottle watering system. Irrigation systems are difficult to implement due to their high cost and complicated design. It has implemented certain projects on automatic irrigation systems utilizing various technologies, taking some essential things into mind from expert support.The autonomous irrigation system for detecting moisture in the soil project intends to develop an irrigated system that uses relays to control submersible pumps based on soil moisture content. It assists in reducing human meddling and ensuring enough irrigation. In Figure 1 the microcontroller is the central component of the project, and a power supply block uses a transformer, rectifier, and voltage regulator to provide 10V to the entire circuit.The Arduino Uno R3 microcontroller is set up to receive an incoming signal from sensing material, which incorporates a comparator that helps with soil moisture monitoring.When the microcontroller receives data from the sensing material, it compares it to the data that has been programmed, generating output signals and activating the relays to operate the submersible pump.

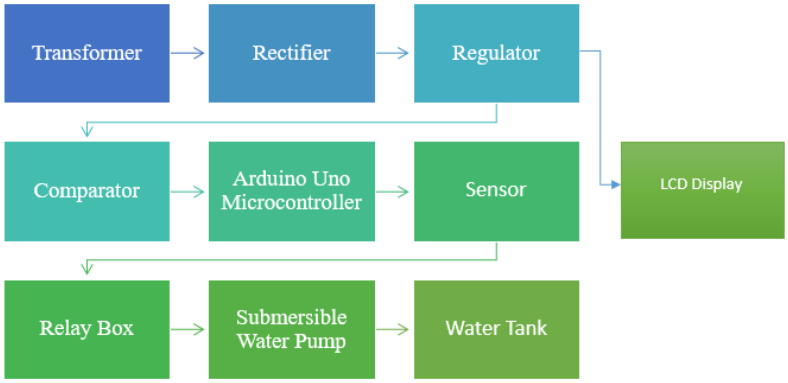

Figure 1: Illustrates the Block Diagram of Automatic Irrigation System with Arduino Uno Microcontroller.

3.2 Instrument:

3.2.1 Transformer and Rectifier:

A transformer is a device that transfers the electrical energy of one circuit to the other circuit according to with require voltages. A rectifier is a type that transforms alternating current, which regularly switches directions, to direct current, which flows in only one direction.

3.2.2 Regulator:

A voltage regulator is an electronic or electrical device that holds the voltage of a source of power within reasonable parameters. The voltage regulator's priority is to keep voltages within safe limits for electronic systems that consume that voltage. In the above system, the voltage regulator is provided 10v which is suitable for working the soil moisture content with a microcontroller.

3.2.3 Comparator:

A comparator is an electronic signal that compares and contrasts inputs and outputs the comparative result. The output value of the comparator shows which one of the inputs is greater or lesser. It's important to keep in mind that the comparator is a non-linear IC application. The op-amp-based comparator compares two inputs and generates the result of the comparison as the output.

3.2.4 Microcontroller:

The Arduino Uno microcontroller is usedthe board features a variety of I/O (Input/Output) pins that can be used to connect it to other boards and circuits. A Universal Serial Bus (USB) connection port, fourteen I/O pins, and an (Input Circuit Serial Programming) ICSP header,among the ports attached are a power supply connection and a reset button. A USB cable allows you to connect it immediately to your computer or laptop.

3.2.5 Sensor:

It is an electrical device that uses natural phenomena as inputs to detect and respond to them, such as light, heat, temperature, pressure, and moisture. This signal is developed as the output of the signal, which is sent to the specified address in readable format over a connection for detection and monitoring.

3.2.6 Liquid Crystal Display (LCD):

A liquid-crystal display (LCD) is a display technology or even another electronically controlled optical system in which light is modulated by liquid crystals with polarizers. Rather than generating light directly, liquid crystals need backlighting or reflector to provide color or monochrome pictures.

3.2.7 Relay:

A relay is an electrical control switch with single or more control signal input terminals and operating contact terminals. Several contacts in any contact form, including creating contact, break contact, or a mix of both, can be used in the switch.

3.3 Data Collection:

There is a lack of any observed climate change data, estimations of water requirements for certain crops are generally sufficient (Table 1). The approximate value of seasonal water

requirement for the different crops is used because some of the crops are seasonal but some of the crops are not seasonal and needs are different such as the cotton crop has more water as compared to the other crop.Not just between crops, including within one type, there is a wide range of values. The growing period of a certain crop is usually assumed to be longer in cool climates and shorter in hot climates.

Table 1: The Approximate Value of Seasonal Water Requirement for Different Crop and Total Growing Period.

Sl.	Crop	Water requirement for the crop (mm/total time spent growing)	Total time spent growing (days)
1.	Beans	250-495	55-60
2.	Citrus	880-1150	240-365
3.	Cotton	650-1250	180-195
4.	Groundnu	450-650	110-120
5.	Maize	450-850	80-110
6.	Sorghum	400-600	120-130
7.	Soybean	400-750	135-150
8.	Sunflowe	650-1050	125-130

3.3.1. Crop Water Requirements and Other Factors:

- Impact due to Climate Change

A crop produced in a hot, bright climate uses more water per day than one planted in a dark, cool climate. Other climate factors influence agricultural water requirements in addition to sunlight and warmth. Two of these variables are humid and wind velocity.Agricultural water demand is higher in dry weather than in humid weather. Ones in windy climates need more water than crops in calm settings. Crop water requirements are greater in hot, dry, breezy, and sunlit conditions.When the weather is frigid, rainy, and gloomy with little or no breeze, the smallest values are obtained. Crops cultivated in different climate zones would require varying amounts of water. A maize variety is grown in a temperate region, for examplein a hotter area, a maize variety would need less freshwater each day.

- The Impact of various types of Crop on Irrigation

The lowest readings are found when the weather is chilly, damp, and gloomy with little or no breeze. Crops grown in various climate zones require different amounts of water.A maze type produced in a temperate climate, for example, uses less water each day than one grown in a hotter one. Short-season crops, such as peas, have a 90-99 day total growing season, whereas relatively long crops, such as melons, have a 120-160 day complete growing season.Fruit trees, for example, are perennial crops that can last for several years in the field. While melons have a

lower daily water need than beans, melons have a greater seasonal water demand since their growing season is much longer.

3.4 Data Analysis:

In the data analysis to find that the water requirement of the different crops according to the seasonal with help of the ETcrop factor which is known as the reference crop evapotranspiration which calculates with the multiplication of the Kc and ETo.

- Calculation of ETcrop:

The methods presented here make calculating crop water requirements pretty straightforward. The following is the basic calculating formula:

ET crop equal to Kc * ETo

Therefore,

ET crop = the water needs of a certain crop in millimeters per unit of time, such as millimeters per day, season, or month.

Kc = the “crop factor”

E To =the "reference crop evapotranspiration" in millimeters per amount of time, such as millimeters each day, monthly, or season.

The crop factor (crop coefficient) changes with the crop's growth phase. In agricultural enterprises, there are 4 stages of crop growth, including the primary stage, when the crop consumes less water: the stage of crop growth when water usage rises: when water use peaks in the middle of the season: late in the growing season when the mature crop demands less water.

Because ETo values are commonly seen or calculated on a daily (mm/day) basis, an estimate for such a whole growth phase must be calculated, but then multiplied by the standard seasonally crop factor Kc. Evapotranspiration of the reference crop ETo (potential evapotranspiration, PET) is the rate of evapotranspiration from a big patch of vegetation in the exponential development phase that thoroughly shades the land and is not solvent. The amount of water that evapotranspires is influenced by the climate. The highest ETo values are found in warm, dusty, blustery, and sunlit conditions, whilst the lowest values are found in cold, humidity, and gloomy conditions with no wind.

4. RESULTS AND DISCUSSION

The automatic irrigation system is sensing soil moisture content using a microcontroller that irrigates the soil with help of a microcontroller that continuously monitors soil moisture content and wirelessly controls pipeline valves to open when the moisture level falls below the minimum threshold for the planted crop. The research paper show the adequate use estimates of water requirement for a different crop such as beans, citrus, cotton, groundnut, maize, sorghum, soybean, and sunflower as well asbecause a crop takes more water each day in a bright and hot climate than a crop grown in a cloudy and colder climate, the overall growing period differs is shown in Figure 2.

Separately from the sunlight and temperature, other climate elements affect crop water requirements such as humidity and wind speed. The result come from this research is taken equation for calculation of crop water requirements are different according to their

needs.Because ETo values are commonly measured (mm/day), an estimate for the entire growth period must be calculated but then multiplied by that of the average seasonal crop factor Kc, which varies depending on the stage of the crop.

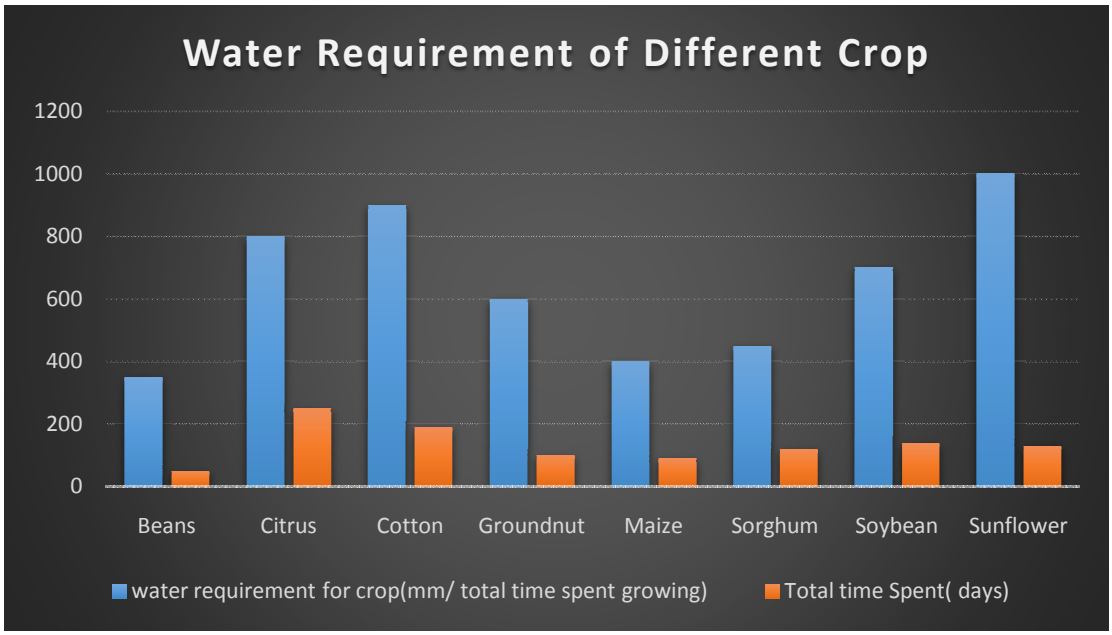

Figure 2: Illustrates the Seasonal Water Requirement for Different Crop and the Total Growing Period.

5. CONCLUSION

Conventional farmers who do not have enough time to irrigate their crops are the principal beneficiaries of this endeavor. It also covers farmers who waste water while irrigating their crops.The study could be expanded to cover greenhouses with limited manual supervision. Automated landscapes and farmlands can benefit from the concept. If implemented appropriately, it can save a lot of water when combined with both the rainwater collection principle. With most types of soil in agricultural settings with substantial rainfall deficiencies, this research can be used to achieve exceptional results.A solution to ease the agricultural process and the strain on farmers is urgently needed. With recent technological advancements, India has been boosting its annual agricultural production,creating a completely-centric economy.Using this strategy in the country's agricultural sector has several goals, one of which is to conserve the environment while enhancing agricultural productivity. Water and time were the most crucial considerations to save the farmer's tiredness.In the future, an automatic irrigation system will lengthen plant watering times and allow crops to grow in a variety of situations. It saves time and can be adjusted for automatic irrigation watering systems based on environmental circumstances.

REFERENCES

[1] S. Rajendrakumar, V. K. Parvati, Rajashekarappa, and B. D. Parameshachari, “Automation of irrigation system through embedded computing technology,” in *ACM International Conference Proceeding Series*, 2019. doi: 10.1145/3309074.3309108.

[2] P. M, S. U.M, B. S, R. N, and A. C. K.M, “Automatic Irrigation System using Soil Moisture Sensor with Bigdata,” *Int. J. Eng. Trends Technol.*, vol. 67, no. 3, pp. 58–61, 2019, doi: 10.14445/22315381/ijett-v67i3p210.

[3] S. Suman, S. Kumar, R. Sarkar, and G. Gautam, “Solar Powered Automatic Irrigation System on Sensing Moisture Content Using Arduino and GSM,” *International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)*. 2017.

[4] J. Serrano *et al.*, "Mapping management zones based on soil apparent electrical conductivity and remote sensing for implementation of variable rate irrigation—case study of corn under a center pivot," *Water (Switzerland)*, 2020, doi: 10.3390/w12123427.

[5] A. Sumalatha and G. E. Kumar, "Energy Efficient Solar Powered Automatic Irrigation System," *Int. J. Eng. …*, 2017.

[6] P. Rajadurai and G. J. W. Kathrine, "An Intelligent Deep Learning-Based Wireless Underground Sensor System for IoT-Based Agricultural Application," in *Applied Learning Algorithms for Intelligent IoT*, 2021. doi: 10.1201/9781003119838-13.

[7] S. Nallani and V. B. Hency, "Low power cost effective automatic irrigation system," *Indian J. Sci. Technol.*, 2015, doi: 10.17485/ijst/2015/v8i23/79973.

[8] N. M, R. P. U, S. K. G, and T. S. S, "Automatic irrigation system on sensing soil moisture content," *IJIREEICE*, 2015, doi: 10.17148/ijireeice.2015.3120.

[9] A. M. Okasha, H. G. Ibrahim, A. H. Elmetwalli, K. M. Khedher, Z. M. Yaseen, and S. Elsayed, "Designing low-cost capacitive-based soil moisture sensor and smart monitoring unit operated by solar cells for greenhouse irrigation management," *Sensors*, 2021, doi: 10.3390/s21165387.

[10] S. Rawal, "IOT based Smart Irrigation System," *Int. J. Comput. Appl.*, 2017, doi: 10.5120/ijca2017913001.

[11] A. H. Blasi, M. A. Abbadi, and R. Al-Huweimel, "Machine Learning Approach for an Automatic Irrigation System in Southern Jordan Valley," *Eng. Technol. Appl. Sci. Res.*, 2021, doi: 10.48084/etasr.3944.

[12] S. Anand, A. Nath, A. Jayan, B. I. B. Brunda.I.B., and C. Vidyashree.C, "Automatic Water Management System," 2021. doi: 10.4108/eai.16-5-2020.2303936.

[13] A. Pogula, "GSM based Smart Irrigation System," *Int. J. Res. Appl. Sci. Eng. Technol.*, 2021, doi: 10.22214/ijraset.2021.35676.

[14] A. Senpinar, "Internet-/Arduino-controlled PV automatic irrigation system for clean environment," *Int. J. Environ. Sci. Technol.*, 2019, doi: 10.1007/s13762-018-2092-1.

[15] J. L. Casanova, J. M. Cuevas, and A. Calle, *Remote sensing in the 21st century : economic and environmental applications*. 2000.

[16] M. F. Hasan, M. Mahbubul Haque, M. R. Khan, R. Ismat Ruhi, and A. Charkabarty, "Implementation of fuzzy logic in autonomous irrigation system for efficient use of water," in *2018 Joint 7th International Conference on Informatics, Electronics and Vision and 2nd International Conference on Imaging, Vision and Pattern Recognition, ICIEV-IVPR 2018*, 2019. doi: 10.1109/ICIEV.2018.8641017.

[17] "Smart Irrigation System Using GPRS and Moisture Sensor," *Int. J. Res. Eng. Appl. Manag.*, 2020, doi: 10.35291/2454-9150.2020.0461.

[18] M. A. F. Malbog, "A Fuzzy Rule-Based Approach for Automatic Irrigation System through Controlled Soil Moisture Measurement," *Int. J. Adv. Trends Comput. Sci. Eng.*, vol. 9, no. 2, pp. 2332–2337, 2020, doi: 10.30534/ijatcse/2020/216922020.

[19] B. N. Getu and H. A. Attia, "Automatic control of agricultural pumps based on soil moisture sensing," *IEEE AFRICON Conf.*, vol. 2015-November, 2015, doi: 10.1109/AFRCON.2015.7332052.

[20] A. Kumar and S. Magesh, "Automated Irrigation System Based on Soil Moisture Using Arduino," *Int. J. Pure Appl. Math.*, vol. 116, no. 21, pp. 319–323, 2017.

CHAPTER 9

BRIEF ANALYSIS OF THE FIRE ALARM AND FIRE DETECTION MODEL WHICH MADE WITH MULTIPLE LOGIC AND SENSORS

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ABSTRACT:*The widespread use of mobile devices and the widespread arrangement of sensing technologies in our everyday contexts create enormous prospects for the deployment smoke detectors. Currently, the majority of the conventional smoke alarm schemes include transmission sensor modules, cables, and each of which is linked to a sensor module, as well as displays. Due to their dual nature, fires can cause both property damage and injuries in addition to being useful for manufacturing and cooking. It has the power to cause destruction among other things since fire and some of its byproducts are used in many productive processes, such as the creation of food, energy, and manufactured goods. In this review also discussed so many data related to fire accident and so on. In this review also discussed cause of death and injuries due to home fire. This review paper cover so many approaches to making the smart fire alarm and fire detection model. From the above study it is clear, every fire detection system having their own pros and cons. so there is many opportunity and future scope with the enhancement in technology and the sensors.*

KEYWORDS: *Alarm, Cause,Detection,Module,Smoke.*

1. INTRODUCTION

The dual nature of fires means that even though they can be valuable for food preparation and manufacturing, they can also result in casualties and property damage. With the employment of fire and some of its byproducts in numerous beneficial applications, including such is the production of power, food, and manufactured goods, it has the capacity to wreck devastation among other things. According the Bureau of Fire Data of the World Working Group for the Prevention and Extinction of Fire, between 70,000 and 80,000 persons perished in fires in 2016. (CTIF).each year as a result of fire outbreaks since the start of contemporary era [1].In the time of a fire outbreak in a building, office, or factory, according to fire safety experts, the occupants typically approximately two minutes remain until it is too late to flee [2]. The number of people killed and property destroyed in fires is rising. Despite the fact that there are active fire safety initiatives being the government agencies. In poor nations, common fire Detection is dependent on people. When in need, an impoverished town planning and national policy make it challenging for firefighters to arriving on schedule [3]. The issue is made worse by poor notice and alert systems.

The widespread use of mobile devices and the widespread arrangement of detecting technologies in our everyday contexts create enormous prospects for the deployment smoke detectors. Currently, the majority of the conventional smoke alarm methods include transmission cables, sensor modules, and each of which is linked to a sensor module, as well as displays. Consequently, the timeliness and accuracy are flawed. Of the conventional alarm mechanism. Misinformation about the front alarm brought on by oil smoke or water mist generates unnecessary loss to individuals [4].Almost 4 billion hectares of the earth's surface are covered in forests, or territory where trees predominate. This is roughly equal to 29% of the surface of the planet. Thus, maintaining biodiversity on a global scale requires the management and conservation of forests. Forest fires that may be caused by humans or

Events that occur naturally have the potential to endanger our world. Leaving behind disastrous conditions like damage and defeats [5].

The fire detection system uses a variety of fire phenomena, including smoke, temperature, and flammable gas, to detect early fire. The losses brought on by fire are increasing. With the further development, more serious a growing social economy and taller skyscrapers. If fire detecting system notices fire and acts quickly. Losses can be minimized as much as feasible, by more than 80 percent. The conventional single fire detection system is insufficiently precise. For fire detection and frequently results in false alarm issues and without an alert. A system for various parameters fire detection possesses good intelligence and strong comprehensiveness. It can increase the accuracy and speed of fire detection.Today, fire is a major issue that nations all over the world deal with frequently. Along with deaths, it will also result in some property damage and unfavorable sociopolitical effects [6]. Statistical data from the China Commercial 233,000 fires were reported by the safety and Fire Association in 2019. 1,335 fatalities were reported nationwide, including 3.612 billion Yuan in direct property damages were recorded. The number of fires and property damages have increased in comparison to 2018, which saw decreases of 4% and 1.9%, respectively. [7]. Types of fire alarm system described by the Figure1.

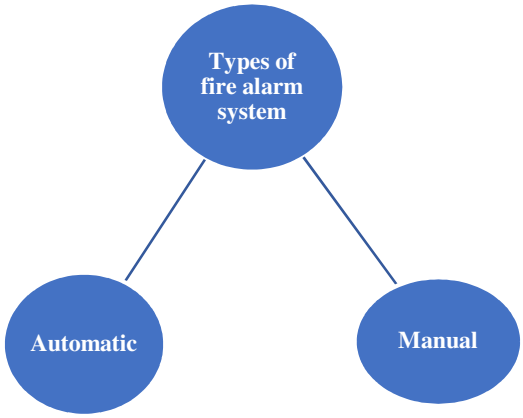

Figure 1. Demonstrate the Types of Fire Alarm System.

2. LITERATURE REVIEW

Robert A. Sowah et al. discussed in their paper about the fire detection alarm model using fuzzy logics and convolutional neural network. This article discusses the design and implementation of a multimodal fire detection system based on fuzzy logic, as well as a web-based warning system using trained convolutional neural networks for proximity and wide-area fire detection. Smoke detectors were the only type of fire detection used by most consumer-grade fire recognition systems until recently, and they provide only limited protection. Both the detection technology that is in use today. We offer a multisensory data fusion with 'convolutional neural networks' (CNN) to address this issue. Technique for detecting and notifying fires across a network. Convolutional neural networks are common techniques for deep learning. They are advantageous for learning since they can carry out feature extraction and classification in the same architecture. A system's goal is to allow for early fire detection in domestic, industrial and commercial, settings by utilizing a variety of fire characteristics [8].

Qin Wu et al. discussed in their paper, the introduction of a sensor network, classification algorithm, and visual interface for an intelligent smoke alarm system. The issue of old

methods' poor timeliness and lack of precision Smoke alarms are provided.The human-caused problem of burning conflagration persists, and homes are particularly vulnerable to it. People have recently started using smoke alarms with a single sensor to detect fire. In everyday life, smoke is released in many different ways. The detection of fire is not accurate with a single sensor. Due to the Internet's rapid progress in technology, users can remotely check on their homes to ascertain present state of the house. This essay proposes a sophisticated smoke alarm system that makes use of Zig Bee communication technology [9].

Jianfei Zhang and Sai Ke, discussed in their paper,Taking into account the problems with the existing target detection model's difficulty for application in complicated fire situations and few detection targets, an upgraded YOLOX fire scenario detection model was introduced to realise multitarget detection of flame, smoke, and people.To enhance the model's overall detection performance, a light attention module was first added. Finally, the backbone channel was replaced with a light transformer module to improve the global backbone channel's capacity to capture information. The channel shuffle approach was utilised to facilitate communication between channels. Using a self-developed fire dataset, the study found that T-mAP YOLOX's rose by 2.24 percent in comparison to The benchmark model with CenterNet significantly improved detection accuracy as compared to the baseline model (YOLOX).

Seyd Teymoor Seydi et al. discussed in their paper,in this work, a deep CNN (Fire-Net) was developed to identify ongoing forest fires across diverse locations. Australia and the USA in particular In contrast to testing, regions were utilized to train the network. Completed for Australia, Africa, Brazil, Ukraine, and not a part of training) areas. The findings showed a high the applicability of the suggested approach. The Fire-Net was then compared to another state-of-the-art deep network, MSR-U-Net, as well as other popular machine learning techniques, for instance. Quantitative evaluation and qualitative examination of active fire detection outcomes. The results of the performance evaluations showed a trade-off between spotting active flames and foreign fires.Considering the size of the ongoing flames in most ml algorithms could operate effectively in unable to locate current fires.

Na Qu et al. discussed in their paper, this research suggests using a sparse representation approach to combine fire parameter data for CO, temperature, and smoke. It produces a sort of overly comprehensive dictionary to identify the sparse solution for fire recognition using the L1 norm, L3/4 norm, L1/2 norm, and L1/4 norm, respectively. For fire, a thorough classification approach is suggested. Identification. The simulation results demonstrate that the solution is obtained with exceptional scarcity using L1 norm and L3/4 norm. And great precision. In comparison to the minimum residual approach and the sum of weights, the comprehensive classification method is more efficient. Coefficients approach. This study makes use of the DSP TMS320F28022 core processor, the TC72 temperature sensor, and the MQ-7 CO gas sensor a smoke sensor, and MQ-9 [10].

Wei Chen et al. discussed in their paper, this research suggests an indoor distributed LoRa-based IoT fire alarm system. A star network topology is achieved by e system with the deployment of distributed nodes and gateways. With LoRa technology. Each node records data synchronization to remote devices and environmental data real-time system monitoring when there is a fire, the real-time alarm can be sent out by a node monitoring system. System has extended deployment times and is simple to use. The weighted fusion algorithm and filtering of the sensor data can effectively determine whether a fire has occurred.in addition to being able to keep an eye on the each node's system condition in real time. Additionally, the Node uses minimal power and routine data transmission sleep and conserving energy [11].

Mengjie Li and Chao Liu, are discussed in their paper about the modern alarm system and its present trend.The market is becoming more and more in demand for an intelligent alarm system as a result of the alarm system's quick development nowadays. To satisfy the needs of society, the traditional alarm system needs technological development. It also has to grow in the direction of integration, both digitally and professionally. Employing integrated intelligent warning systems using multisensory digital data integration techniques, it is possible to more precisely extract the measured object's data and holistically from many angles, to increase the system alarm's precision. This article tries to research the use of Intelligent re alarm systems with multisensory data fusion. The ID3 algorithm's multivalued bias is a problem, and this CAC ID3 algorithm is suggested in the publication [12].

Haoyang Han et al.The DMS-2017B machinery operation simulator and the notion of affordances were suggested in this paper as a means to evaluate the design element of a ship fire alarm. Comparatively to the experiment in the cabin, the experiment in the simulator can uniformly provide a noisy atmosphere to environmental variations' impact on the experimental results. The simulator experiment can furthermore in the actual experiment, simulate a catastrophic setting to prevent harm to participants' bodies. To evaluate various maritime vehicles are equipped with alarms, and the design of devices for machine control, navigation, and other types of transmission author have information via the auditory and visual systems [13].

3. DISCUSSION

A fire alarm system informs individuals when smoke, fire, carbon monoxide, or other fire-related hazards are found. Both manually activated fire alarms such as manual call points or pull stations as well as automatically activated smoke and heat detectors can cause these alarms to go off. Alarms come in the form of wall-mounted sounders, horns, or mechanized bells.Additionally, they can be speaker strobes that flash an alarm before playing an evacuation announcement cautioning residents against using the elevators. Fire alarm sounders can be set to specific frequencies and tones, including low, medium, and high, depending on the country and device maker. The vast majority of fire alarm systems in Europe produce an alternating siren sound. It might be difficult to believe, but according to the NFPA's most recent study on residential structure fires, from 2014 to 2018, five general fire causes were responsible for 86% of recorded home fires, 95% of home fire fatalities, and 83 % of home fire injuries. Cooking was the second-leading cause of house fire mortality and by far the main cause of home fires and fire injuries. It's simple to overlook the high temperatures and risks associated with cooking because it's such a normal activity in our life. The second most common source of house fires and fatal house fires are heating equipment. The most frequent cause of these incidents was creosote build-up in chimneys, while fires involving stationary and portable space heaters.The fourth most common reason for home fires and the fifth most common cause of home fire fatalities was intentionally starting flames. Nearly two-thirds of intentional fire deaths, not simply those caused by home fires, were suicides, according to death certificate statistics. Smoking materials resulted in the majority of home fire fatalities over this time period, despite the fact that they were fifth in terms of home fires. Only 17% of adults smoked combustible tobacco products in 2017, citing the Centers for Disease Control and Prevention (CDC). The leading cause of home fire, occurring death and injuries reported in between the year 2014 to 2018 are given below in Table 1.

Table 1. Leading Cause of Home Fires and Occurring Death and Injuries Which Is Reported Between the Years Of 2014 To 2018.

S.no.	Cause	Fire	Civilian death	Civilian injuries
1	Cooking	49%	21%	44%
2	Heating equipment	14%	19%	12%
3	Electrical distribution and lighting equipment	10%	18%	10%
4	Intentional	8%	14%	7%
5	Smoking material	5%	23%	10%

Analysis of the following given data in the graphical form are given below by the Figure 2. The analysis regarding to the leading cause of death and injuries due to home fires.

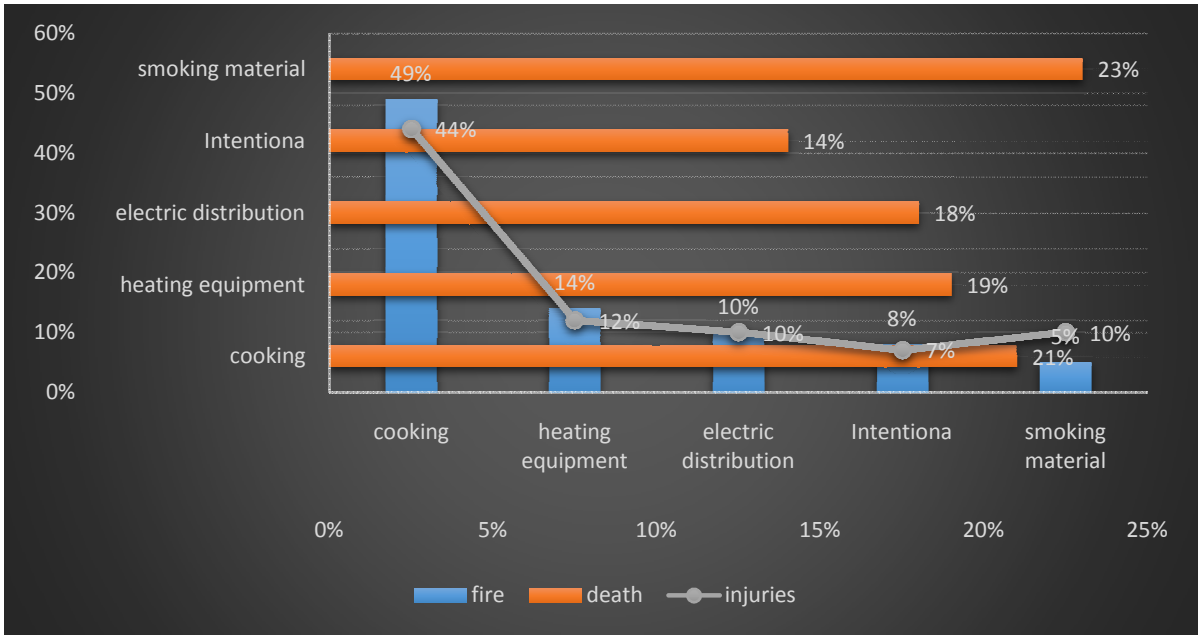

Figure 2. Illustrate the Analysis of Leading Cause of Death and Injuries Due to Home Fire Between the Years 2014 to 2018.

With the exception of the Northwest and Upper Mississippi River Valley, a large portion of the country experienced July rainfall that was above average. Widespread precipitation was brought on by increased monsoonal flow in the Southwest, which also reduced wildfire activity there. In Alaska, where the month was warm and dry and excellent for wildfires, a number of sizable flames broke out. Despite the above-average rainfall in July, the drought conditions in the West did not significantly change. The Southern Rockies and Southern Plains did see some relief from the drought in some areas. Over 20% of Alaska was experiencing drought conditions as of July 30th, with a tiny area of central Alaska facing severe drought. Acres burned each fire in January to June in between the year 2000 to 2021. Information shown in Table2

Table 2: The Data of Acres Burned Per Fire In June between Years of 2000 to 2021.

S.no.	Year	Acres
1	2000	66.43
2	2002	122.11
3	2004	174.31
4	2006	77.67
5	2008	70.48
6	2010	201.7
7	2012	251.76
8	2014	38.73
9	2018	158.94
10	2021	136.78

The analysis of the above given data which is regarding the wildfires in June month between the years 2000 to 2021 given below in Figure 3.

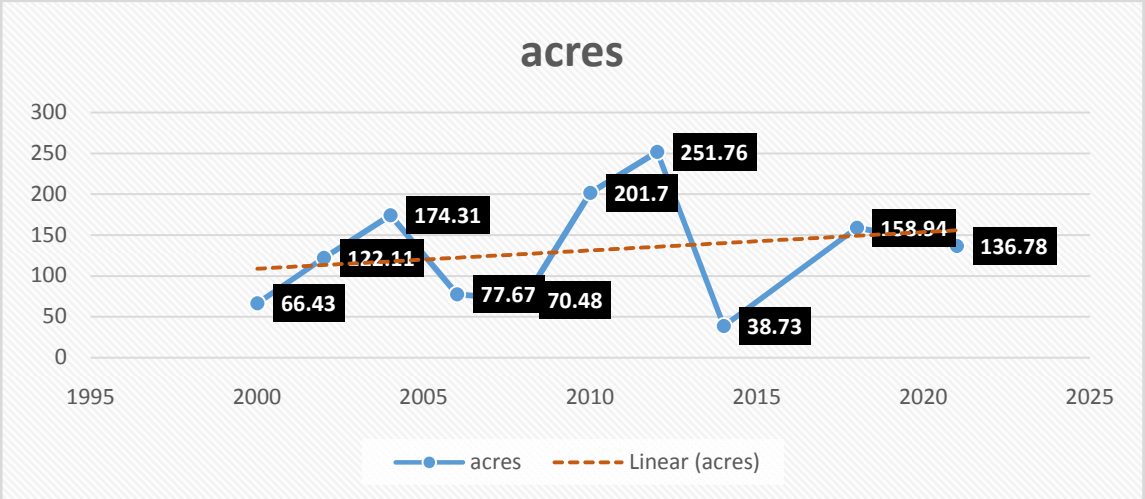

Figure 3. Illustrate the Analysis of the Wildfire in June Month between the Years 2000 To 2021.

The domestic market is expanding quickly, and society is advancing, which is causing a rapid expansion in the construction industry and the construction of numerous major structures. The variety of building types and uses changes concurrently, and the likelihood of a fire also climbs to a particular degree. Several different types of fire sources could be to blame, or perhaps brought by human influences. In the above paper study, having the knowledge about the fire alarm system and different approaches of the system. There are so many approaches to making a fire alarm system and also by the use of the fire alarm system user protect his home by fire accident. There are numerous fire alarm model which is existing but each have their own methodology and concepts. There are many data which is discussed above which is

related to the fire accident. For making the fire alarm system they need various types of sensors and modules also use various types of software and platform. Advantages of fire alarm system are classified below in Figure 4.

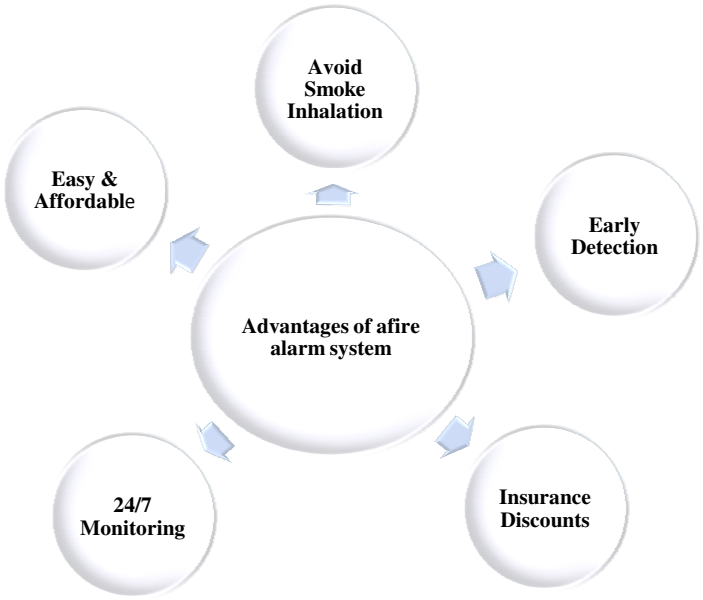

Figure 4. Illustrate The Advantages Of The Fire Alarm System.

*Easy and Affordable***.**

A system costs extremely little money to have. Many of them are irreplaceable, even if you have insurance that will replace any lost things. Photo albums, presents from relatives, and artefacts passed down from one generation to the next fall under this category. Living somewhere else for at least a while would also cause you great discomfort. The psychological agony of losing your house and belongings is the last factor.

*24*7 Monitoring.*

A house fire alarm system offers the homeowner safety seven days a week, twenty-four hours each day. When you are abroad and while you are asleep at night, your home will be watched. You can feel confident knowing that this monitoring is ongoing for you and your family. By the help of fire alarm system user live their life freely they have not much concern about the fire accidents.

Insurance Discount.

This may result in lower home insurance costs. Customers with these systems receive savings on homeowner coverage frequently. This is due to the possibility of saving a home rather than having to completely lose it. Additionally, it shows the insurer that the homeowner is accepting responsibility for their actions and is ready for the worst.

Avoid smoke inhalation.

The most crucial justification may be the only one you actually require. Anyone inside the home at the time of this could be saved. This is especially important at night. If a fire starts, people who are sleeping could not be roused in time. People frequently pass away from smoke inhalation while attempting to flee. Having a system in place can provide you with security and peace of mind.

4. CONCLUSION

There are a lot of opportunities for the usage of smoke detectors due to the extensive use of mobile devices and the ubiquitous use of sensing technologies in our everyday environments. The bulk of modern smoke alarm systems comprise displays, transmission cables, sensor modules connected to one another, and sensor modules themselves. Consequently, the timeliness and accuracy are flawed. Of the conventional alarm mechanism. Misinformation about the front alarm brought on by oil smoke or water mist generates unnecessary loss to individuals.Almost 4 billion hectares of the earth's surface are covered in forests, or territory where trees predominate. This is roughly equal to 29% of the surface of the planet. There are so many approaches to making a fire alarm system and also by the use of the fire alarm system user protect his home by fire accident. There are numerous fire alarm model which is existing but each have their own methodology and concepts. There are many data which is discussed above which is related to the fire accident. . In the above paper study, having the knowledge about the fire alarm system and different making approaches of the system**.** From the above study it is clear, every fire detection system having their own pros and cons. so there is many opportunities and future scope with the enhancement in technology and the sensors.

REFERENCES

[1] H. Alqourabah, A. Muneer, and S. M. Fati, "A smart fire detection system using IoT technology with automatic water sprinkler," *Int. J. Electr. Comput. Eng.*, 2021, doi: 10.11591/ijece.v11i4.pp2994-3002.

[2] E. Jang, Y. Kang, J. Im, D. W. Lee, J. Yoon, and S. K. Kim, "Detection and monitoring of forest fires using Himawari-8 geostationary satellite data in South Korea," *Remote Sens.*, 2019, doi: 10.3390/rs11030271.

[3] X. Huang and L. Du, "Fire detection and recognition optimization based on virtual reality video image," *IEEE Access*, 2020, doi: 10.1109/ACCESS.2020.2990224.

[4] R. Zafar, S. Zaib, and M. Asif, "False fire alarm detection using data mining techniques," *Int. J. Decis. Support Syst. Technol.*, 2020, doi: 10.4018/IJDSST.2020100102.

[5] P. Sridhar and R. R. Sathiya, "Retraction: Real Time Fire detection and Localization in Video sequences using Deep Learning framework for Smart Building," *Journal of Physics: Conference Series*. 2021. doi: 10.1088/1742-6596/1916/1/012027.

[6] Y. Gao, M. Hao, Y. Wang, L. Dang, and Y. Guo, "Multi-scale coal fire detection based on an improved active contour model from landsat-8 satellite and UAV images," *ISPRS Int. J. Geo-Information*, 2021, doi: 10.3390/ijgi10070449.

[7] H. Wu, D. Wu, and J. Zhao, "An intelligent fire detection approach through cameras based on computer vision methods," *Process Saf. Environ. Prot.*, 2019, doi: 10.1016/j.psep.2019.05.016.

[8] R. A. Sowah, K. Apeadu, F. Gatsi, K. O. Ampadu, and B. S. Mensah, "Hardware Module Design and Software Implementation of Multisensor Fire Detection and Notification System Using Fuzzy Logic and Convolutional Neural Networks (CNNs)," *J. Eng. (United Kingdom)*, vol. 2020, 2020, doi: 10.1155/2020/3645729.

[9] Q. Wu *et al.*, "Intelligent Smoke Alarm System with Wireless Sensor Network Using ZigBee," *Wirel. Commun. Mob. Comput.*, vol. 2018, no. 2, 2018, doi: 10.1155/2018/8235127.

[10] N. Qu, J. Wang, J. Liu, and Z. Li, "Composite Fire Detection System Using Sparse Representation Method," *Math. Probl. Eng.*, vol. 2017, 2017, doi: 10.1155/2017/6784764.

[11] W. Chen *et al.*, "Research and Design of Distributed Fire Alarm System of Indoor Internet of Things Based on LoRa," *Sci. Program.*, vol. 2021, 2021, doi: 10.1155/2021/7462331.

[12] C. Wen, K. Li, Y. Liao, and Z. Xiao, "Design of an Intelligent Alarm System Based on Multi-sensor Data Fusion," *J. Phys. Conf. Ser.*, vol. 1961, no. 1, 2021, doi: 10.1088/1742-6596/1961/1/012025.

[13] H. Han, J. Zhang, and R. Jiang, "Feature Design Assessment of the Ship Fire Alarm System," *Sci. Program.*, vol. 2021, 2021, doi: 10.1155/2021/3934428.

CHAPTER 10

SMART HOME ELECTRIC ENERGY MANAGEMENT SYSTEM WITH THE INTERNET OF THINGS (IOT)

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ABSTRACT:An electrical energy management system (EMS) for smart homes converts and reduces demand based on consumer convenience and real-time electricity pricing, increasing energy efficiency and decreasing electricity costs. It is difficult to determine the energy waste due to electrical equipment failure, lack of real-time monitoring of the system, and it does not sense the temperature of the air condition. Hence to overcome this problem author focuses smart home electric management system with the help of the Internet of Things (IoT) which provides a platform enabling monitoring and controlling various consumer IoT devices, such as temperatures, lighting, alarm systems, and appliances. It concluded that smart home automation systems allow you to operate all the appliances in their house whenever it's convenient for them, saving money and electricity. In the future, as systems improve by reducing energy costs and improving user satisfaction, affordable IoT-powered gadgets are bringing us closer to the potential of a smart home.

KEYWORDS: Appliances, IoT, EMS, Sensor, Smart Home.

1. INTRODUCTION

An energy management system (EMS) is a framework used by energy consumers, such as businesses, governments, and other industrial and commercial entities, to control their energy consumption. It helps businesses explore opportunities to implement and scale up energy-saving technology, especially those that do not demand a significant financial outlay. Successful network management system (NMS) deployment usually requires specialized knowledge and staff training. As part of the energy management system, energy use objectives are specified, action plans are created to achieve them, and progress is tracked [1],[2]. Energy policy development and implementation are also included. It may be necessary to use new energy-saving technologies, reduce energy waste, or optimize existing processes to save energy expenditure [3],[4]. There are now countless examples of industries and other businesses that have used EMS and dramatically increased their energy performance [5],[6]. They have been successful in reducing energy costs, limiting associated expenses, mitigating the risks associated with unpredictable energy prices, and most importantly, increasing productivity and operational stability as in Figure 1. Many aspects of your technical processes can be changed if your organization is ready. , Investing in the time and energy required to build an efficient EMS. Smart meters provide an interface to the smart grid for both customers and local energy suppliers [7],[8]. These electronic meters are installed instead of your old mechanical meters and enable the automated and complex flow of data between your home and its energy supplier. For example, smart meters will give signals from your energy supplier which can help you reduce your energy bills. Smart meters give utility access to additional data about the amount of electricity being used in their service areas.

A home EMS can be used to process energy data entering and leaving the home from its smart meter, allowing one to easily understand it on a computer or handheld device allows.

Viewable format Users can track home energy usage in great detail with Home EMS to maximize energy conservation. For example, you can monitor your EMS whenever various appliances and electrical gadgets are turned on and off, so that you can see the energy impact of those items. An EMS enables you to track real-time data and price signals from a local utility and set automatic electricity usage for times when rates are lowest [10], [11]. To balance the energy load in their area and avoid peak demand rates, customers can select settings that require precision instruments and equipment to automatically shut down when power outages are caused by high demand risk occurs. The utility may offer a reward for doing so.

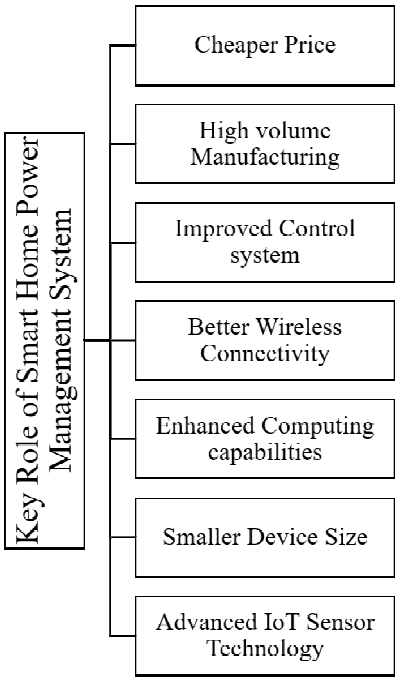

Figure 1: IllustratesProminent Proponents of Smart Home Power Systems that Give Existing Home Equipment Monitoring Capabilities and Improve their awareness of their Surroundings [9].

Many devices in your smart home will be networked so that they can be accessed and controlled using your EMS. When you are about to leave the house, it can turn on the house heater or air conditioner without work. Users can also use EMS to monitor the energy use of specific appliances or equipment, such as your recirculation pump. Additionally, smart devices will be able to respond to your energy supplier's signals to save energy during periods of high demand [12]. The switch is more complex than a straight on/off switch. While you may not be paying attention, millions of air conditioners may be operating in a similar manner, significantly reducing the demand for the electrical grid [13]. As an example, a smart air conditioning system may slightly lengthen its cycle time to reduce its load on the grid. Similarly, a smart dishwasher or refrigerator may delay operation for off-peak hours or delay itsdefrosted cycle. These intelligent technologies will, of course, facilitate consumer controls to disable automatic controls as needed.

1.1. Domestic Power Generation:

The interoperability of smart grids will be more and more important as consumers switch to residential electricity generation. Wind turbines and solar power electrical systems are now widely accessible, and people who live in rural areas may also consider installing a small hydroelectric system on a nearby stream. Domestic hydrogen fueling systems, which use

natural gas to generate heat and electricity, are also being offered by businesses. All these small power generation systems will be connected to the grid more efficiently with the help of smart grid control devices and electronic meters, which will also give utilities and owners information about the company and help them decide when to use excess energy [14]. Using Feedback is different from using Grid. One potential feature of a smart grid would be to allow your neighborhood to use your solar array and local neighbors even when there is no electricity from a corporation. The so-called island would enable a residence to use distributed energy sources to generate electricity, such as solar, hydro, and wind projects on a nearby rooftop, while utility workers could bring the system back online.

In the present study as part of an energy management system, objectives for energy use are specified, action plans are made to achieve them, and progress is tracked. Energy policy development and implementation are also included. This research is featured in several sections where the first is an introduction and the second section is a literature review and suggestions for previous studies in the context of Importance of Smart Metering in Diverse Fields of Smart Cities. In addition, the methodology section of this study is mentioned where the data in different sub-sections are examined. After that, the results and discussion part are discussed where the results are compared with existing data, followed by the methods applied in this research. Finally, the conclusion of this research is declared where the research gives the result as well as the future scope.

2. LITERATURE REVIEW

Muhammad Saidu Aliero et al. [15] have explained global energy sources that are of concern to human and environmental health today. According to the author's analysis of worldwide demand for energy consumption in various energy consumption sectors, the construction industry has been identified as one of the major users of energy. To address the unnecessary use of energy and guarantee a safe and healthy environment for green smart cities, the author adopted a variety of strategies. As the results demonstrated, Smart Home Energy Management Systems (SHEMs) transform electrical home appliances into autonomous devices by turning sensor nodes into them. It concluded that energy consumption, waste, and supply dependence in the construction sectors are reduced through the use of smart grid technology and SHEM solutions, creating a comfortable and healthy living environment.

Xiuwang Wang et al. [16] have a new Internet of Things-based best practice for residential energy management explained. The IoT system used in this study is based on ZigBee, which is known to have the lowest power consumption of all wireless technologies. To accelerate convergence, the author's optimization technique is based on a new improved version of Butterfly's algorithm. As seen from the results, the suggested solution enhances the system by reducing energy costs and increasing user happiness. The study concluded that an advanced butterfly optimization algorithm would increase system effectiveness in terms of power consumption cost and user satisfaction.

Javed Iqbal et al. [17] have explained that in the smart house scenario, IoT-based infrastructure is demonstrated using ZigBee protocol technology. Implementation of a system for deployment of sensors, detection and development of electrical devices in a smart home or smart manufacturing, testing the proposed scheme on actual electrical equipment, and recording of energy usage using the proposed electronic hardware sleep work according to the author's The proposed system has four main phases. The result shows that when compared directly with wireless sensor network (WSN) based solutions, the suggested architectures outperformed in various contexts. To test the integrity of the system for better

usage and lower billing in future smart homes, it was concluded that the technology was tested on real-time data obtained from a sample set of home dedicated hardware for six hours.

The above study shows that the global energy sources that are today a concern to human and environmental health as well as a smart house scenario, an IOT-based structure is shown using ZigBee protocol technology. In this study, the author researched the monitoring of smart electrical energy management with IoT.

Research Questions:

- How to Monitor Smart Electrical Energy Management with IoT?
- How to Use Smart Electrical Power Management to Operate Electrical Appliances?

3. METHODOLOGY

3.1.Research Design:

This smart power management system treats the microcontroller as the primary control element to which all the devices are connected. For example, the Arduino board is connected to the temperature measurement. The sole purpose of the temperature sensor is to detect the temperature and provide that information to the Arduino. The fan turns on or off after the threshold value and also alerts the application interface in Figure 2 if the temperature is lower or higher than the threshold value. Similar to that, the light sensor determines whether the light intensity exceeds the current threshold value before conducting itself.

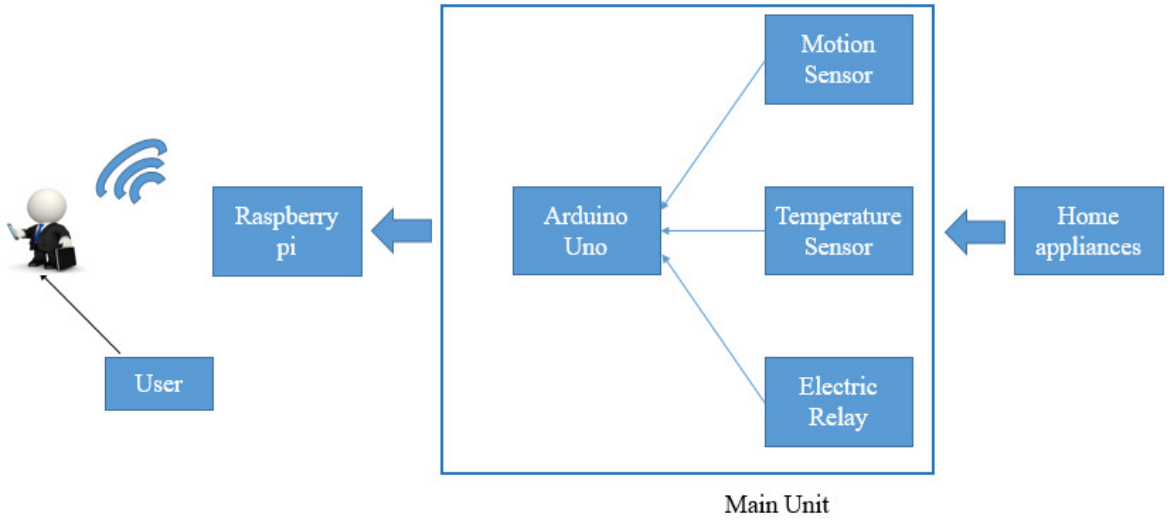

Figure 2: Illustrates the Smart Home Electric Energy Management System in which it Operates with Help of IoT.

3.2. Instrument:

Each component works together as a single unit which is connected by the Raspberry Pi microprocessor. Since the Raspberry Pi connects to the server quickly and completes the interface between both the Raspberry Pi and the application, the user can access all the information through the Raspberry Pi. Users have the option to manually define threshold values in the application interface, and can also add new devices and their restrictions.

3.2.1. Motion Sensor:

An electrical device designed to detect and analyze motion is known as a motion sensor or motion detector. In addition to smartphones, hand towel dispensers, gaming systems, and

virtual reality headsets, motion sensors are commonly installed in the home and occupational security systems. Motion sensors typically consist of three main parts: a sensor unit, an integrated computer, and electronics (or mechanical components), unlike many other separate sensors that can be moved and separated. These three components come in a variety of shapes and sizes because motion sensors can be configured to perform incredibly complex tasks. Motion sensors can be fitted to switches, floodlights, turn on sound alerts, and even call the police.

3.2.2. Arduino UNO microcontroller:

The Microchip ATmega328P microcontroller is the foundation of the Arduino Uno, an open-source microcomputer board. The board has several analog input/output pins (I/O) pins that can be used to connect to the shields of various expansion panels and other equipment. An open-source electronic platform called Arduino is built on simple hardware and software. A light on a sensor, a fingertip on a button, or a motor or Light Emitting Diode (LED) on an Arduino board can be turned on or off to read input from a tweet. Some of these devices are household appliances.

3.2.3. Temperature Sensor:

It is a device that uses electrical impulses to measure temperature. It works by giving readings through electrical signals. By detecting the voltage between the diode terminals, detectors are constructed of two metals that produce an electric current, or impedance, when the temperature changes. With an increase in voltage, there is an increase in temperature. It is used because of its quick response time and low thermal mass. Typically, all vibrating wire types are interchangeable.

3.2.4. Electric Relay:

Relays are switches used to electronically and electromagnetically close and open circuits. It controls how circuit connections open and closes in an electrical circuit. The relay does not activate when the relay contacts are open while the relay contacts are open. The IoT Electric Relay is a four-output programmable power relay that can be used to build an Internet of Things project with safe, reliable power control. The IoT Energy Relay makes it easy to manage the flow of electricity to a device using an SBC or microcontroller such as an Arduino or Raspberry Pi.

3.2.5. Raspberry Pi:

A credit-card-sized, inexpensive computer called a Raspberry Pi connects to a monitor screen or television and operates with a regular keyboard and mouse. It's a capable little gadget that enables users of all ages to learn to program in a language like Scratch and Python and to explore computing. Therefore, the Raspberry Pi is the best choice if an IoT system needs to gather data from multiple sensors, access information from databases, communicate with a smartphone, and deliver a complex result on a single display.

3.2.6. User Interface:

Aspects of the user interface are how the user interacts with the computer system. Displays, pages, buttons, images, forms, etc. are all included in this. Software and programs on computers and mobile devices are the most obvious examples of user interfaces. Users are made aware of their needs and want, and the originators of the technologies at their disposal respond to cable network intelligence to enhance their ability to jointly govern.

3.3. Data Collection:

This section used various devices for home appliances with different voltage ratings, operating voltages, home controller loads, scale factors, and actual loads determined in kilowatts (kW). This home has a water heater, air conditioner, clothes dryer, as well as an electric car with controllable loads (Table 1). It will be necessary to change the hair dryer for the clothes dryer; Use an actual air conditioner, an electric baseboard heater, to represent watt-hours, and another electric baseboard heater to symbolize an electric car. The proposed Smart Electric Energy System will employ IoT to autonomously adjust the load in the home to demonstrate load management action. Real-time electrical measurement of an electric baseboard heater, an air conditioner, and a hair dryer. The electrical usage of the four control loops in the proposed home is represented by multiplying these values using the scale factors compared to an exponent in arithmetic, a scale factor is still a number that is multiplied to represent a number on a different scale. When a real-world collection of numbers must be represented in a different order of magnitude to match a certain number system, a scale factor is used shown in Table 1. The smart home appliance power generation system then manages to combine those same scaled-up readings with the estimated critical. Burden. Data from the loading database to identify total household consumption (kW). After transmitting electrical impulses to the user with the help of an electrical relay, the main unit will operate under the instructions of the user sent via a signal from his smartphone.

Table 1: Represent the Actual loads used in Estimating Load Size versus Performance and Scale Factors.

Sl.	Home appliances load in kilo-watts	Load in the kilo-watt	The actual load used in the demonstrated Load in kilo-watt	Scale factor
1.	Charged the Electric Vehicle	3.0 kW	0.58 kW	5.1
2.	Heating Coil	3.5 kW	0.7 kW	5
3.	Pump	0.5 kW	0.15 kW	3.3
4.	Hair Dryer	3.5 kW	0.85 kW	4.1
5.	Water Heater	4.3 kW	0.6 kW	7.1
6.	Air conditioner	2.0 kW	0.58 kW	3.4
7.	Washing Machine	1.4 kW	0.65 kW	2.1

3.4. Data Analysis:

The easiest way to save energy is to stop wasting it. A modern generation of sensor-based learning thermostats, smart lights, and systems with high voltage alternating current is built to autonomously maintain the correct position in areas and maintain optimum levels of energy use. Light, motion, humidity, and atmospheric carbon level sensors, among others. These technologies can continuously modify the system in response to transfer conditions, preventing unnecessary energy use, as in Figure 3. The applications for IoT energy efficiency are numerous and are easily accessible to customers. Think intelligent lighting that fades based on the amount of daylight present in the space and automatically turns off when no one is using it. A user can also learn how to use a cooling thermostat before heating a room to save money by not consuming energy during high-demand periods. A notable example is the

current IoT energy management system offered by General Electric. To build a smart power system in commercial and industrial locations including factories, shops, and entire towns, the company provides a collection of light emitting diode (LED) lights, sensors, control, and analytical instruments. The solution claims to reduce the cost of electricity by up to 65%. Accidents and environmental blackouts are two situations where predictive strategies cannot be used, although smart analytics systems are often used to reduce losses and address problems. For example, by using sensor data, technicians can locate the problem, assess the damage, and design a successful repair strategy.

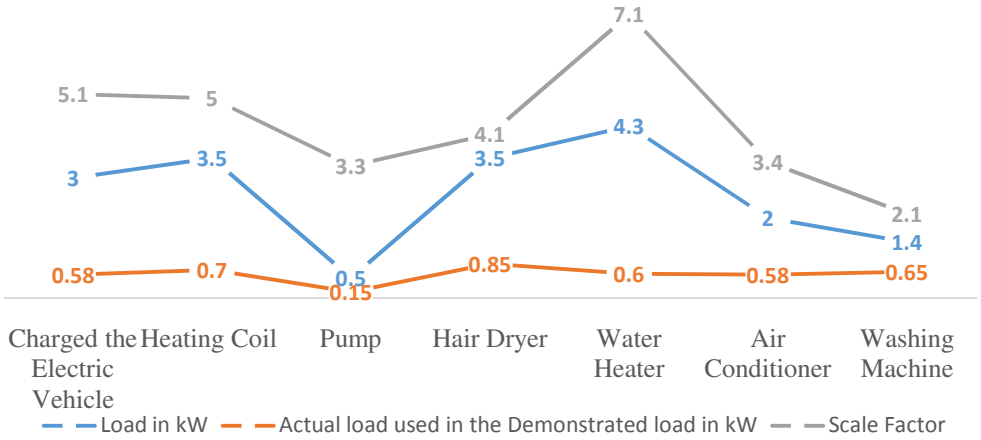

Figure 3:Illustrates the Various Appliances showing Total Household Consumption (kW) of electricity.

4. RESULTS AND DISCUSSION

By allowing the energy-efficient performances of smart homes, active home environment tracking, and improved social well-being, IoT sensors have been and will continue to alter modern families. The specific aspects that must be included in future IoT sensors for smart home electric energy usage management have been presented, along with an overview of the IoT sensors that are currently available on the market, their technical and financial assessment, research programs to improve IoT sensor functionality, and research initiatives. The development of IoT sensors for smart home electric energy usage control is gaining a lot of good momentum.

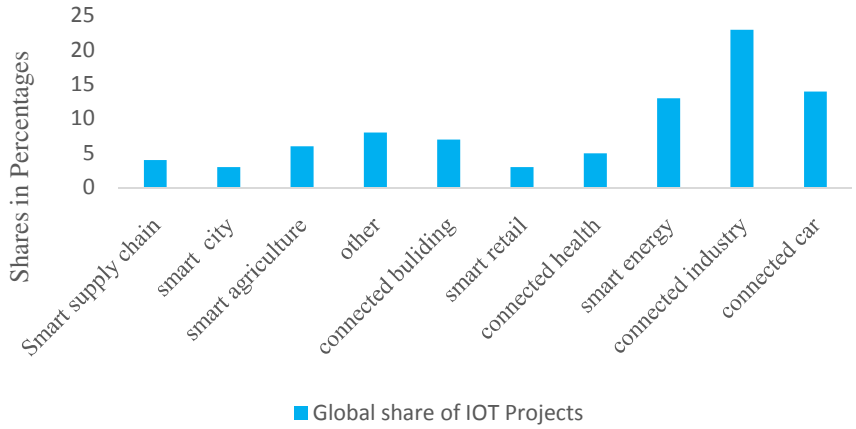

Figure 4: Illustrates the Global Share of IoT Project Worldwide which show Smart City is one of the Modern Application Areas of IoT Including Smart Homes.

Enhancing IoT sensor fault tolerance for irregular sensor events, wireless intervention, transmitting errors, ambiguous logic, and empirical uncertainties by using advanced control algorithms to increase power, fix bandwidth-related IoT sensor information sharing network problems, and improve IoT sensor fault tolerance. Enhanced packet loss identification by the use of cutting-edge detection methods. The problem of interoperability between heterogeneous systems, resource-constrained IoT, and other reliable communication methods like communication systems PLC.By integrating new sensing devices into smart home applications using service-based proxy structures, such as sign language recognition and brain-computer interfaces (BCIs), aged and physically handicapped people can benefit from monitoring systems in smart house sensing. The batteries are a technique for aggregation-based data privacy and security for IoT sensor data and are often the biggest and heaviest part of these sensors.IoT initiatives centered on the industry, smart cities, smart energy, and smart vehicles have a greater market share over others in Figure 4.

5. CONCLUSION

The successful development of modular IoT-based home energy management systems allows customers to regulate the electricity usage of their devices. This simple function allows consumers to operate devices from any location and integrate multiple non-smart devices into the IoT sector that focuses on energy efficiency and power management in both urban and rural locations. Also offers a cutting-edge strategy. Additionally, the suggested method was successfully applied in three real situations that exemplify potential use cases. Offices, high energy consumers and reasonable electricity consumers. These solutions will address some issues on their own, but they will be only small progress in the absence of a comprehensive strategy that includes the gradual democratization of energy infrastructure. It needs to execute specific solutions and address small issues to create a sustainable system for the environment and society. Around the same time, must take a comprehensive approach and transform our infrastructure to support the interconnection of fully autonomous local suppliers and micro grids. A primary IoT hub that collects, reads and controls the system based on the information received can coordinate the system. Automation of these functions will significantly improve the overall energy performance of the system at the apartment, building, community and city levels. There are many interconnected initiatives within and outside factories that fall into the range of industrial IoT applications. Projects outside a factory often include remote control, monitoring or monitoring of interconnected machinery, as well as overall control of remote industrial processes such as oil rigs.

REFERENCES

[1] X. Wu, X. Hu, X. Yin, and S. J. Moura, “Stochastic Optimal Energy Management of Smart Home With PEV Energy Storage,” IEEE Trans. Smart Grid, vol. 9, no. 3, pp. 2065–2075, May 2018, doi: 10.1109/TSG.2016.2606442.

[2] M. Li, G. Y. Li, H. R. Chen, and C. W. Jiang, “QoE-aware smart home energy management considering renewables and electric vehicles,” Energies, 2018, doi: 10.3390/en11092304. vol. 11, pp. 2304

[3] L. Chandra and S. Chanana, “Energy Management of Smart Homes with Energy Storage, Rooftop PV and Electric Vehicle,” 2018. doi: 10.1109/SCEECS.2018.8546857. vol. 5-6, pp. 1-6.

[4] M. K. Rafique et al., “Optimal scheduling of hybrid energy resources for a smart home,” Energies, 2018, doi: 10.3390/en11113201. vol. 11, pp. 3201.

[5] J. P. Sausen, M. F. B. Binelo, M. D. Campos, A. T. Z. R. Sausen, and P. S. Sausen, “Economic Feasibility Study Of Using An Electric Vehicle And Photovoltaic Microgeneration In A Smart Home,” IEEE Lat. Am. Trans., vol. 16, no. 7, pp. 1907–1913, Jul. 2018, doi: 10.1109/TLA.2018.8447356.

[6] T. Molla, B. Khan, and P. Singh, “A comprehensive analysis of smart home energy management system optimization techniques,” J. Auton. Intell., 2018, doi: 10.32629/jai.v1i1.14. vol. 5, pp. 1-6.

[7] T. Sattarpour, D. Nazarpour, and S. Golshannavaz, "A multi-objective HEM strategy for smart home energy scheduling: A collaborative approach to support microgrid operation," Sustain. Cities Soc., 2018, doi: 10.1016/j.scs.2017.09.037. vol. 97, pp. 26-33

[8] K. Ahuja and A. Khosla, "Importance of smart metering in diverse fields of smart cities," Int. J. Grid Distrib. Comput., 2018, doi: 10.14257/ijgdc.2018.11.3.04. vol. 11, pp. 33-50.

[9] G. Bedi, G. K. Venayagamoorthy, and R. Singh, "Internet of Things (IoT) sensors for smart home electric energy usage management," 2016. doi: 10.1109/ICIAFS.2016.7946568. vol. 5, pp. 1-6

[10] P. R. Joshi and M. S. Prof, "IOT Based Smart Power Management System Using WSN," Int. Res. J. Eng. Technol., 2017. vol. 65, pp. 101.

[11] P. Yakimov and A. Iovev, "Investigation and Development of IoT Based Solutions for Implementation the Cloud Technologies in the Energy Systems Control," Inf. Technol. Control, 2018, doi: 10.1515/itc-2017-0032. vol. 15, p. 10-15.

[12] C. Mihaela, C. Mircea, and D. Daniel, "Smart Hub Electric Energy Data Aggregation Platform for Prosumers Grid Integration," 2021. doi: 10.1109/MPS52805.2021.9492713. vol. 2-5, pp.1-7.

[13] Charles ARTHUR, "nergy management system," 2021. https://www.unido.org/stories/what-energy-management-system#:~:text=An energy management system (EnMS,to manage their energy use. vol. 20-25, p. 104.

[14] abhishekkumar, "Smart Home Energy Monitoring & Management System," 2015. https://www.instructables.com/Smart-home-energy-management-system-SHEMMS/ vol. 22, p. 101443.

[15] M. S. Aliero, K. N. Qureshi, M. F. Pasha, and G. Jeon, "Smart Home Energy Management Systems in Internet of Things networks for green cities demands and services," Environ. Technol. Innov., vol. 22, p. 101443, 2021, doi: 10.1016/j.eti.2021.101443.

[16] X. Wang, X. Mao, and H. Khodaei, "A multi-objective home energy management system based on internet of things and optimization algorithms," J. Build. Eng., vol. 33, p. 101603, 2021, doi: 10.1016/j.jobe.2020.101603.

[17] J. Iqbal et al., "A generic internet of things architecture for controlling electrical energy consumption in smart homes," Sustain. Cities Soc., vol. 43, pp. 443–450, 2018, doi: 10.1016/j.scs.2018.09.020.

CHAPTER 11

ANALYSIS OF THE INTERNET OF THINGS BASED SMART CITIES AND ITS ADVANTAGES

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ABSTRACT:A "smart city" is an urban area that uses Internet of Things (IoT) and information and communications technologies (ICT) to deliver usable data for efficient resource and asset management. This comprises information gathered from people and mechanical equipment that is then processed and analyses to track and manage power stations, water supply systems, waste disposal, traffic and transportation systems, etc.Train yards, electricity generation facilities, and tunnels the globe has recently seen tremendous urban expansion, which is mostly attributable to the ongoing rise in global population. In addition, It is proven by the fact of 54% of people are compared to 46% of the population who live in cities, remote regions, and it is anticipated that it will by 2050, the percentage will rise to 66%. In this paper author discussed many articles regarding smart cities which based on the internet of things and many other technologies. In this article also discussed about the smart city and its advantages which helps to make this article effective.The percentage of people who live in cities would be around 70% as compression to villages. Even if certain megacities are already struggling to accommodate the current influx of people, we need to construct smart cities to make these metropolitan regions more livable and really sustainable.

KEYWORDS: Infrastructure,Internet of Things, Population, Smart City,Technologies.

1. INTRODUCTION

As the second decade of the twenty-first century draws to a conclusion, urban ecosystems are growing as populations continue to make the shift from rural and Due to economic possibilities, demographic changes, and generational shifts, some suburban regions have become significant metropolitan centers [1]. Preferences. 70 percent of people worldwide are by 2050, and there are now estimated to live in the cities there are more over 400 cities with a population of one million people. Social interaction is essential to human existence. Dynamism and is among the main engines behind the expansion of cities.

Nevertheless, cities, particularly in the Western Hemisphere, roads, bridges, and other infrastructure are frequently deteriorating [2]. Train yards, electricity generation facilities, and tunnels the globe has recently seen tremendous urban expansion, which is mostly attributable to the ongoing rise in global population. In addition, It is proven by the fact of 54% of people are compared to 46% of the population who live in cities, remote regions, and it is anticipated that it will by 2050, the percentage will rise to 66%. Urban planners and relevant agencies are working to address urbanization. An emphasis on decreasing expenses through developing technology especially by making sure resources are used as efficiently as possible and establishing a sustainable living environment [3].

A "smart city" is a highly inhabited place that connects its physical components with cutting-edge information and communication technology, according to Treiblmaier et al. Information flow, enhancing the city's overall effectiveness operations and raising inhabitants' quality of life [4]. The fundamental idea is to provide a setting where the city has completely integrated technologies for tackling urbanization's problems, in particular by incorporating high-value services [5]. Application of smart cities which based on the internet of things (IOT) given below by figure 1.

Figure 1: Demonstrate the application of IOT based smart cities.

Urban relocating has impacted current rising urbanization as a result of greater work opportunities and access to the better educational system. Cities offer accessibility to improved communication, transportation, and services. Developing an urban development is now a reality rather than a pipe dream. Smart Cities work to improve the standard of living for its residents. Quality by employing the to address typical urban issues, contemporary technology and the internet. Shrewd cities to define the temporal activity of the city, depend on streaming data acquired from multiple sensors. Several institutions, governmental organizations, and research Institutions are making great efforts to develop a smart city that is linked and well-equipped [6]. A smart city makes use of the advancement of cloud services the Internet of Things likewise Industry 4.0. The World Health Organization (WHO) reported in its Global Status report - 2015 that the global total number of traffic fatalities had reached 1.25 million. Tens of millions are either hurt or incapacitated each year. Various programs, such the United Nations' project for the Decades of Action for Traffic Safety from 2011 to 2020, had to bettering road safety laws and regulations. Networked interdependencies are necessary to build a flexible, adaptable, and information-rich smart city environment. Advancements in the fusion of static and dynamic sources will drastically expand the range of urban environments that are networked, enabling smart, behavior-aware, and information choices transactions.

2. LITERATURE REVIEW

Nada Alasbali et al. discussed in their paper block chain standardization guidelines for smart IOT networks in smart cities. This research paper provides a conceptual overview of block chain-based database management, IoT integration, and smart city solutions. Due to the fact that a significant portion of the problems caused by variability cannot be solved by experimentation, previous research have shown that the barriers to BC integration are multifaceted and persistent. It is essential to make sure that IoT connections are useful, significant, and quick. While the process of privatization software and APIs is underway. A more urgent need is for a decentralized, extensively used available security standards for

authentication and validation. Research has shown the advantages of BC participating in this ability to serve as a common proof-of-work idea for validating Information moves within a network. Moreover, techniques for the project to advance, overcoming obstacles that are known is essential smart city concept.The study also found that a revised standard of measurement is urgently required for IoT-based smart city systems to go beyond its systemic restrictions. Practice that is not currently permitted by developer-restricted data management systems in the private state.

Abd-Elhamid M. Taha [7]discussed in their paper about the A Smart City IoT Architecture for Measuring Road Safety. This work demonstrates the practicality of an affordable road safety monitoring and evaluation system within the framework of smart cities by utilizing advancements inside the Internet of Things (IoT). The newly proposed architecture makes it possible to conduct thorough and dynamic traffic safety assessments that support the increasingly popular Safe System methodology promoted by World Health Organization (WHO). The formative evaluation framework in use for trip planning is further shown. Future studies will entail investigating further uses, especially when it comes to increasing motorists' road safety circumstances as they were travelling.

Khizar Abbas et al. [8]discussed in their paper about the Block chain and IoT convergence for safe transportation systems in smart cities. This paper represents Smart cities provide its residents cutting-edge amenities to improve lives. However, it has been noted that the normal burden of collecting, storing, processing, and analyzing diverse data would present some challenges. Technology was pushed into the framework of a smart society by the development of the Internet of things, cloud computing, social media, and other Industry 4.0 influences, potentially introducing vulnerabilities to sensor data, applications, and smart city applications. These flaws cause issues with data security.

M. M. Kamruzzaman et al. discussed in their paper about the Healthcare Services Powered by IoT and Fog Computing for Smart Cities. The current study is focused on defining the influence and potential of IoT, fog computing, and block chain on healthcare services as a result of smart cities in order to acknowledge this. The study has done a systematic review of the literature which is most pertinent to the paper's issue in order to achieve this goal. To choose the most pertinent and useful The researcher employed AMSTAR and PRISMA to find reliable papers, which resulted in the selection of the top 10 block chain, IoT, and fog computing have emerged as drivers of productivity in the healthcare sector, according to the results of the current study. Fog computing has been touted as the important technology for low-cost monitoring system, cutting latency and boosting efficiency, while block chain has been touted as the important technology for providing protection of private information, building a decentralized database, and improving data interoperability.

Nada Alasbali et al. discussed about Stakeholders' perspectives on block chain integration into IoT-based smart cities were examined.This study employed a mixed method design strategy with an exploratory study design. Data were gathered by structured questionnaire surveys (quantitative) and interviews (qualitative). IBM SPSS was used to analyze the data, and it produced thematic analysis, cross-tabulation, Correlation analysis, and ANOVA for numerical data. Therefore, future study can examine block chain technology in greater depth to a series of decentralized transactions and block chain based that will continue to develop in order to realize the smart and wiser goals of an urban automation and control paradise. During the next several years, lifestyle importance will increase

Daniel Minoli et al. [9]discussed in their paper about the Practical Considerations for the Integration of IoT Applications and 5G Networks in Smart City Environments.From an IoT

standpoint, this is arguably fortunate because many "mainstream" IoT applications will support smart city initiatives, smart campuses, and smart buildings. New-generation 5G IoT applications, as well as improved mobile internet (eMBB)-based 5G services, are primarily driven by the bandwidth need for a variety of Smart City applications. More specifically. Additionally, in order for 5G cellular technology to accommodate large data rates, the millimeter wave spectrum must be used. Solutions for millimeter wave, however, place a necessity on compact cells.This overview paper will discuss a number of practical issues related to generation 5 g IoT applications, specifically in Smart City environments, including a need for small cells, the transmitting issues at millimeter wave frequencies, building penetration issues, the need for Distributed Antenna Systems, and the impending introduction of pre-5G IoT technologies like NB-IoT and NB-IoT. LTE-M, which might serve as stand-ins for the commercial rollout and adoption of 5G IoT.

Xuewei Li et al. discussed in their paper about the Refractory Data Prediction Using a Hybrid Machine Learning Model Using IoT Smart Cities.In order to give additional theoretical and technological assistance for IoT smart cities, they suggest in this article employing machine learning methods to anticipate building fire-resistance data. In this research, three inter - related machine learning algorithms—Extreme Random Tree (ET), AdaBoost, Gradient Boosting Machine (GBM), as well as the grey wolf optimization technique used to analyze the fire resistance data of building beam elements in a real fire setting. Optimize. The grey wolf algorithm is enhanced, and it is combined with the machine learning model. The GWO-ET, GWO-AdaBoost, and GWO-GBM are three machine learning hybrid models are made up of algorithm.

Chao Huang et al. [10]they discussed in their paper about the Using the Analytic Network Process, Analyze and Evaluate Smart Cities for IoT Depending on Use Cases. There are billions of linked gadgets IoT generates enormous amounts of data that are tied to the cloud for management, processing, and storage. Sending all data at once using the cloud might put your security and privacy at risk. Various smart city requirements should be taken into account for In order to meet the demands of the expanding population, we need both quick and efficient solutions. To the opposite of IoT innovations and growing technologies have greatly different research directions again for smart city have been established. In consideration of the smart city's use cases, the planned research outlines the ANP's methodology for assessing intelligent cities. The technique was mostly based on the established criteria.The choice of smart city may also have a significant impact on how people live in the future. The suggested study's experimental findings demonstrate that the strategy is successful for assessing the IoT-ready smart cities based on use scenarios.

3. DISCUSSION

A technologically advanced urban setting known as a "smart city" employs various electrical devices and sensors to gather certain data. In turn, the data is utilized to enhance operations throughout the city. Information obtained from such data is used to handle assets, resources, and services effectively. To manage and monitor road and transport systems, power stations, utilities, water supply networks, garbage, criminal detection, information systems, schools, libraries, healthcare, and other community services, data from citizens, devices, buildings, and assets is processed and evaluated. Smart cities are those that utilize technology in innovative ways while also having effective monitoring, planning, and governing systems. The idea of a "smart city" combines information and communications technologies (ICT) with numerous physical devices linked to an Internet of Things (IoT) network in order to interact with inhabitants and improve the effectiveness of local operations and services. City authorities may engage directly both with community and urban infrastructure thanks to

smart city technology, which also enables them to keep an eye on what is occurring in the town and how this is changing. ICT is utilized to improve urban services' quality, effectiveness, and interactivity, as well as to cut costs and resource usage and improve citizen-government interaction. Applications for "smart cities" are created to control urban traffic and enable quick responses. Therefore, a smart city could be more equipped to handle problems than one with a more traditional "transactional" connection with its residents. However, the phrase itself is still vague and susceptible to multiple meanings. The advantages of the smart city illustrate below by the given Figure 2.

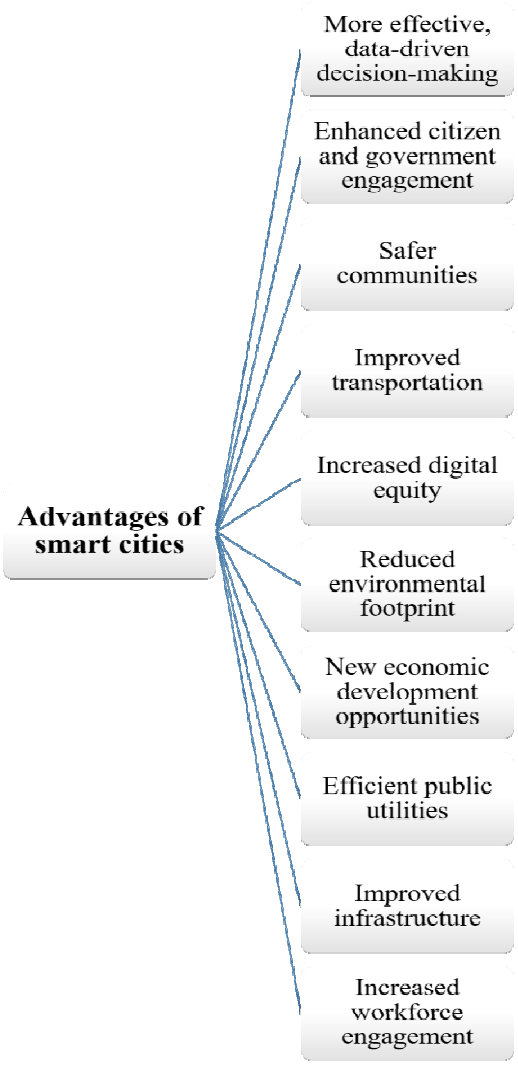

Figure 2: Demonstrate the advantages of the smart cities.

3.1. Improved data-driven decision-making:

Connected gadgets and "big data" advancements have given cities access to data that was previously unavailable. City authorities may readily access and evaluate a vast quantity of information with the help of the well data analytics strategy, and derive relevant, useful insights. When desirable indicators can be tracked in real-time by a city, service levels soon improve. Effective big information applications and tactics give a city the knowledge it needs to, among other things, estimate and prepare for increase in citywide population growth, detect patterns in citizen interests, worries, and requirements, and locate police in high-risk locations. Stronger decision-making is made possible by a plethora of options provided by

big data & the Internet of Things (IoT). By lowering expenses and enhancing services, this ultimately improves the quality of life for locals.

3.2. Government engagement and enhanced citizen:

Today's citizens demand powerful, user-friendly digital services from their cities. People now expect their city to provide them with collaboration tools, contemporary, user-friendly websites, smartphone apps, self-service portals, and accessible online accounts. Increasing the availability of digital services in local communities improves the quality of life for citizens connected to the internet in smart cities. Smart cities benefit from having open access to public data, interactive maps, and dashboards tracking government performance, budget transparency, live-streamed city council sessions, and a robust social media presence. Civic involvement and public confidence in municipal authorities are both boosted by these smart technologies.

3.3. Safer communities:

A smart city is one that is safer. Criminal behavior can be decreased by utilizing technological advancements and seeking private/public collaborations. The use of technologies like body cameras, networked crime centers, license plate recognition, gunfire detectors, and next-generation 911 gives police enforcement an advantage. Many communities have already begun to invest in smart technology to support the development of a safer neighborhood. Recently, the City of Detroit collaborated with nearby companies to create a linked cloud video platform enables police enforcement to instantly view video from corporate security cameras. The outcomes thus far have been notable.

3.4. Environmental footprint reduce:

Smart communities are taking action to counteract the consequences of rising greenhouse gases, pollution in our seas, and waste on our streets. Cities now have additional instruments to reduce their ecological effect thanks to energy-efficient structures, air quality monitors, and renewable energy sources. By placing clean air sensors around one city, for example, officials can track the peak periods of poor air quality, identify the sources of pollution, and receive the data analytics they need to create action strategies. These sensors can set the groundwork for lowering air pollution even in the most densely populated places, which would undoubtedly save lives given that pollution-related illnesses kill millions of lives annually.

3.5. Transportation Improved:

According to Smart City press, investments in smart city transportation are predicted to increase by over 25% yearly over the next five years. The potential for connected transportation systems to significantly improve citywide efficiency is considerable. Smart technology enable cities to better serve inhabitants despite frequently quickly rising populations, from improved traffic management to the ability for transit users to follow bus or train positions.Intelligent traffic lights are one example of a technology that optimizes traffic flow and relieves congestion during rush hour. The use of other smart transportation technology, including smart parking management, enables communities to tap into new sources of income. Because of the decline in traffic, the rise of autonomous cars, and effective vehicle routing, there is a chance that more land may be used for development. A recent mobile app introduction by the City gives residents access to online payment processing, up-to-date bus and train timetables, and real-time vehicle tracking. Residents of

Chicago now find it simpler to use the city's transport systems thanks to the app, which is compatible with all public transit alternatives.

3.6. Digital equity increased:

Smart city technologies have the ability to give residents access to a more egalitarian environment. Individuals must have access to inexpensive gadgets and high-speed internet connections in order to achieve digital equity. Deployment of open Wi-Fi hotspots can provide all citizens with dependable internet access thanks to their smart placement across a city. Consider the Municipality of Seattle, which has created a strategy to give skill training, guarantee the availability of cost-effective gadgets, and offer reasonable and accessible internet connections.

3.7. New economy development opportunities:

According to a recent analysis, the capital spending in smart city technologies has a significant potential multiplier impact of up to 10, which translates to a gigantic increase in growth of gross domestic product (GDP) when cities innovate. Together with local governments, many sizable private sector corporations are investing a lot of money in the infrastructure and programs of smart cities. Investments in smart cities are becoming more and more crucial in boosting cities' regional and worldwide competitiveness to draw in new citizens and companies. Businesses are better equipped to make educated decisions using predictive analytics from embedded digital city technology by providing an online information platform with access all city information.

3.8. Efficient public utilities:

Smart technologies are offering cities the tools they need to successfully save and decrease the unintentional waste of water and power since there is a finite amount of natural resources that can be used to fulfil human demand. Cities can now swiftly locate pipe leaks and repair damaged sections in a short amount of time, minimizing the quantity of water wasted. In order to more accurately pinpoint periods of high demand and disruptions, smart electric grids also enable two-way communication between power suppliers and customers. Smart metering technology has been employed in Cape Town, South Africa, to address the city's chronic water issue. Customers' water consumption is tracked by its smart meters, which transmit the information to their accounts. The daily bill for Cape Town residents then includes a breakdown of their water usage. After the commencement of the advanced metering pilot project, residential houses noticed a 40–60% decrease in water usage. Smart sensor technologies and data analytics have shown to be an effective way to assist save precious resources.

3.9. Improved infrastructure:

Over the course of their useful lifetimes, ageing roads, bridges, and structures frequently require significant maintenance and repair expenditures. Cities may use predictive analytics offered by smart technology to find problem areas and address them before an infrastructure disaster occurs. Smart sensors may discover tilts or fissures in buildings and bridges, transmit data demonstrating detrimental structural changes, and send messages to people informing them of the need for inspection or repair. Cities have a huge potential to avert infrastructure disasters, which might save tax dollars and lives.

3.10. Workforce engagement increased:

A key requirement for achieving a successful smart city is a highly effective staff. Smart technology implementation helps reduce the stress of manual activities that many city personnel must deal with on a daily basis. The development of mobile devices, bots, autonomous agents, and sensors enables city workers to focus their attention on more strategic projects while spending less time on routine manual tasks. By automating laborious procedures, providing workers with more possibilities to realize their full potential, and improving citizen services, smart cities may alter the working environment. The tremendous advantages that linked cities provide are difficult to overlook. However, to achieve uptake and success, implementation requires vision, funding, and careful preparation, much like with any big metropolitan technology programme. It is, after all, prudent to start taking the initial steps toward imagining what your smart city may include.

4. CONCLUSION

As the twenty-first century's second decade comes to an end, urban ecosystems are expanding as populations continue to move from rural and some suburban areas have developed into large metropolitan centers as a result of economic opportunities, demographic shifts, and generational shifts. Preferences. By 2050, it is predicted that 70 percent of the world's population will reside in cities, and there are now more than 400 cities with a million residents. Human life requires social connection. Dynamism is one of the primary forces driving urban growth. However, roads, bridges, and other infrastructure are regularly decaying, especially in Western Hemisphere cities.

Even if the notion of a "smart city" is still developing, the following points are already obvious: Information and communication technology are used by smart cities to improve service levels, citizen wellbeing, sustainability, and economic growth. Given the predicted substantial expansion in urban populations so over coming decades, smart city technologies can make towns more efficient and effective. As a result, according to BCC Research, spending on smart city technologies in North America will rise from $118.5 billion United State dollars to $244.5 billion in 2021.Currently, two-thirds of cities have made investments in smart city technologies, and more are considering doing so. The reality of smart cities will be further cemented by increased federal financing as well as solid relationships with local governments or private sector technology companies. By 2050, it is predicted that approximately 70% of the world's population would reside in cities. We need to build smart cities to make these metropolitan areas more livable and really sustainable, even if certain megacities are already failing to handle the present inflow of people.

REFERENCES

[1] Y. Mehmood, F. Ahmad, I. Yaqoob, A. Adnane, M. Imran, and S. Guizani, “Internet-of-Things-Based Smart Cities: Recent Advances and Challenges,” *IEEE Commun. Mag.*, 2017, doi: 10.1109/MCOM.2017.1600514.

[2] K. Szum, “IoT-based smart cities: A bibliometric analysis and literature review,” *Eng. Manag. Prod. Serv.*, 2021, doi: 10.2478/emj-2021-0017.

[3] D. Jiang, “The construction of smart city information system based on the Internet of Things and cloud computing,” *Comput. Commun.*, 2020, doi: 10.1016/j.comcom.2019.10.035.

[4] M. Mital, V. Chang, P. Choudhary, A. Papa, and A. K. Pani, “Adoption of Internet of Things in India: A test of competing models using a structured equation modeling approach,” *Technol. Forecast. Soc. Change*, 2018, doi: 10.1016/j.techfore.2017.03.001.

[5] M. Rishav, R. Maity, D. Ghosh, V. N. Ganesh, and Sivakumar, “Internet of thing based smart power grid for smart city,” *Int. J. Recent Technol. Eng.*, 2019.

[6] U. Majeed, L. U. Khan, I. Yaqoob, S. M. A. Kazmi, K. Salah, and C. S. Hong, “Blockchain for IoT-based smart cities: Recent advances, requirements, and future challenges,” *Journal of Network and Computer Applications*. 2021. doi: 10.1016/j.jnca.2021.103007.

[7] A. E. M. Taha, “An IoT Architecture for Assessing Road Safety in Smart Cities,” *Wirel. Commun. Mob. Comput.*, vol. 2018, 2018, doi: 10.1155/2018/8214989.

[8] K. Abbas, L. A. Tawalbeh, A. Rafiq, A. Muthanna, I. A. Elgendy, and A. A. Abd El-Latif, “Convergence of Blockchain and IoT for Secure Transportation Systems in Smart Cities,” *Secur. Commun. Networks*, vol. 2021, 2021, doi: 10.1155/2021/5597679.

[9] D. Minoli and B. Occhiogrosso, “Practical Aspects for the Integration of 5G Networks and IoT Applications in Smart Cities Environments,” *Wirel. Commun. Mob. Comput.*, vol. 2019, 2019, doi: 10.1155/2019/5710834.

[10] C. Huang and S. Nazir, “Analyzing and Evaluating Smart Cities for IoT Based on Use Cases Using the Analytic Network Process,” *Mob. Inf. Syst.*, vol. 2021, 2021, doi: 10.1155/2021/6674479.

CHAPTER 12

DUAL AXIS SOLAR TRACKER FOR MONITORING POWER WITH THE HELP OF INTERNET OF THING (IOT)

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ABSTRACT: ***A solar tracker is a tool that keeps track of the sun's path through the sky. Solar trackers and connected solar panels can follow the sun's rays and provide you with extra green energy. The "dual-axis solar tracker" tracks the sun's movement from east to west as well as its angular height position. Dual-axis systems operate similarly to single-axis systems, but by spinning their axes along vertical and horizontal axes, they are better able to collect solar energy. Solar trackers boost solar cell efficiency and provide their highest output. The objective of this study is to make a particular sunlight-based tracker and impart information through IoT. This procedure utilizes essential and auxiliary sensors to decide the area of the sun. Sun oriented trackers pivot the sun powered authority to follow the sun's course and keep an ideal slant point. Photovoltaic (PV) board energy effectiveness is fundamentally expanded by sunlight based global positioning frameworks. A computerized sunlight based global positioning framework is planned and created utilizing a mechanical construction with a stuff course of action, a "Light Dependent Resistor" (LDR), and DC motors. It is carried out utilizing a Sun-Earth Geometry-based Arduino UNO regulator. As indicated by the discoveries, an independent sunlight-based GPS beacon is more dependable and successful than a proper one.***

KEYWORDS: ***Dual Axis Solar Tracker, IoT, Renewable Energy, Solar Tracker, Solar Cell.***

1. INTRODUCTION

Global climate change is now at a crucial point. Both natural and human-caused factors may contribute to climate change. Examples of natural climate change drivers include variations in the earth's orbit, solar oscillations, and ocean currents. The primary human-caused climate change contributors are greenhouse gases produced by human activity. Crop damage and extreme weather patterns throughout the globe are examples of natural events that may be utilized to detect global warming or climate change. Environmentally friendly power comes from regular assets including daylight, wind, downpour, tides, and geothermal intensity. Environmentally friendly power is the energy source that is extending the speediest around the world. Environmentally friendly power can be effectively and immediately recharged and doesn't exhaust the planet's limited assets. Since it permits organizations to gather energy cost speculations and income while diminishing the outcomes of environmental change, sustainable power is significant to a country's energy needs [1], [2].

Malaysia's primary energy sources in the past have been coal and oil. The government started taking these actions when it became clear that coal and oil would no longer be the main sources of electricity. It started an initiative to use hydropower, solar energy, and other environmentally friendly sources. More over 14,365 GWh, or 19 percentage, of Peninsular Malaysia's total power consumption in 2006 came from home energy use in Malaysia. As the requirement for power develops after some time, sunlight-based energy offers an answer for those electrical issues. Sun oriented energy is the energy gathered from the sun as sun powered radiation. The sun is presently the most abundant and dependable wellspring of energy [3]. The sun gives energy, intensity, and light to every single living thing. Sunlight based energy is free, doesn't contaminate the climate, and is consistently accessible. It is additionally harmless to the ecosystem. The advancement of the sunlight-based tracker is utilized in this specific undertaking as a result of Malaysia's heat and humidity, which is sticky and moist the entire year. It's memorable's significant that sunlight-based energy enjoys a few benefits and inconveniences contrasted with traditional energy source. It is not a question of running out of energy sources that is the basic problem with using solar energy. However, given that certain traditional energy sources have large environmental emissions, it is a cause of worry.

1.1. Solar Tracker:

An object may be positioned at an angle to the Sun using a solar tracker. The two greatest common applications for solar trackers are placing "photovoltaic" (PV) panels or (solar panels) such that they continue perpendicular to the Sun's rays and positioning space telescopes to determine the Sun's direction [1], [4]–[6]. PV sun powered trackers change the direction of a sunlight powered charger in light of the Sun's situation overhead. At the point when the sun powered charger is kept up with opposite to the Sun, more daylight enters the gadget, fewer light is reflected, and more energy is assimilated, which may later be changed over into power. To decide the Sun's area concerning the thing being adjusted, complex hardware is used in sun oriented following. PCs, which can handle complex calculations that empower the framework to follow the Sun, as well as identifiers that can follow the Sun without a PC by interfacing with a sun powered charger with such a straightforward circuit or give data about the Sun's place to a work area are the most widely recognized parts of these instruments. Sunlight based trackers give critical benefits to environmentally friendly power. Sunlight based following could increment power age by between 30 percentage as well as 40 percentage.

The expanded result of force is anticipated to open up new business sectors for sunlight-based energy. Be that as it may, there are various significant inconveniences to sunlight-based trackers. A static sunlight powered charger can accompany a decades-in length guarantee and need practically zero support. Then again, sunlight-based trackers have a lot more limited guarantees and need at least one actuator to move the board. Dynamic global positioning frameworks might involve a minuscule measure of energy as an outcome of these moving parts, which increments establishment costs and diminishes unwavering quality. PC based calculation sun-oriented trackers are more costly, need more support, and disintegrate significantly more rapidly than static sun powered chargers since they rely upon continually changing electrical parts with parts that might be challenging to fix in moderately brief timeframes. Your solar panels may create more solar electricity by following the movement of the sun in the sky, like a sunflower, with the help of solar trackers. But the cost of solar tracking systems is expensive. Is the greater solar power production worth the solar tracker's higher price tag? Installing additional solar panels makes more sense in the majority of circumstances. Everything you need to know about solar trackers, including their varieties and whether or not they're a good purchase, is covered here. The kind of system determines how a solar tracking system travel. Sun tracking systems come in three different varieties:

- Manual solar trackers

Human trackers need manual movement of the panels in order to follow the sun all day long [5], [7]. This is not always possible since somebody must continuously check the sun as well as move the solar panel system around.

- Passive solar trackers

When exposed to sunshine, a low-boiling-point liquid used in passive trackers evaporates. The liquid evaporating causes the tilt mechanism to become imbalanced. Due to the uneven distribution of the sun's rays, the panels slant.

- Active solar trackers

In order to alter posture, active trackers use motors or hydraulic cylinders. The PV panels will rotate to face the sun thanks to the motors in active trackers [6], [8]. Although this is more practical than manual trackers, the motors' moving components might malfunction. This can result in increased maintenance costs during the system's lifetime.

1.2. Solar Tracker founded on which direction they move:

The direction in which they travel may then be used to further divide up solar trackers. There are two types of solar trackers:

1.2.1. Single Axis Solar Tracker:

Single axis trackers keep track of the sun's path from east to west. Utility-scale projects often use them. Production may be increased by "between" 25 and 35 percent with a single axis tracker. Sun tracker with a single axis. The manner of a system's mobility may be used to categories solar tracking systems. These tracking systems include a PV surface that can be tilted and rotated around axes to determine the best angle for capturing the most sunlight. Single-axis tracking is the process of moving or adjusting the PV surface by rotating around a single axis. Compared to dual-axis trackers, single-axis trackers will collect less energy per unit, but because of their smaller installation footprint and lower racking heights, they will operate and maintain more simply. There are two different kinds of single-axis trackers: centralized and decentralized trackers [4], [9]–[11]. A single motor powers a driveline between rows in centralized or dispersed trackers, allowing a complete section of panels to be moved. One motor is used in each tracking row in decentralized systems. Additionally, there are situations where each set of racking has trackers with motors, enabling rows to be more easily adjusted during installation and, in certain circumstances, allowing them to track independently of nearby modules (Figure 1).

The expanded result of force is anticipated to open up new business sectors for sunlight-based energy. Be that as it may, there are various significant inconveniences to sunlight-based trackers. A static sunlight powered charger can accompany a decades-in length guarantee and need practically zero support. Then again, sunlight-based trackers have a lot more limited guarantees and need at least one actuator to move the board. Dynamic global positioning frameworks might involve a minuscule measure of energy as an outcome of these moving parts, which increments establishment costs and diminishes unwavering quality. PC based calculation sun-oriented trackers are more costly, need more support, and disintegrate significantly more rapidly than static sun powered chargers since they rely upon continually changing electrical parts with parts that might be challenging to fix in moderately brief timeframes.

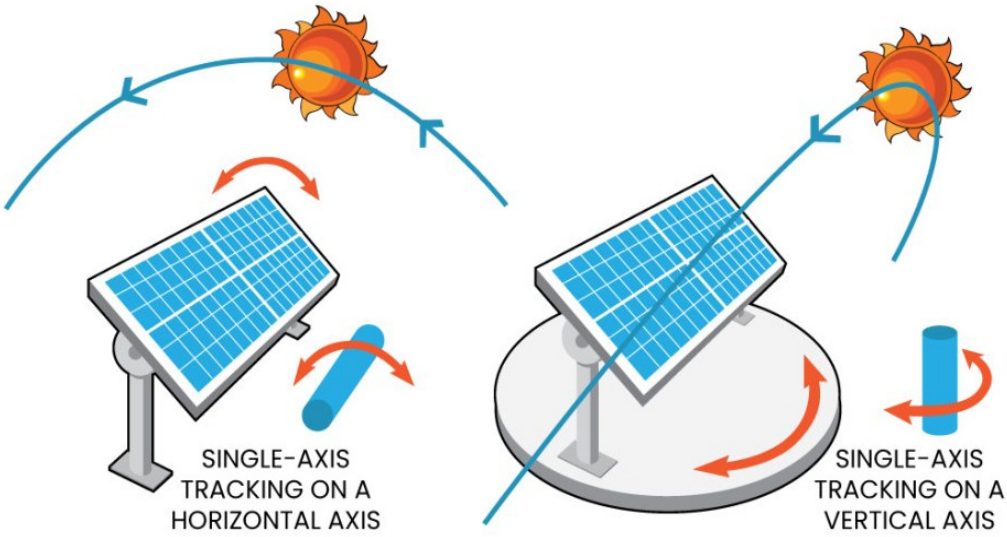

Figure 1: Representing the "Single Axis Solar Tracker" [Source sinovoltaics].

1.2.2. Dual Axis Solar Tracker:

As well as following the sun's movement from north to south, this tracker additionally tracks it as it makes a trip from east to west. Two pivot trackers are being used all the more frequently in private and independent venture sunlight based projects with restricted space to deliver sufficient ability to meet their energy needs [1], [3], [6], [12]. A double pivot global positioning framework can straightforwardly quantify the Earth's revolution in regard to the sun, which vacillates every year, and will reliably give more energy than a solitary hub rendition. A double pivot sunlight-based tracker produces 30 to 45 percent more energy than fixed-slant nearby planet groups. Double pivot tracker

organization at utility scale is still in its earliest stages, in spite of the fact that it is more run of the mill in private and little business applications. Every one of these trackers is put on a solitary raised present together on help the more extensive scope of points the introduced boards will accomplish. A solitary double pivot tracker might oblige up to 20 boards.

Higher height makes it harder to reach panels for cleaning. Dual-axis trackers, on the other hand, leave the land below available for various uses, like agriculture or even carports, since they have more headroom. In spite of the fact that observing frameworks for rooftops are as yet a moderately undiscovered industry, they are starting to show up. These rooftop trackers work to some degree correspondingly to double pivot trackers and turn on a merry go round style track at the lower part of its racking, permitting them to follow the sun more precisely than single-hub trackers do. Double pivot trackers can possibly support energy creation by around fourth percentage. Daylight is made out of the straight light emission, which incorporates around 90.00% of the sun-oriented energy, and the diffuse daylight, which contains the leftover ten percentage. The blue sky is the diffuse part on a crisp morning, and it extends proportionately when it is darkened. To augment assortment as the greater part of the energy is in the immediate pillar, the sun should be noticeable to the boards however long is down to earth. A standard sunlight powered charger switches only 30 over completely to 40 percent of the sun-oriented radiation got into electrical energy (Figure 2).

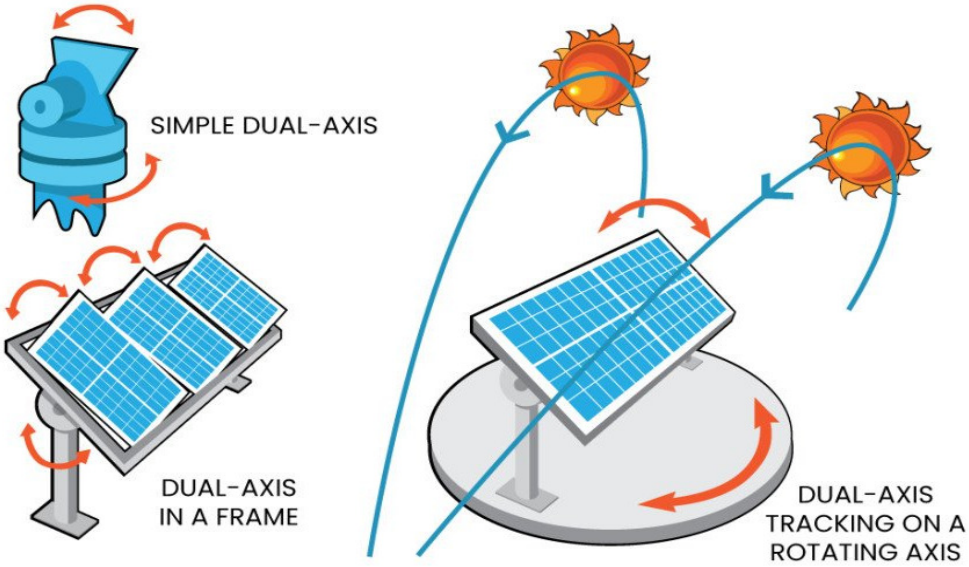

Figure 2: Representing the Dual axis solar Tracker [Source sinovoltaics].

Renewable energy is fast overtaking fossil fuels as the price of them varies as an energy source. So, it is essential that engineering and technology students understand and respect renewable energy technologies at the educational level. One of the most well-known wellsprings of environmentally friendly power is sunlight based energy [13]–[15]. A few examinations were directed to decide how to expand the effectiveness of photovoltaic frameworks (sunlight powered chargers). One such technique is the utilization of sunlight powered charger global positioning frameworks. RTC-based sunlight powered charger global positioning frameworks are viable with this innovation. More energy might be produced in light of the fact that sun-oriented following empowers the sun powered charger to keep an opposite profile to the sun's beams persistently.

This research is divided into several section like first section is introductory part that gives the overview about the topic, and next section is literature review that discussed the different study done and this section end with research question. After that methodology of the study is explained with the help of various sub section (Design, instrument, data collection and analysis), after the methodology section results are discuss on the basis of collection and analysis of the data. Finally study end with the conclusion section that gives the final outcome, suggestion and future scope of the research.

2. LITERATURE REVIEW

Bhagwan D. V. conducted research to examine the utility and economic feasibility of solar trackers in solar photovoltaic systems. Once built, solar panels may provide electricity for many years without the need for maintenance. According to the authors the earth revolves around the sun, solar energy in modern solar panels is only usable during certain hours of the day. Solar photovoltaic systems are examples of such solar energy harvesting devices, to address this problem, solar trackers are utilized. [16].

Mst Jesmin Nahar et al. that research presents the design and execution of a sun tracker system particularly created for PV conversion panels. Depending on the tracking sensor or sunlight detector, the recommended single-axis solar tracker automatically adapts. That method also eliminates incident sunlight that interferes with sensors in the sunshine monitoring system. A sensor used to accurately gauge light intensity is the LDR. The output power of the fixed panel and the automatically adjusted panel are 8.289 watts as well as 14.287 watts, respectively, according to the testing findings, representative that the automated sun tracking system is 72.450 percent more effective than fixed panels [17].

Amit Chakraborty Chhoton and Narayan Ranjan design the dual axis solar tracking system. That research examines the effectiveness of an Arduino-based dual-axis solar tracking device. The primary goal of research is to determine whether or not a static solar panel is superior to a solar tracker. The hardware and software systems in this study are separated into two sections. Four light dependent resistors (LDRs) are employed in the hardware section to identify the sun as the strongest light source. The solar panel is moved by two servo motors working together to place it where the LDRs can detect the lightest. The software component's code was created using the C programming language with the Arduino UNO controller in mind. Higher performance in terms of voltage, current, and power was found after examination and comparison of the solar tracker system with fixed or static solar panels. As a result, it is shown that the solar tracker is more useful for obtaining the greatest amount of sunlight for star harvesting applications. The results indicated that when compared to fixed and single axis solar tracking systems, dual-axis solar tracking systems generated an additional 10.53 watts of electricity [18].Typically, a solar tracking system moves reflecting surfaces or the solar panel's face to track the Sun. Due to more advanced and effective sun trapping technology, solar trackers are being employed in both household and commercial-grade solar panels more and more. Dual-axis tracking is believed to produce 40 percent higher output via energy absorption and provides for the most precise positioning of the solar device. These solar trackers are more costly and complicated, however.

Research Question:

- How IoT used for monitoring Dual Axis Solar Tracker?
- What is the need to monitor dual axis tracker?

3. METHODOLOGY

3.1. Design:

The suggested system aims to create a dual-axis solar tracking system that can follow the sun more successfully than the current traditional methods, with reduced maintenance costs and increased capacity for power generation, in any weather condition. Solar power facilities need to be continuously monitored to generate the most electricity possible. This helps restore efficient power generation from power plants while keeping an eye out for broken solar panels, weak connections, dust accumulation on panels that hinders operation, and other issues of a similar kind affecting solar performance. As a result, we propose in this paper an IOT-based, fully automated system for remote, automatic solar power monitoring. To keep track of a solar panel, we utilise an Arduino-based system.

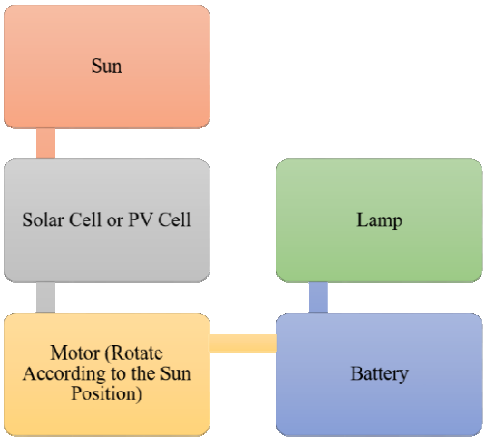

Figure 3: Illustrating the Block Diagram of Dual Axis Solar Tracker for Monitoring Power.

3.2. Instrument Used:

The Sun tracking solar panel consists of various component such as solar panel LDRs, servo motor and Micro controller and many more which are shown in Figure in Figure 4:

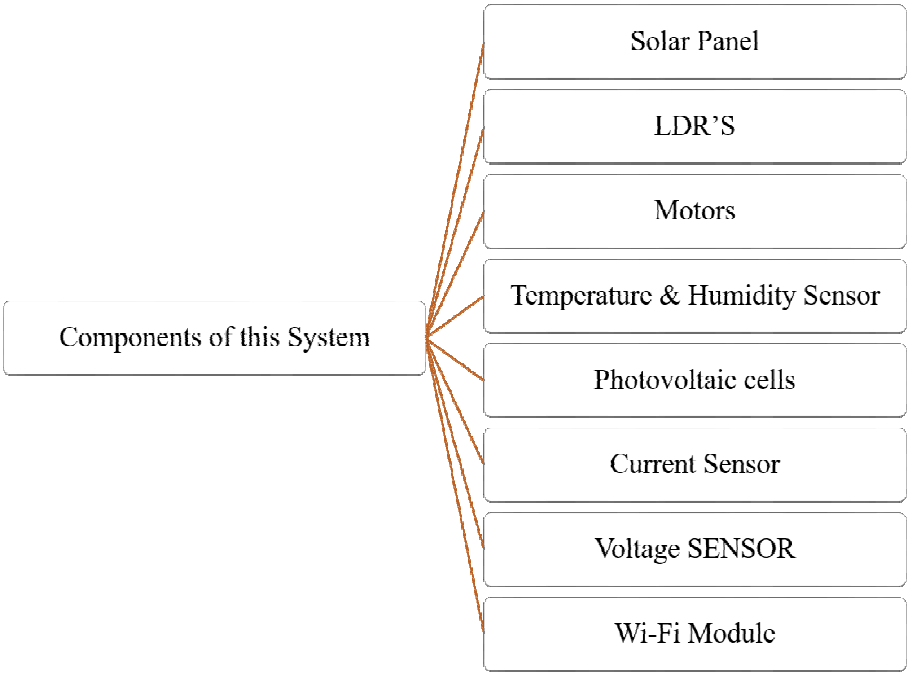

Figure 4: Illustrating the Components that are used in this System.

3.3. Data Collection and Analysis:

Our device provides data to the IoT system and periodically monitors the output of the solar panels. Here, we use IoT to transmit across the internet solar power characteristics to IoT. It now displays these parameters to the user with the aid of an effective Graphical users Interface (GUI) and alerts them when the output falls below predefined thresholds. As a result, the greatest amount of electricity is produced, and remote monitoring of solar plants is made very easy. This model contained online data displays for temperature, humidity, and other factors, as well as a module for weather forecasts. All of these data types are visible in our smartphone app. The solar panels will get an Omni phobic coating to save maintenance time and costs by shielding them from harm in windy and dusty conditions. The work is motivated by the need to develop and use a hybrid dual-axis solar tracking system with reduced motor power and accurate tracking. In order to steer the motors in the right direction, the microcontroller compares the light intensity and generates the necessary control signals.

3.3.1. Algorithm for Tracking:

This technique is used to calculate the solar azimuth and zenith angles. The solar panel or reflector is then positioned towards the sun at these angles. Other methods make advantage of real-time light-intensity observations, while others just employ mathematics and astronomical references.

3.3.2. Controlunit:

The control unit directs the movement of the positioning system and runs the algorithm for tracking the sun.

3.3.3. Positioningsystem:

The panel or reflector is moved by the positioning mechanism to face the sun at the proper angles. Both hydraulic and electrical positioning techniques are available. Encoders, variable frequency motors, or linear actuators are used by electrical systems to track the panel's present position and modify it to perform certain tasks.

4. RESULTS AND DISCUSSION

Since some years ago, tracking systems for solar panels have been under research. It is preferable to have the solar panels monitor the sun's position as it crosses the sky throughout the day. The boards are always parallel to the direction that the sun is shining. In general, this will maximise the amount of electricity that PV systems can absorb. According to estimates, switching to a tracking system from a fixed design may enhance power production by 30.00 percentage to 61 percentage. Despite the rise in system cost, the increase is sufficient to make tracking a practical option. The tracking heliostat may be electronically controlled by a microcontroller to orient it normal to the sun. The system must track the sun's location in the sky while it is up. Active control must be used, as well as well-timed motions. Both automated and user-friendly operation are required. The benefits of a sun tracker are shown in Figure 5 with little operator intervention and only when necessary.

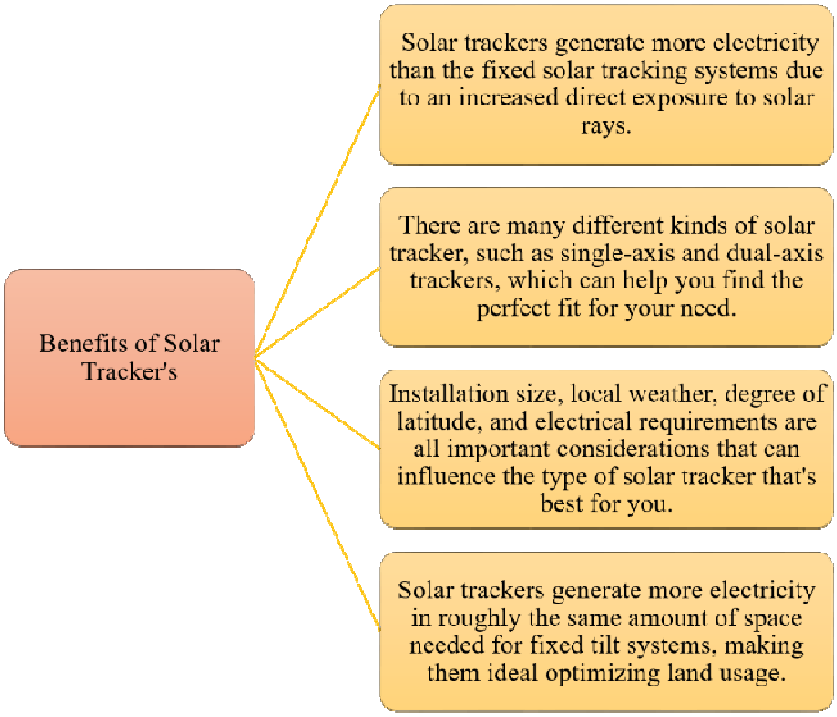

Figure 5: Representing the Benefits of Solar Tracker.

This tracker follows the sun not just as it goes from north to south, but also as it moves from east to west. Residential and small commercial solar projects with limited space are more likely to use two axis trackers so they can generate enough electricity to fulfil their energy demands. Solar trackers are

often not worth the extra cost, particularly for home solar systems. The lack of widespread adoption of solar trackers in the domestic solar market is due to this. Solar trackers are handy when there isn't much room for an installation. Installing a solar tracking system will enable you to generate more electricity in a constrained location if you don't have enough room for extra solar panels. Large-scale utility or commercial systems may benefit from the usage of solar trackers. Solar trackers may possibly quadruple the cost of installing solar panels, although they are quite costly and will improve the energy output of the solar panel system. To improve the energy production of the system, adding additional solar panels is often less expensive than adding a solar tracker. A solar tracker may be the ideal choice for you if you have a little amount of space and are unable to add extra solar panels.

5. CONCLUSIONS

When compared to single axis trackers and fixed systems, dual-axis solar trackers are more effective in terms of electrical energy generation. Solar power plants can produce more energy thanks to solar monitoring systems. The highest energy gain is often produced by an automated solar tracking system wherever it is installed. This makes it the most adaptable system since it has a high energy gain and can be utilized anywhere. From a global energy perspective, solar trackers are advised since they continually enhance the amount of energy gathered. Orienting with two degrees of freedom is possible. The position of the DC motors is controlled by an Arduino Uno controller to ensure that the DC geared motors create point-to-point intermittent motion. With a computer or mobile device, standalone functioning and wireless communication is possible, making the system dependable and viewable. A more precise and effective tracking system is ensured using LDR sensors and high precision voltage and current sensors. It now uses an efficient application to show the user the sensor parameters and notifies the user when the sensor parameters exceed certain limitations. This makes remote solar plant monitoring incredibly simple and guarantees the best energy output.

REFERENCES

[1] A. I. Bin Ibrahim, F. D. B. A. Rahman, and M. Bin Rohaizat, "Dual axes solar tracker," *Int. J. Electr. Comput. Eng.*, 2018, doi: 10.11591/ijece.v8i3.pp1887-1892.

[2] M. P. Gupta *et al.*, "Azimuth-Altitude Dual Axis Solar Tracker," *IOSR J. Electr. Electron. Eng.*, 2016, doi: 10.9790/1676-1105012630.

[3] C. R. Algarín, A. O. Castro, and J. C. Naranjo, "Dual-axis solar tracker for using in photovoltaic systems," *Int. J. Renew. Energy Res.*, vol. 7, no. 1, pp. 137–145, 2017, doi: 10.20508/ijrer.v7i1.5147.g6973.

[4] N. Kuttybay *et al.*, "Optimized single-axis schedule solar tracker in different weather conditions," *Energies*, vol. 13, no. 19, 2020, doi: 10.3390/en13195226.

[5] S. Motahhir, A. EL Hammoumi, A. EL Ghzizal, and A. Derouich, "Open hardware/software test bench for solar tracker with virtual instrumentation," *Sustain. Energy Technol. Assessments*, vol. 31, pp. 9–16, 2019, doi: 10.1016/j.seta.2018.11.003.

[6] A. El Hammoumi, S. Motahhir, A. El Ghzizal, A. Chalh, and A. Derouich, "A simple and low-cost active dual-axis solar tracker," *Energy Sci. Eng.*, 2018, doi: 10.1002/ese3.236.

[7] A. Z. Hafez, A. M. Yousef, and N. M. Harag, "Solar tracking systems: Technologies and trackers drive types – A review," *Renewable and Sustainable Energy Reviews*, vol. 91. pp. 754–782, 2018. doi: 10.1016/j.rser.2018.03.094.

[8] C. Kasburg and S. Frizzo Stefenon, "Deep Learning for Photovoltaic Generation Forecast in Active Solar Trackers," *IEEE Lat. Am. Trans.*, vol. 17, no. 12, pp. 2013–2019, 2019, doi: 10.1109/TLA.2019.9011546.

[9] A. B. Pulungan, R. Risfendra, W. Purwanto, H. Maksum, and O. Setiawan, "DESIGN AND DEVELOPMENT OF REAL TIME MONITORING SINGLE AXIS SOLAR TRACKER BY USING INTERNET OF THINGS," *Int. J. GEOMATE*, vol. 18, no. 69, pp. 81–87, 2020, doi: 10.21660/2020.69.25863.

[10] C. S. Chin, A. Babu, and W. McBride, "Design, modeling and testing of a standalone single axis active solar tracker using MATLAB/Simulink," *Renew. Energy*, vol. 36, no. 11, pp. 3075–3090, 2011, doi: 10.1016/j.renene.2011.03.026.

[11] A. A. Fernandez, A. Rakhmatsyah, and A. A. Wardana, "Monitoring floating solar tracker based on axis coordinates using lora network," *Int. J. Renew. Energy Dev.*, vol. 9, no. 2, pp. 141–149, 2020, doi: 10.14710/ijred.9.2.141-149.

[12] P. K. B, S. Jonnalagadda, M. Srihari, and H. Bonothu, "DUAL-AXIS SOLAR TRACKER," *Int. J. Recent Sci. Res.*, 2017.

[13] A. Sundaram, H. Zuhair, and A. Garni, "A Smart Garden System with a Dual-Axis Solar Tracker," *Int. J. Adv. Sci. Technol.*, 2020.

[14] F. J. Gómez□uceda, J. Ramirez□faz, M. Varo□martinez, and L. M. Fernández□ahumada, "New omnidirectional sensor based on open□source software and hardware for tracking and backtracking of dual□axis solar trackers in photovoltaic plants," *Sensors (Switzerland)*, 2021, doi: 10.3390/s21030726.

[15] F. J. Gómez□uceda, J. Ramirez□faz, M. Varo□martinez, and L. M. Fernández□ahumada, "New omnidirectional sensor based on open□source software and hardware for tracking and backtracking of dual□axis solar trackers in photovoltaic plants," *Sensors (Switzerland)*, vol. 21, no. 3, pp. 1–17, 2021, doi: 10.3390/s21030726.

[16] Bhagwan Deen Verma, Anurag Gour, and Dr. Mukesh Pandey, "A Review Paper on Solar Tracking System for Photovoltaic Power Plant," *Int. J. Eng. Res.*, vol. V9, no. 02, pp. 160–166, 2020, doi: 10.17577/ijertv9is020103.

[17] M. J. Nahar, M. R. Sarkar, M. Uddin, M. F. Hossain, M. M. Rana, and M. R. Tanshen, "Single Axis Solar Tracker for Maximizing Power Production and Sunlight Overlapping Removal on the Sensors of Tracker," *Int. J. Robot. Control Syst.*, vol. 1, no. 2, pp. 186–197, 2021, doi: 10.31763/ijrcs.v1i2.333.

[18] A. C. Chhoton and N. R. Chakraborty, "Dual axis solar tracking system-A comprehensive study: Bangladesh context," *4th Int. Conf. Adv. Electr. Eng. ICAEE 2017*, vol. 2018-Janua, no. January, pp. 421–426, 2017, doi: 10.1109/ICAEE.2017.8255393.

CHAPTER 13

AN OPTIMIZE DESIGN OF AN ELECTRICAL SUBSTATION EARTHING SYSTEM AND MONITORING WITH A WIRELESS SENSOR NETWORK (WSN)

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ABSTRACT:*The demand for electrical energy has grown rapidly in the last few years. As a result, more and more substations are being built to handle the increasing load requirements. Electrical power systems must be grounded for several technical and safety purposes. Keeping the resistance of the earthing system as low as possible allows fault current to flow to earth without interruption. The problem arises due to a lack of monitoring of electrical substations such as protection from leakage current and voltage, difficulty to analysis fault, difficulty to analysis temperature, and pressure of soil resistivity. This research with Wireless Sensor Network (WSN) design and monitoring that is essential when designing an earthing system, standard equations are used to obtain the appropriate characteristics, including touch and phase capacitance for protection, increased earth capacitance, cable impedance, fault current and soil measurements are included. It concluded that the earthing system for the substation is critical to the design of the substation. There are many steps to designing a secure and effective grid, and both security and dependability are requirements.In the future, every utility company will now have to automate substations to improve their efficiency and to improve the quality of electricity being provided as the complexity of the distribution system expands.*

KEYWORDS:*Electrical Substation, Earthing System, Grid, Networks, WSN.*

1. INTRODUCTION

Real-time data is needed by electrical substations for efficient power supply to consumers, adaptive power distribution to end users, and increased profitability. Mobile sensors and better low-power wireless devices are being developed to meet these demands [1],[2]. Such sensing devices enable adaptable, self-healing electrical automation systems that enable tele-maintenance, tele-protection, and tele-control while monitoring the substation's hardware [3],[4]. However, there is still much to learn about how to integrate them into electrical substations. All of the above standards will be referred to collectively as the Wireless Sensor Network (WSN) standards in the remaining sections of the paper [5],[6]. The effectiveness of WSN at electrical substations is dependent on stable communication in the challenging and complex impulsive noise environment (INE) of the substation. An understanding of features such as wireless channel architecture or link quality information in this type of environment is critical for WSN deployment in smart grids [7],[8]. WSNs have been recognized thanks to the need for process measurement and advances in wireless technology and electronics.

A smart sensor network is a term used to describe the technology used to enable the development of these systems with these sensors and communication networks [9],[10]. In this scenario, it is important to perform local processing, participate in the system and, if appropriate, transmit in addition to collecting sensor data. These intelligent sensor networks provide more efficient fault detection, monitoring, and other functions, increasing system uptime and dependability. As one of the difficulties in the design, development, and installation of wireless sensing networks, they can pinpoint locations where electromagnetic

interference may hinder your performance or render it unusable. In these circumstances, hybrid networks that combine wired and wireless technologies may be more appropriate.

Since the sensor node can sometimes be located in locations that are inaccessible or challenging to reach, these hybrid designs also enable better power management between these networks. In some circumstances, the physical link can potentially serve as a communication system redundancy [11],[12]. Without some sort of infrastructure improvement, it is not possible to monitor the substations being installed and operated without establishing a monitoring program using commercially available options. In this instance, many problems arise from modifications of the structure to accommodate the passage of communication cables [13],[14]. At present, online monitoring of these power substations is not being done. After some customers have alerted the concessionaire to a problem, the crew must travel to the area where the problem occurred [15],[16]. Earth rods, buried earthing matrices to metal parts of structures as well as equipment, cables connecting interconnection neutrals to earthing systems, and insulating materials protecting the earth's surface are usually components of such effective substation earthing systems are components. Potential discrepancies between grounded locations within the substation result from lightning arresters trying to enter the grounding system grid, excessive heat wave switching of the insulating material, and associated transmission from line to ground-fault circuits current and distribution. Without a properly constructed earthing system, significant potential disparities can arise between different locations in substation construction.

The primary threat to personal safety exists under specific circumstances, the goals of a successful earthing system are: to ensure appropriate human safety to exclude the possibility of a fatal electric shock to anyone working on or passing by earth structures. In the event of a failure, the touch and phase voltages must be at safe levels. A safe value will not trigger ventricular fibrillation by producing enough current in the body. Provide a means to conduct and dissipate electrical currents under both ideal and fault conditions, without violating any operational constraints or adversely affecting service continuity. Provide earthing to protect equipment and cables from lightning strikes and surges caused by switching substation machinery as in Figure 1. To enhance the functioning of the protective equipment, especially at the lowest fault levels, provide such a low resistance that will allow the detection and removal of the protective relay ground fault.

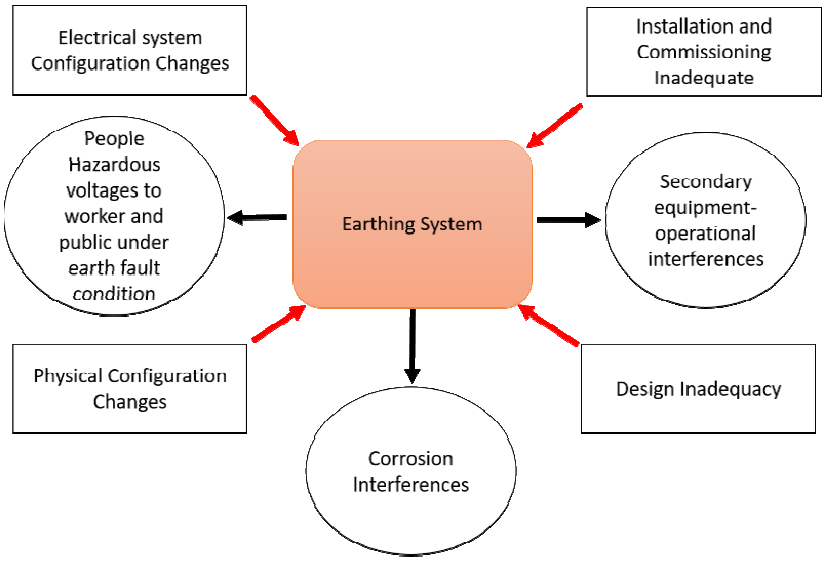

Figure 1: Illustrates the External Elements that Might Influence the Installation's Risk Profile and have an Impact on the Earthing System.

The recent liberalization of the power industry has made substation automation even more important and necessary for the development of the next generation of modern power grids. This research is featured in several sections where the first is an introduction and the second section is a literature review and suggestions from previous studies in the context of designing electrical substation earthing systems. In addition, the methodology section of this study is mentioned where the data in different sub-sections are examined. After that, the results and discussion part are discussed where the results are compared with existing data, followed by the methods applied in this research. Finally, the conclusion of this research is announced where the research results suggest as well as provide future scope.

2. LITERATURE REVIEW

Ei Ei Cho and Marlar Thein Oo [17] have explained the simulations for 230 kV substation earthing system design and parameter computation.The main objectives are to provide knowledge on safe earthing procedures in alternating current substation designs and to establish acceptable limits for possible differences throughout normal and fault scenarios. The author uses traditional formulas for constructing an earthing system to obtain desirable properties, which include touch or step voltage norms for safety.The matrix laboratory (MATLAB) software generates the earthing system design results, and although the exact fault current level is not specified, it is estimated that the fault current will be 10 times the normal current. Finally, earthing systems are important in substations, not only for the safety of the workmen or for the characteristics of the soil.

N. Harid [18] et al. have explained that a remote monitoring program for ground current flow, particularly leakage currents, in high-voltage electrical power stations is being designed and built. The major objective of the system is to use wireless local area network techniques to continually monitor a variety of plants inside a substation.It includes built-in overvoltage protections and consumes less power. Such Data Acquisition (DAQ) systems coupled leakage voltage and current sensors to transmitter and receiver modules, which were each connected to a wireless controller enabling data processing and storage. It has been demonstrated that the system can be configured to continually receive data at an 80 kHz frequency response via two channels and analyze certain values, such as the peak value of both the leakage current as well as the root mean square value. It was concluded that a unique wireless position monitoring system was feasible for use in high-voltage electrical power stations.

Nitin. R. Bhasme and Swapnil. G. Shah [19] has explained the Calculation of its characteristics and design of the earthing system of the 400 kV substation. The main objective of this work is to develop a safe and economical earthing system for 400 kV substations located in uneven terrain. Standard formulas are used in the design of grounding systems to achieve desired properties such as minimum conductor size, minimum electrode size, maximum fault condition level, and soil resistivity. It was found that choosing the appropriate soil resistivity, vertical electrode size, and horizontal conductor length may be the safest project option. It was concluded that when developing high voltage substations the calculation of phase or touch voltages should be carried out, and the levels should be carried out in compliance with predetermined specifications.

Mohammad Ali Adelian [20] has explained that designing a suitable substation grounding system is difficult because there are many factors involved. The main goal of a grounding design is to offer a mechanism for protecting electrical currents in both normal and faulty conditions. The maximum fault current, grid resistance, as well as step voltage levels shall be simulated for proper planning and construction of the grounding grid. It was shown that there are several ways to increase and overcome the challenges of earthing systems, including

placing the earthen pits in the right places, always supplying water to the pits, and using bentonite powder, soft coal, and black salt. Finally, computer systems have been built to make substation grounding design simpler and more accurate.

The above study shows that the proposed designs and build of a remote monitoring system for ground currents including leakage currents in very high-voltage electrical power substations as well as designing a suitable substation grounding system are difficult because there are many factors involved. In this study, the author researched the design of an electrical substation earthing system and its monitoring with a WSN.

Research Questions:

- How to Design an Electrical Substation Earthing System?
- How to Monitor Electrical Substation Earthing System with the help of WSN?

3. METHODOLOGY

3.1.Design:

A substation monitoring system, an ecosystem including both hardware and software components, can monitor a variety of equipment including transformers, power switches, as well as circuit breakers. Distribution and transmission power stations employ substation monitoring systems to collect real-time information on the overall operating condition of the substation, along with specialized equipment. The Substation Monitoring Program uses data monitoring to identify substation failures, tripping, or equipment breakdowns, providing a quick response to any such event. The safety and reliable functioning of substation equipment is facilitated by the substation monitoring system. The combination of the substation earthing system and its monitoring with WSN is shown in Figure 2.

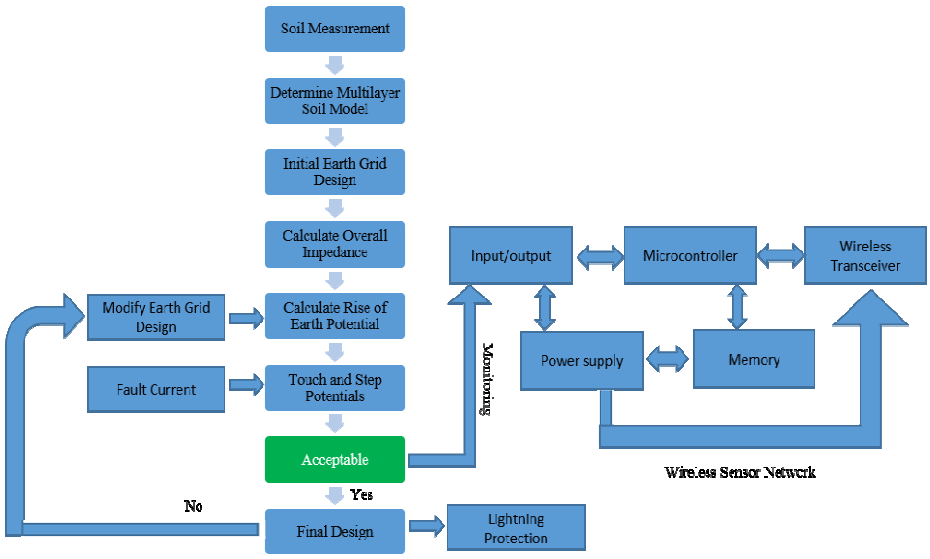

Figure 2: Illustrates the Electrical Substation Earthing System and its Monitoring with a WSN.

WSN is used to track and record the physical conditions of the environment and to compile the resulting information in one place. WSNs monitor a variety of environmental factors, including wind, humidity, noise, pollution levels, and temperature. These are comparable to wireless ad hoc systems, as they rely on wireless connections and the emergence of an automated network to transmit sensor data wirelessly. WSNs are geographically dispersed autonomous sensors that track physical or environmental factors such as current, voltage,

temperature, sound, humidity, etc. Each node in a WSN is associated with one or more sensors, and their number ranges from a few to thousands. , Each node in a smart sensor network typically consists of a microprocessor, a radio transceiver and an external antenna connected to it, and an electromechanical device to communicate with the sensor, as well as a source of energy that would normally be collected. Is. goes. Integrates energy. All sensors, including energy, memory, computing power, and telecommunications bandwidth, are affected by resource restrictions on the network, such as size and cost. The WSN topology can be as simple as a star network or as complex as a multi-hop wireless mesh network. Two possible techniques for networking hop-to-hop propagation are routing and flooding.

3.2. Instrument:

In the segment, it is possible to monitor natural or unintentional deterioration over time by encouraging state-of-the-art and effective methods and tools for online monitoring and diagnosis in Table 1. It will not cause major incidents, which can cause very costly damage to electricity providers and users if done early and corrected. It is possible to simultaneously prolong the life of the equipment, increase the maintenance schedule, reduce outages and reduce the cost of planned repairs.

Table 1: Illustrates the component used for monitoring of electrical substation with help of WSN.

Sl.	Components	Working in Wireless Sensor Network
1.	Microcontroller	Here, the data acquisition procedure is managed by a 16-bit high-performance, low-power microcontroller with an onboard serial connection module. The benefit of using a separate embedded system is that it gives the user the freedom to select the microprocessor and programming language that best meets the specifications of the operation under consideration.
2.	Power Supply	Solar power is intended to be the system's primary source of self-power, with energy storage available for nighttime and low-irradiation functioning. To avoid the need for the replacement battery and maintain a steady energy source for continuous monitoring of something like the leakage current, electrical substation.
3.	Wireless Transceiver	This electrical device's primary capabilities are to broadcast and receive various signals. The transceiver is a component of the network interface card found in local area networks. It can both send and receive electrical impulses traveling over the network line.
4.	Circuit Breaker	A switching device known as a circuit breaker stops the aberrant or fault current. It is an electromechanical device that switches on and off as well as interrupts the passage of a large magnitude (fault) current. The circuit breaker's primary purpose is to close or open an electrical circuit, protecting the electrical system in the process.
5.	Memory	Memory is most commonly used to describe the ongoing process of knowledge retention across time. It is a crucial component of human cognition because it enables people to recall and make use of prior experiences to frame their perception of and action in the present.

3.3. Data collection:

Substation earthing systems are crucial for maintaining the correct operation of electrical systems as well as protecting anyone working close to earthed equipment and facilities from the risk of electric shock. For good design, reliability, privacy, and legislative duties must all be taken into account. In the segment taking the standard value for designing of electrical substation system in Table 2.

Table 2: Illustrates the Constant Values Referred for Design Calculations in the Substation Earthing System.

Sl. No.	Parameters	Units	Symbol	Value
1.	Ambient temperature	^{0}C	T_a	50
2.	Thermal coefficient of resistivity	-	αr	0. 0034
3.	Time of the fault current's flow	Sec	T_c	1s
4.	Resistivity of substation soil	Ωm	ρ	202.8
5.	Fault duration time	0. 5s	T_s	0. 7s
6.	Maximum allowable temperature	^{0}C	T_m	455
7.	Length of one earth rod	m	L_r	4
8.	Conductor's burial depth	m	h	0.8
9.	the grid conductor's diameter	mm	d	36
10.	Reference depth of the grid	m	ho	2
11.	Conductor spacing	m	D	8
12.	Resistivity of conductors	μΩ/cm	ρr	20.5
13.	the material's surface resistance	Ωm	ρs	2600
14.	thermal capacity factor	j/cm³/°c	TCAP	4.931

3.4. Data analysis:

Analysis of the best earth field potential distribution principles using horizontal earth electrodes especially meshes ones with easily controlled surface potentials. Vertical electrodes with high touch potential values have the least advantageous potential distribution. In contrast, low earthing resistances with constant values that are mainly seasonal can be easily achieved using vertical electrodes. The horizontal electrode and vertical electrode are combined for low earthing resistance.

3.4.1. Soil Measurement:

The substation under investigation is located in areas with extremely low soil moisture content and extremely high soil resistivity as a result of the presence of rock beds. For reliable estimation of characteristics where there is a large fluctuation in the resistivity of the soil, a multi-layer soil model is suggested. When there are two layers of soil, it can be quite

difficult to design a substation grounding grid, especially when the resistivity of the soil inside the lower layer is higher than that of the upper layer.

3.4.2. Fault Current:

Fault current is the term for the flow of an unintended, uncontrolled, high current through a power system. Fault current is generated by a very low impedance fault voltage. These may be in full phase and may be smaller than the ground. The resulting high current can sometimes cause destructive arcs, explosions, and explosions as well as overheating of forces, equipment and conductors. Lightning, animals, dirt, garbage, fallen equipment, rust, and human error are just a few examples of things that can go wrong.

The calculation of fault current is based on Ohm's law.

"I=V/R", Where current (I) is equal to the voltage (V) divided by resistance (R).

3.4.3. Calculation Rise of Earth Potential:

In overhead plus underground three-core cable power distribution networks, a technique for calculating the leakage current split between the cable sheathing and the overall mass of the earth, as well as EPR and transmitted earth potential enhancement, will be described. The fault circuit network within those models will have a ground mat as a separate lumped impedance member. These models cannot explicitly calculate the contact and phase voltages related to the earth's potential rise (EPR). However, the transmitted EPR can be determined.

3.4.4. Calculate Overall Impedance:

The formula below can be used to determine the cable's surge impedance:

Z_0= square root of L_C/1000*C*10^{-6}

Where:

Zo = Surge Impedance of Cable (Ohms)

LC = Conductor Inductance (MH)

C = total capacitance of cable (microfarad).

3.4.5. Touch potential:

The tactile potential is the electric charge that is produced when a person's foot comes into contact with an active object. This is analogous to the voltage difference between the far point and the item. The ability to touch can achieve almost its full potential even when an object is grounded somewhere other than when it is in contact with another person. For example, anyone who comes close to a crane or its poorly insulated unloading line will be exposed to a touch potential, which is approximately equal to the full fault voltage when energized with the system in neutral and comes in contact with one of the connections.

3.4.6. Step potential:

In case of tower and substation failure, the current will reach the earth. The soil will have a uniform voltage distribution based on the distribution of different resistivity (generally, a horizontally stratified soil is assumed). Personnel standing too close to the grounding system may be at risk of power dissipation in the surrounding soil. Those that move in the direction of the voltage gradient may be exposed to potentially harmful voltages.

4. RESULTS AND DISCUSSION

This research demonstrates the utility of a revolutionary wireless position monitoring system used in high-voltage electrical substations. The system can be used individually or as a part of a multi-sensor network to detect leakage current and voltage across various equipment. This was one of the main factors in our initial choice to proceed with this project. Modern facilities sometimes depend on regularly received data which is additionally obtained manually as they lack the necessary infrastructure to receive real-time data. Therefore, sometimes it can be challenging to find out the actual position of the machine. Here, users can view the real-time data of the machine regardless of the fault. Earthing system design ideas aim to find the right balance between cost, practicality as well as risk management while ensuring adequate robustness in design. An analysis is usually required to examine interactions between different exposure scenarios, such as contact and phase voltage hazards, and the impact of different design specifications on the overall tolerance for exposure to such sites and systems. Table 3 Safety protocols, operational requirements, hardware interference restrictions, corrosion interference constraints, cost-effectiveness, ability to cheaply and effectively monitor primary performance parameters at the time of implementation, maintenance, planning, and construction, and to be robust and reliable throughout gives a list of. Lifetime, i.e. resistant to common failure modes and easily verifiable for extended periods, are some of the concept-building considerations.

Table 3: Illustrates the Various Component Factor and their Value For Grid Construction Design.

Sl.	Parameters	Value	Symbol	Unit
1.	Earth conductor size	793.1	A	mm^2
2.	The total length of the earth conductor in the switchyard	34405.5	LT	m
3.	Step voltage criteria	2103	Estep	volts
4.	Maximum mesh voltage achievable	375.18	Em	volts
5.	Earth resistance	0.302	Rg	Ohms
6.	Touch voltage criteria	650.252	Etouch	volts
7.	The spacing factor for mesh voltage	0.385	Km	
8.	Maximum grid current	24	Ig	kA
9	The spacing factor for step voltages	0.360	Ks	
10.	Earth potential rise	6054.38	GPR	volts
11.	Maximum step voltage possible	390.68	Es	volts

5. CONCLUSION

A key component of substation design is substation grounding, construction must be reliable and safe. A safe and efficient grid design involves several processes. Hand calculations can be time-consuming and challenging. Calculations and design adjustments can be time-consuming processes. Computer tools have been developed to make substation grounding design more straightforward and accurate. The engineering construction of a grounded network in substations is an iterative process that makes it easy to discover ideal techno-

economic results according to computer-aided design technology. An optimization issue that enables the best choice of grounding grid layout, including installation considerations for complimentary transmission line electrodes, while also presenting an accepted touch and phase voltage to meet the technical requirements of the system and function. Improvements in wireless communication and technology as well as the need for process equipment made it possible to design the WSN. A smart sensor network is a term used to describe the technology used to enable the development of these systems with these sensors and communication networks. In this scenario, it is important to perform local processing, participate in the system and, if appropriate, transmit in addition to collecting sensor data. These intelligent sensor networks provide more efficient fault detection, monitoring, and other functions, increasing the dependability and maintenance of the system.

REFERENCES

[1] A. Cardoso, I. C. do Santos Peres, E. Lamounier, G. Lima, M. Miranda, and I. Moraes, "Associating Holography Techniques with BIM Practices for Electrical Substation Design," in *Advances in Intelligent Systems and Computing*, 2018, pp. 37–47. doi: 10.1007/978-3-319-60204-2_5.

[2] R. M. Arias Velásquez and J. V. Mejía Lara, "Current transformer failure caused by electric field associated to circuit breaker and pollution in 500□kV substations," *Eng. Fail. Anal.*, 2018, doi: 10.1016/j.engfailanal.2018.05.017.

[3] M. V. Shevlyugin, A. A. Korolev, A. O. Korolev, and I. A. Aleksandrov, "A Digital Model of a Traction Substation with Two Types of Current," *Russ. Electr. Eng.*, 2018, doi: 10.3103/S1068371218090134.

[4] M. Kanaan and K. Chahine, "CFD study of ventilation for indoor multi-zone transformer substation," *Int. J. Heat Technol.*, 2018, doi: 10.18280/ijht.360112.

[5] A. S. Omran, N. H. Abbasy, and R. A. Hamdy, "Enhanced performance of substation dynamics during large induction motor starting using SVC," *Alexandria Eng. J.*, vol. 57, no. 4, pp. 4059–4070, Dec. 2018, doi: 10.1016/j.aej.2018.10.009.

[6] T. W. Ngwe, S. Winn, and S. M. Myint, "Design and Control of Automatic Power Factor Correction APFC for Power Factor Improvement in Oakshippin Primary Substation," *Int. J. Trend Sci. Res. Dev.*, 2018, doi: 10.31142/ijtsrd18320.

[7] A. Sarid and M. Tzur, "The multi-scale generation and transmission expansion model," *Energy*, 2018, pp.977-991, vol 148, doi: 10.1016/j.energy.2018.01.091.

[8] G. C. Montanari *et al.*, "Next generation polymeric high voltage direct current cables—A quantum leap needed?," *IEEE Electr. Insul. Mag.*, vol. 34, no. 2, pp. 24–31, Mar. 2018, doi: 10.1109/MEI.2018.8300441.

[9] H. Smail, R. Alkama, and A. Medjdoub, "Optimal design of the electric connection of a wind farm," *Energy*, 2018, pp.972-983, vol 165, doi: 10.1016/j.energy.2018.10.015.

[10] J. Lee, S. Lee, H. Cho, K. S. Ham, and J. Hong, "Supervisory control and data acquisition for Standalone Hybrid Power Generation Systems," *Sustain. Comput. Informatics Syst.*, 2018, pp.141-154, vol.20, doi: 10.1016/j.suscom.2017.11.003.

[11] M. Atudori and P. Van De Vall, "Modern Techniques in the Modelling of High Voltage Power Systems," 2018. pp.0444-0449,doi: 10.1109/ICEPE.2018.8559736.

[12] A. Canova and L. Giaccone, "Real-time optimization of active loops for the magnetic field minimization," *Int. J. Appl. Electromagn. Mech.*, 2018, pp. 97-106, vol. 56, doi: 10.3233/JAE-172286.

[13] Y. V. Bladyko, "Mechanical Calculation of Flexible Wires when a Concentrated Load is Being Replaced with a Distributed One Taking into Account the Structural Elements," *Energ. Proc. CIS High. Educ. Institutions Power Eng. Assoc.*, 2018, pp. 220-234, vol. 61, doi: 10.21122/1029-7448-2019-61-3-220-234.

[14] A. Tatematsu, S. Moriguchi, and T. Ueda, "Switching surge analysis of an EHV air-insulated substation using the 3-D FDTD method," *IEEE Trans. Power Deliv.*, 2018, pp.2324-2334, vol.33, doi: 10.1109/TPWRD.2018.2807878.

[15] L. Magenes, H. Q. Dinh, and A. Klein, "How new Energy Codes are Impacting Electrical Substation Designs: Copyright Material IEEE, Paper No. PCIC-2018-11," in *2018 IEEE Petroleum and Chemical Industry Technical Conference (PCIC)*, Sep. 2018, pp. 93–100. doi: 10.1109/PCIC31437.2018.9080439.

[16] Y. V. Bladyko, “Mechanical Calculation Of Flexible Wires When The Concentrated Forces Are Replaced By A Distributed Load,” *Energ. Proc. CIS High. Educ. institutions power Eng. Assoc.*, vol. 61, no. 2, pp. 97–107, Apr. 2018, doi: 10.21122/1029-7448-2018-61-2-97-107.

[17] E. E. Cho and M. T. Oo, “Design of Earthing System for New Substation Project (Shwe Sar Yan) in Myanmar,” pp. 430–434, 2008.

[18] N. Harid, A. C. Bogias, H. Griffiths, S. Robson, and A. Haddad, “A wireless system for monitoring leakage current in electrical substation equipment,” *IEEE Access*, vol. 4, pp. 2965–2975, 2016, doi: 10.1109/ACCESS.2016.2577553.

[19] S. G. Shah, N. R. Bhasme, and P. G. Student, “Design Of Earthing System For Hv/Ehv Ac Substation (A Case Study Of 400kv Substation At Aurangabad, India),” *Int. J. Adv. Eng. Technol.*, vol. 6, no. 6, pp. 2597–2605, 2014.

[20] M. A. Adelian, “Improvement of Substation Earthing,” no. 4, pp. 100–104, 2014.http://citeseerx.ist.psu.edu/viewdoc/download?2014, doi=10.1.1.679.938&rep=rep1&type=pdf

CHAPTER 14

COMPREHENSIVE REVIEW OF DC MOTOR AND MEASUREMENT OF ITS SPEED USING HIGH-END MICROCONTROLLER

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ABSTRACT:*The construction of a microcontroller-based control system to alter a direct current (DC) motor's speed is described in this paper. Without wasting any energy, the power supply to the load of the DC motor was managed using the pulse width modulation (PWM) approach. This paper emphasizes the parts and construction of this microprocessor circuit and tests the finished circuit. In this study, the pulse changes the armature voltage input DC voltage using pulse-width modulation (PWM) using the microcontroller program was built. The results show the DC motor's speed is altered and the path of DC motor rotation is altered by starting and pushing an interrupt signal to the microcontroller switches. In this paper after many literature reviews, the author concludes that the DC motor is driven via a channel it employed a monolithic integrated buffer circuit, and additionally, the control circuit has been created and fabricated.The goal of this paper is to analyze the effectiveness of the microcontroller by which speed can be calculated effectively.*

KEYWORDS: *Direct Current (DC), Motors, Microcontroller, Power, Pulse Width Modulation (PWM).*

1. INTRODUCTION

Numerous control systems make use of direct current (DC) motors and DC motor speed control involves adjusting the motor's driving speed to a value necessary to carry out a task. Throughout many control systems nowadays, DC motors are used and DC motor is a solid choice for driven by variable speed systems and hybrid stepper applications choice. Since a DC motor's torque is considerably high and has a fairly lax speed regulation. Latest technology developments in rare earth magnet development Commentator engineering and mode manufacturing permanent magnet (PM) dc motor methods with an ironized and extremely low-inertia rotor expands its use in many control systems.The stator, which is the fixed component of a DC motor, and the rotor, which is the inner revolving component and is sometimes referred to as the electromagnet, are its two fundamental components [1], [2].

A DC motor's speed of the motor is determined by the interplay of the two magnetic fields created by the revolving electromagnets in the armature and the stator's stationary permanent magnets. The author can control the DC motor's rotational speed by manipulating this interconnection. There are several methods for achieving this speed control. Pulse width modulation (PWM), is a straightforward and straightforward approach that may be used to drive a DC motor by using a sequence of "on" and "off" pulses and adjusting the clock frequency of the spikes while maintaining a constant frequency [3], [4].

The speed control is controlled by modulating or changing the time of these pulses; specifically, the greater the pulse is "on," the greater the motor will revolve, and the smaller the pulse is "on," the slower the speed will rotate. As a result, the motor will revolve more quickly the larger the sampling rate, the higher the average voltage supplied to the neutral wire, the greater the permanent magnet flux inside the stator winding, and the broader the pulse width. Technology advancements have made microcontrollers a more advantageous chip for controlling diverse electro-mechanical systems. Products and equipment that are

automatically controlled employ microcontrollers. Microcontrollers make it affordable to effectively control increasingly more systems and devices by lowering the size and cost [5], [6].

DC motors often have their excitation temperature and field currents adjusted to achieve variable speed. But if the armature voltage can be adjusted, the speed fluctuation range is excellent. It is possible to utilize a PWM or chopper circuit to get changeable DC voltage. DC motor speed is often managed using PWM. The chopper or PWM circuit, however, is particularly difficult to design and construct. This allows for the regulation of the output power across the motor's terminals and, therefore, the control of the power provided to the motor. When "switching on" and "switching off" are performed quickly back-to-back, the motor spins between zero and its maximum rated speed at a slower pace. A PWM technique-based controller operates in this manner, using a pulse train to turn the motor "on" and "off." The motor will revolve slowly while it is briefly "on" and then abruptly "off." The motor will rotate at a faster speed, say, almost at full or grand total rated speed, when it is "on" for the majority of the novel and "off" for only a brief period.

A throw type four channel driver IC (L293) was utilized in the driver unit and this transistor-based control signal, dc charging driver is designed to drive switching power transistors as well as inductive loads like relays, solenoids, DC, and stepping motors. It can take normal DTL logic levels. Each combination of channels has an empowering input to make it easier to utilize them as two bridges. The logic has a second supply input that enables functioning at a lower voltage, and intrinsic clamp devices are also included. This device may be used in transmitting electricity at up to 7 kHz in frequency. Its output channels can handle currents of up to 700 mA each. It has the enable feature [7], [8].

Step-down transformers, bridge rectifiers, capacitors, and power supply ICs of health maintenance organizations (HMOs and 7812 are used in the design of the dc power supply to get Electrical output of 5 V and 12 V, respectively. Three push-type switchgear are part of the switching unit and are used to deliver inputs as well as interrupts to the microcontroller's different ports respectively.Figure 1 embellishes the microcontroller-based push switches and DC motor.

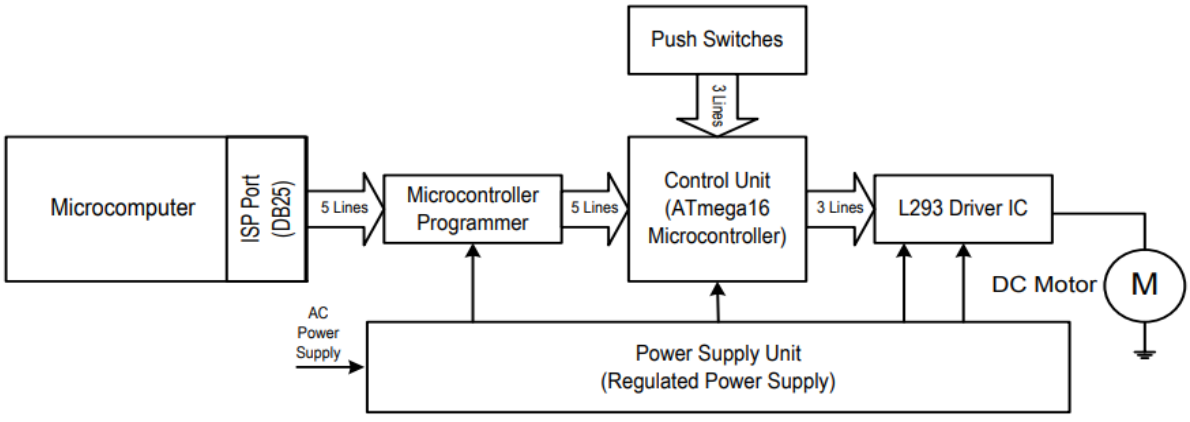

Figure 1: Embellishes the microcontroller-based push switches and DC motor [9]**.**

It includes four separate components, a microcontroller, a driving unit, a switching unit, and a DC power supply unit. An A8-bit ATmega16 microcontroller serves as the component's control unit. Through its intermittent inputs (PB0, PB1, and PB2), it receives input signals from the various switches of the switcher unit (SW0, SW1, and SW2) before sending the appropriate output ports. The duty cycle of either the voltage Regulator signals is adjusted

using ports PB0 and PB1, respectively, while the rotational direction is adjusted using port PB2. Guess it depends on the message at port PD5, ports PC0 and PC1 are utilized to transmit the instructions for the PN junction of the DC motor. The driver ICs are linked to port PD5.

2. LITERATURE REVIEW

Hammoodi et al. in their study embellish the functioning of DC motors while considering the factors on which the speed depends. After a brief explanation, the PID (Proportional-Integral-Derivative) controllers are applied to the previously stated motor speed control as an electronic controller (PID), which is also known as a DC motor. In this paper, the author applied a methodology in which they stated that a Brush DC motor's closed-loop speed control is created using the well-known PID control technique. The results show that the goal of this study is to build and simulate a novel control system that will automatically depend on the PID controller to maintain the speed of the DC motor constant before fluctuations in the load. The author concludes that the system was created and put into operation utilizing a DC motor [10].

Amiri et al. in their study embellish that a geared DC motor's non-linear characteristics make an estimation of its parameters essential. In this study, the genetic characteristics of a switched Reluctance propeller are calculated. In this paper, the author applied a methodology in which they stated that Kirchhoff's law and a numerical solution of the DC motor's shafts and gearbox are used to establish the mathematical model. The results show that the geared DC motor's parameters are originally calculated via MATLAB. To reduce the inaccuracy of the real and simulated angular trajectory recorded by an encoder, the approximated parameters are chosen as beginning values for the Genetic Algorithm (GA). The author concludes that the different voltages used as the input to the real DC motor and its numerical method serve to validate the best-estimated model three-phase phase synchronous motor. It is clear from the outcomes and numerical analysis that GA is acceptable [11].

Ibrahim et al. in their study illustrate that In addition to starter energy control techniques, this paper also discusses how to adjust the electrode and field resistances of a DC motor to define the mechanism of speed control. In this paper, the author applied a methodology in which they stated that in this work, a PI controller is used as a donor to regulate the speed of a DC motor. The results show the control of Terco DC power input using MATLAB Simulink real-world data. The author of this paper concludes that the MATLAB simulation circuit is roughly identical to those of the real connection [12].

In this paper, the author elaborates on the DC motor and its functioning In addition to starter energy control techniques, this paper also discusses how to adjust the electrode and field resistances of a DC motor to define the mechanism of speed control. In this work, a PI controller is used as a donor to regulate the speed of a DC motor. This paper demonstrates the control of Terco DC power input using MATLAB Simulink and real-world data. The results from the MATLAB simulation circuit are roughly identical to those from the real connection.

3. DISCUSSION

Electromechanical methods might be used to regulate the speed of a DC motor. In the past, dc drives' speed controls were mostly mechanical and needed substantial hardware put into action. The advancement has started these returns to a stance of imposing significance, they were supposed to be replaced with AC drives. Some Spinning mills and paper mills significantly use hoists, traction, printing, machine tools, and mine winders crushers, mills, industrial facilities, and excavators. This is a mechanism that may be used to utilize DC

provided in the study motor for a variety of uses. We may make use of the DC to regulate the motor for many purposes speed and direction based on the area of interest. PWM, or pulse width modulation, is the method for producing electricity by using switching devices as the result of an analog signal that is continually changing. In general, this PWM converter has extremely high electrical effectiveness and controllability either a three-phase induction motor or a synchronous motor [13].

3.1.Software Application:

It is required to build three waveforms of completely sinusoidal current in the motor relative to phase shifts seen in the windings. Power generation from sine waves using a linear amplifier system's efficiency would be poor, 68% is the maximum. Efficiency may rise by as much as 89% if fast electronic circuits are used in place of linear circuits depending on the situation, switching devices are characteristics of the power switch for semiconductors. The grid side wave mostly relies on the duty ratio's modulation. Coding and debugging are two terms for the same thing in a high-level language (such as c or java).

The use of a high-level language compiler speeds up manufacturing. The C programming language was used with WinAVR to program the microcontrollers. The programming language has been commented on to make it easier for any sporadic upkeep and future improvements. For the Atmel AVR line of RISC microprocessors, WinAVR is a collection of open-source, executable software development tools hosted on the Windows operating system. It comes with the C and C++ GNU GCC compilers. All the AVR development tools are included in WinAVR [14].

This contains the AVR-gdb debugger and the compiler AVR-GCC and compiling is the program that is transformed from human language to machine language as a medium of o's and ans1s after being compiled. The Hex file extension is used to store this particular file (.Hex). Additionally, the compiler produces mistakes in the programmer that must be fixed for it to run correctly.Figure 2 embellishes the circuit diagram of the microcontroller-based system.

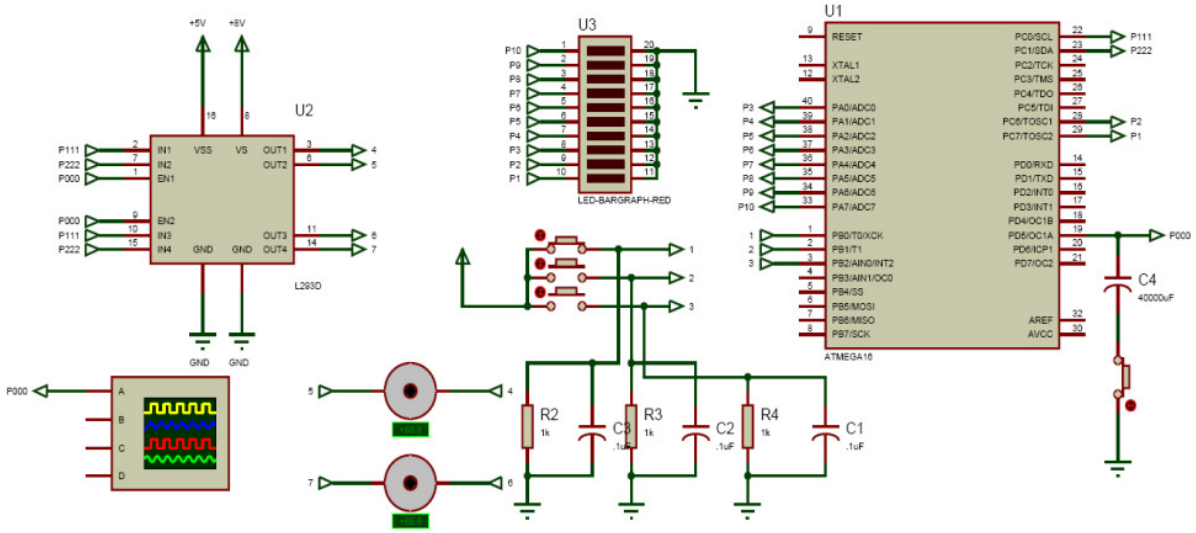

Figure 2: Embellishes the circuit diagram of the microcontroller-based system [15]**.**

Burning is a special programmer that connects to a PC's peripheral, you can burn the machine language (hex) file onto the microcontroller's program memory. The serial port of a computer has been used. The machine language file was burned into the program memory of the

microcontroller using the Ponyprog programmer for this purpose. “Ponyprog is serial device programming software that is compatible with Windows 95/98/ME/NT/2000/XP and Intel Linux. It has a user-friendly GUI interface”. Its function is to read and write to all serial devices. It supports the Atmel AVR and Microchip PIC microcontrollers, as well as the I2C Bus, Microwire, SPI EEPROM, and SPI. The microcontrollers were programmed using a high-speed programming mode in around two seconds. “Like the EEPROM, the programming language, which is of the Flash kind, has a finite lifetime. The AVR microcontroller family's Atmega16 Programmer (ISP), which is used to burn the program into AVR microcontrollers, allows for up to 1,000 reprogramming without any danger of data damage”.

3.2.Assessment:

The systems engineering phase is complete, and the system can be installed at any industrial site as a personal network area network if the system operates as the user expects it to and completes all jobs quickly and effectively. If not, the whole procedure is redone to fix the mistakes. The limited resources a programmer has to work with is one of the challenges of programming microcontrollers. When opposed to microcontrollers, PCs have almost unlimited resources like RAM and processing speed. The code on mobile processors should use as few resources as feasible compared to a PC, yet being less expensive and using less power makes it a preferable choice [16].

The code for controlling the functionality of the associated liquid crystal display (LCD) module is found in the C file LCD. The code regulates the cursor's movement, properties, and placement as well as the startup of the LCD and the printing of data to the LCD. It provides the option to string-wise or character-by-character send data to the LCD. The software's command set is based on the LCD's command set, which is based on Hitachi HD44780 ICs titled(), delete(), display() and displaying are all included in this file( ).Figure 3 illustrates the different graphs and performance of the dc motor.

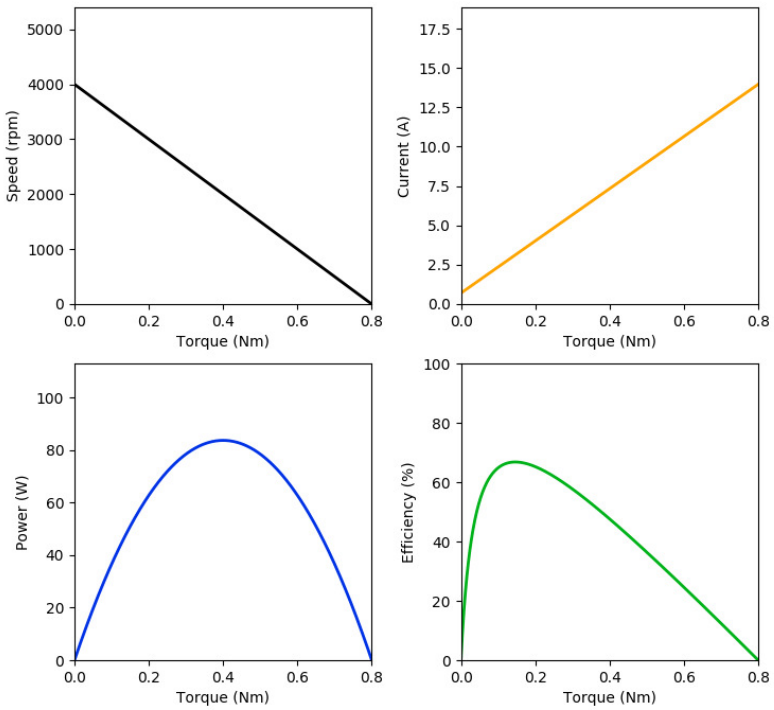

Figure 3: Illustrates the different graphs and performance of the dc motor [17]**.**

DC Devices for controlling motor speed have several uses in daily life. It works well in robotic motion control, professional office automation, and some home appliances. Applications for it in small-scale industries Settings will undoubtedly support a developing country's efforts to develop as ours. This created a control system based on a microcontroller to alter the claimed speed of just a DC motor in this study will undoubtedly reduce the demand for efficiency in settings for small- and medium-sized industries. This circuit's functionalities have been located, and the finished circuit has been examined.Figure 4 embellishes the construction part of the dc motor.

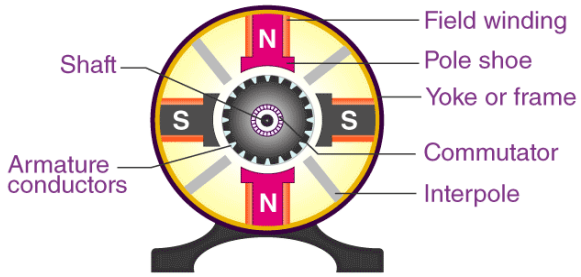

Figure 4: Embellishes the construction part of the dc motor [18]**.**

This connection was used to regulate the power of the electric fan. Additionally, it may regulate a lamp's brightness, the movement of miniature toys, and a variety of other solutions. Due to the use of PWM, power loss in this circuit is negligible as a method for regulating the motor's speed. Also, because the transistor is either totally "on" or fully "off", giving it a linear kind of control, the catastrophic failure in the switching devices is minimal, leading to improved speed stability. Additionally, since the motor's voltage amplitude is constant, the motor is constantly operating at maximum intensity. It implies that a considerably slower rotation speed may be used without the generator malfunctioning. Table 1 discloses the motor speed setting of the dc motor at different points.

Table 1: Discloses the motor speed setting of the dc motor at different points.

Motor Speed Setting	Motor Speed (RPM) Increase	Motor Speed (RPM) Decrease
0	0	0
1	235	235
2	346	360
3	551	559
4	623	634
5	669	680
6	721	732
7	741	756
8	845	856

There are three operating areas on DC motors and the first is referred known as the constant-torque range and extends from 0 to the base speed. The capacity to generate maximum torque stays constant when the motor voltage rises from zero to base voltage. As the voltage changes, motor power rises from zero to rated power. This area is often designated as changeable constant torque. This feature of a DC motor made it ideal for use in applications that needed to run at different speeds while being fully loaded. Figure 5 embellishes the torque of the DC motor and its performance.

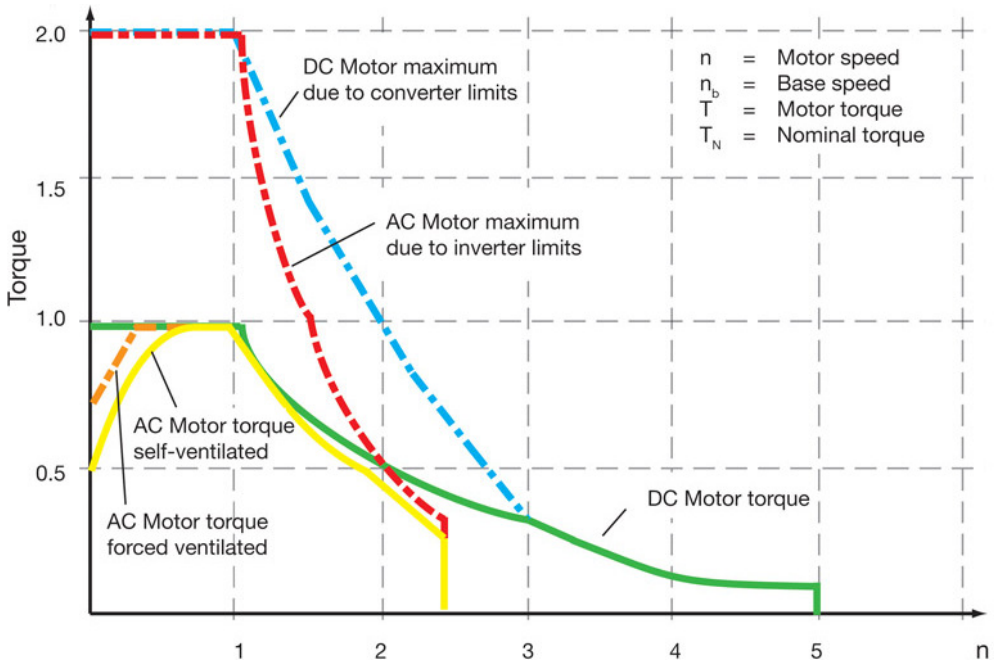

Figure 5: Embellishes the torque of the DC motor and its performance [19]**.**

The field-weakening (FW) operating range, also known as the constant-power range, is the second area. This operating range typically spans a speed that is two or three times higher than the basic speed. The motor accelerates when the proportional gain is decreased while operating at the operating point (full voltage). As speed rises in this area, power stays constant. The torque that can turn the load is reduced to compensate for the speed increase. This area is often designated as CP or continual variable torque.

This field-weakening range is used to run the take-up rollers at the end of a paper mill. The machine outputs paper at a set pace. The strain on the spool is least when a fresh roll is begun yet it must resolve the quickest since it is at its greatest diameter. The DC motor is now operating in its full practice area mode, which results in the lowest torque and highest speed. The weight is growing as the roll swells with paper, requiring greater torque to move the spindle.

As the paper roll fills up, the roll diameter grows, and the spindle has to revolve more slowly to maintain the roll's linear surface speed at the same rate as the paper machine, the paper comes out of the machine at a set pace. The field is reinforced as the roll grows while working in the practice area range, which raises torque and lowers spindle speed. Nearly all of the machinery in the paper industry that handled rolls of paper were powered by DC motors. This was made possible by the field-weakening property.

The field-weakening range is extended in the third operational range and the range of this stretched field weakening is around four to five-fold the basic speed. It becomes more challenging for the charge to travel seen between the brush and the synchronous motor when

the field is progressively reduced for an even higher speed. When there is excessive crackling at the wilderness junction, too much current will flow, which harms both parts. By restricting the current going to the brushes at these higher rates, damage may be avoided. Because speed is now a factor in both power and torque, this sector is classified as the third area.

4. CONCLUSION

A sensor DC motor control system design to alter the direction and the speed of a DC motor's rotation is presented in this study. Pulse width modulation (PWM) of the input DC voltage is used to change the armature voltage. Changes to the DC motor's rotational direction are made by sending an intermittent signal to the microcontroller. The control circuit's PCB was developed, and the whole system was put into operation on it. The test results are tabulated and demonstrate excellent agreement with the anticipated outcome.This study effectively applied the design of a sustainable system to manage the speed and direction of a geared DC Motor. The future potential of this paper is due to its ability to adjust speed, DC motors may alter their speed, torque, and even rotational direction at any moment to adapt to changing conditions.

REFERENCES

[1] M. L. Hamida, H. Denoun, A. Fekik, and S. Vaidyanathan, "Control of separately excited DC motor with series multi-cells chopper using PI - Petri nets controller," *Nonlinear Eng.*, vol. 8, no. 1, pp. 32–38, Jan. 2019, doi: 10.1515/nleng-2017-0174.

[2] H. M. Abdul Abbas, R. F. Chisab, and M. Jabbar Mnati, "Monitoring and controlling the speed and direction of a DC motor through FPGA and comparison of FPGA for speed and performance optimization," *Int. J. Electr. Comput. Eng.*, vol. 11, no. 5, p. 3903, Oct. 2021, doi: 10.11591/ijece.v11i5.pp3903-3912.

[3] B. Song, Y. Xiao, and L. Xu, "Design of fuzzy PI controller for brushless DC motor based on PSO–GSA algorithm," *Syst. Sci. Control Eng.*, vol. 8, no. 1, pp. 67–77, Jan. 2020, doi: 10.1080/21642583.2020.1723144.

[4] S. P. Alloju, "Speed Control of DC Motor Using PWM," *SSRN Electron. J.*, 2021, doi: 10.2139/ssrn.3917884.

[5] J. Cui *et al.*, "A New Control Technology Based on Virtual DC Motor," *Zhongguo Dianji Gongcheng Xuebao/Proceedings Chinese Soc. Electr. Eng.*, 2019, doi: 10.13334/j.0258-8013.pcsee.180782.

[6] A. Bisoi, A. K. Samantaray, and R. Bhattacharyya, "Control strategies for DC motors driving rotor dynamic systems through resonance," *J. Sound Vib.*, vol. 411, pp. 304–327, Dec. 2017, doi: 10.1016/j.jsv.2017.09.014.

[7] R. K. Achary, S. Durgaprasanth, C. Nagamani, and G. S. Ilango, "A Simple Voltage Modulator Scheme for Torque Ripple Minimization in a Permanent Magnet Brushless DC Motor," *IEEE Trans. Power Electron.*, vol. 35, no. 3, pp. 2809–2818, Mar. 2020, doi: 10.1109/TPEL.2019.2926122.

[8] S. Sun *et al.*, "Novel modulation method for torque ripple suppression of brushless DC motors based on SIMO DC–DC converter," *J. Power Electron.*, vol. 20, no. 3, pp. 720–730, May 2020, doi: 10.1007/s43236-020-00071-1.

[9] N. Priyadarshi, S. Padmanaban, L. Mihet-Popa, F. Blaabjerg, and F. Azam, "Maximum power point tracking for brushless DC motor-driven photovoltaic pumping systems using a hybrid ANFIS-FLOWER pollination optimization algorithm," *Energies*, 2018, doi: 10.3390/en11051067.

[10] S. J. Hammoodi, K. S. Flayyih, and A. R. Hamad, "Design and implementation speed control system of DC motor based on PID control and matlab simulink," *Int. J. Power Electron. Drive Syst.*, 2020, doi: 10.11591/ijpeds.v11.i1.pp127-134.

[11] M. S. Amiri, M. F. Ibrahim, and R. Ramli, "Optimal parameter estimation for a DC motor using genetic algorithm," *Int. J. Power Electron. Drive Syst.*, vol. 11, no. 2, p. 1047, Jun. 2020, doi: 10.11591/ijpeds.v11.i2.pp1047-1054.

[12] M. A. Ibrahim, A. N. Hamoodi, and B. M. Salih, "PI controller for DC motor speed realized with simulink and practical measurements," *Int. J. Power Electron. Drive Syst.*, vol. 11, no. 1, p. 119, Mar. 2020, doi: 10.11591/ijpeds.v11.i1.pp119-126.

[13] Ö. KASIM, "Speed Control of DC Motor under reverse torque disturbance with Ant Colony Optimized PID Controller," *Aksaray Univ. J. Sci. Eng.*, 2021, doi: 10.29002/asujse.892979.

[14] K. Liu, Z. Zhou, and W. Hua, "A Novel Region-Refinement Pulse Width Modulation Method for Torque Ripple Reduction of Brushless DC Motors," *IEEE Access*, 2019, doi: 10.1109/ACCESS.2018.2888630.

[15] E. Köse and A. Mühürcü, "The control of Brushless DC motor for electric vehicle by using chaotic synchronization method," *Stud. Informatics Control*, 2018, doi: 10.24846/v27i4y201804.

[16] X. Yao, J. Zhao, J. Wang, S. Huang, and Y. Jiang, "Commutation Torque Ripple Reduction for Brushless DC Motor Based on an Auxiliary Step-Up Circuit," *IEEE Access*, 2019, doi: 10.1109/ACCESS.2019.2943411.

[17] Y. Naung, S. Anatolii, and Y. Htet Lin, "Speed control of DC motor by using neural network parameter tuner for PI-controller," in *Proceedings of the 2019 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering, ElConRus 2019*, 2019. doi: 10.1109/EIConRus.2019.8656911.

[18] A. Rauf, S. Li, R. Madonski, and J. Yang, "Continuous dynamic sliding mode control of converter-fed DC motor system with high order mismatched disturbance compensation," *Trans. Inst. Meas. Control*, 2020, doi: 10.1177/0142331220933415.

[19] C. Guerrero, V. Santibanez, Y. Araiza-Olvera, E. Ibarra-Figueroa, and B. Perez-Perez, "Control of velocity of DC motors by classical and passivity methods measuring only position: Theory and experimental comparison," *IEEE Lat. Am. Trans.*, 2020, doi: 10.1109/TLA.2020.9082926.

CHAPTER 15

AN APPROACH FOR DIGITAL SIGNAL PROCESSOR BASED MOTOR CONTROL SYSTEM

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ABSTRACT:*The designs of DSPs are appropriate for high-speed digital processing, which is a fundamental algorithmic activity. The DSP is an effective instrument for controlling electric motors, and its enhanced processing power allows for more motor/motion control versatility.The demand for better performance, more connectivity, easier programming, and lower costs has increased the requirements for motor control systems. The motor control processor determines the amount and frequency of the motor winding voltage needed to drive the motors at the required frequency. Hence the author focusses on the development of digital signal processor (DSP) (TMS320C30) of based motor control system. It found that providesreducing costs by effective control in all speed ranges, meaning proper sizing of power device circuits. It concludes that the DSP controller allows for an intelligent control strategy that can lower system expenses overall and increase drive systems dependability.Even though all information in nature and anywhere it is available may be viewed as a signals, the future of signal analysis is promising very bright and long-lasting in temporal and in other directions.*

KEYWORDS:*Digital Signal Processor, Electric, Software, Speed, Motor Control System.*

1. INTRODUCTION

Approximately half of a electricity used in the United States is used to power electric motors, which are frequently excessive for the task at hand [1],[2]. Uncontrolled motor drives do not perform well under light loads. The overall cost of ownership can be decreased by using a smaller engine with an equivalent or even greater output by switching onto a more effective control approach [3], [4]. The motors itself may frequently cost higher than the one it is replacing, however this can be offset by greater energy efficiency and the removal of certain parts of the system which can be substituted by software [5],[6].Every year, tens of millions of electric engines are produced for a variety of uses, including those in office equipment, automobiles, appliances, instruments, and factory floors [7], [8]. Government rules and customer demands both need motors to be quieter, more effective, and safer. Consumers desire more additional features compared to ever before in addition to decreased energy costs.

Customers are ready to pay more for the advantages that come with feature-rich models, particularly when they are aware that these models have lower total ownership costs [9],[10]. The main parts of electric appliances like refrigerators and washing machines include electric motors. The appliance's overall energy consumption can be decreased by adjusting the motor's speed [11], [12]. An input converter, a three-phase power inverters, and the motor control circuits make up the core components of a variable frequency AC drive system [13],[14]. The CPU can sample motor feedback signals including inverters bus current and voltage thanks to an analog to digital converter. The control law determines a fresh estimate of the rotor position and determines the PWM duty cycle necessary to provide the necessary voltage to the motor.

The DSP algorithms also conducts diagnostic tasks by keeping track of the motor's current and speed as well as the dc bus voltage. With the advent of high performing Digital Signal Processors (DSPs), complex control algorithms like flux vector control are now feasible, enabling the use of Alternating Current (AC) motors for the same precise motor speed control

than DC motors. Conversely, an AC electric motor is less expensive than a DC motor because the primary winding are simply put into slots inside the stator laminations, and the secondary winding of a stator are made of metal bars that have been cast through into steel laminations which thus make up the rest of the rotor.An induction motor requires almost little maintenance because it has no brushes or other moving components save the rotor, at minimum in the cage form. As a result, in variable-speed situations, AC motors are gradually replacing DC machinery.

1.1.Digital Signal Processor(DSP):

Signals need to be processed before the information they hold may be seen, studied, or converted into another signaling type that could be helpful. Analog products in the real world perceive and alter signals such as sound, illumination, temperature, and tension. The real-world output is then transformed using analog-to-digital conversions into the digital format, which consists of 1s and 0s. The electronic information is subsequently gathered and processed by the DSP, which takes over. After then, the digital information is used in the real world.Another of the two ways it does this is either digitally or analogously, using a digital-to-analog converters. Everything happens rather rapidly. Through a receiver and perhaps other resources, analog audio is supplied into the recording process. This analog signal would then be converted into a digital signal through an analog-to-digital converter and transmitted towards the DSP.

The DSP also keeps the file in memory while doing the MP3 encoding. When a file is played again, it is taken from memory, decoded by the DSP, and afterwards converted yet again by the digital-to-analog converter (DSP) into an analogue signal so that it may be played out over the audio system.In a more complex scenario, the DSP would in fact function as that of the user interface and control volume. Data from a DSP may be used by computers to run functions including security, phone, home theater, and data compression. Signals can be condensed to move from one place to another more quickly and efficiently (e.g.during videoconferencing, voice and video can be transmitted through phone lines). Signals may also be boosted or modified to provide information which humans would perceive (e.g.Enhanced diagnostic imaging using a computer or echo cancelling on a smartphone). The analogue signal used in real-world telecommunication can be managed, but DSP provides the advantages of high speed and precision.

The present study focuses on the DSP is the ideal motor control system component that allows the creation of cutting-edge motor control systems. This research is characterized into several sections where the first is an introduction and the second section is a literature review and suggestions of previous studies in terms of designing of DSP based of alternative current (AC) motors drives system. Furthermore, the methodological section of this study is mentioned where the data is examined in the different sub-sections. After that, the results and discussion part are discussed where results are compared with the existing data followed by the methods applied in this research. Lastly, the conclusion of this research is declared where the research gives outcomes as well as future scopes.

2. LITERATURE REVIEW

Qiang Fei [15] et al. has permanent magnet synchronous motors (PMSMs) are frequently employed in the field of industrial servo controls, especially in high-precision applications. According to this study, integrating an MPC with just an angle-based ILC can improve PMSM drive systems performance by lowering torque ripple. While effectively minimizing periodic velocity fluctuation, the novel control approach that has been presented increases the speed reaction time. The results shown that the recommended technique is effective in

reducing speed ripple and improving control performance. Finally, it obtains a control sequence that is ideal for the upcoming situation and has strong parameter robustness and quick reaction.

Luzheng Bi [16] et al. have explained that a vital part of human-robot collaboration systems, the electromyography (EMG) signals is really a biological indication that is widely used to predict human motor intentions. Regression and classification methods have been the most often utilized in studies involving identifying motor intentions using EMG signals. The performance metrics necessary for system validation, the kinematic motion parameters derived from the EMG data, as well as the models and techniques utilized in continuous motion predictions are all presented.It showed how an automation process could be suitable doing repetitive and precise operations in organized contexts but might not be ideal for other jobs in unstructured situations that call for quick judgment, adaptability, and flexibility. In conclusion, the EMG is directly mapped towards the desired output goal whenever the direct estimating technique is utilized to estimate parameters.

Rogério Thomazella [17] et al. has explained how chatter may produce components that are outside of the geometric and dimensional limits or possibly result in irreparable harm, such as changes to the toughness and surface quality of the functional decomposition.The objective of this study is to present a novel vibration signal processing technique for chatter detection during transverse surface grinding with AISI 1045 steel with different grinding wheels. This technique is based on the ratio of power (ROP) statistic and the short-time Fourier transform (STFT). Applying the ROPSTFT to that same vibration monitoring, it was found that the frequencies associated with the chattering are multiple versions of that frequency so because harmonic components created by the rotational frequency of a sanding back wheel fluctuate as the chatter phenomenon develops. In conclusion, transformation coefficients that are not subject to these restrictions, such as the wavelet decomposition, can be used to compute the ROP.

A. Lotfy [18] et al. has explained that as the utilization of controller systems in industry has increased, optimization techniques have been used more recently to increase the accuracy and performance of these systems. The major emphasis is on using an enhanced genetic algorithm to regulate the ideal fuzzy controller settings in order to increase convergence speed and accuracy. To create fuzzy controllers as efficiently as possible, a pipeline methodology is offered that uses specialized methods to reduce the bit width needed.In contrast to previous fuzzy controllers, it showed that accurate performance, high fast convergence, and the like advantages in efficient implementations were possible. In conclusion, the effectiveness of the clock in some areas of the fuzzy controller is improved by the reasonable increase of equipment sources.

The above study shows the domain of industrial servo control, PMSMs are often utilized, particularly in high-precision applications. And also the EMG signal is a biological signal that is frequently utilized to anticipate human motor intentions, a crucial component of human-robot cooperation systems. In this research, author are develops of DSP based motor control system.

3. METHODOLOGY

3.1.Research Design:

In the research design develop of motor control system with help of digital signal processor in which modern motors such brushless DC motors, multilevel inverter AC motors, switching reluctance motors, and ultrasonic motors are made possible by the integration of motor control into contemporary design, motor manufacturing technologies, microelectronics,

including power systems. The modern motor is an electric motor with an electronic control component that naturally come together to form an inseparable whole, a system. Without the control circuit, the engine cannot operate by itself.People will naturally wish to control a few of these embedded motors. Motor Control: a mechanically motion control system that achieves exact position control, variable speed, accelerating control, torque control, and quantity of the controlled machinery integrated control using a specified control algorithm. A comprehensive motor controller is depicted in Figure 1 and consists of seven fundamental functional units.

The control loop even before channel contains three components in additional to a microprocessor with DSP cores: an interfacing unit, a control unit, and a motor position unit. For brushless DC motor drives, switched reluctance electric motor, and synchronous AC servo machine control rectangular waveform control aspects, angular position units are designed. They provide real-time transmission position of the rotor to start generating the proper position of commutation, the information necessary to establish a composite current feedback message, and also the information necessary again for biosynthetic pathways of analog motor speed voltage.The employment of speed and position sensor methods to produce system outer loop feedback path is known as a speed and position feedback module. An alarm signal is delivered to a DSP, or straight off the power output stage, by a self-protection device, which is a semiconductor device or motors temperatures, current, voltages, etc. to identify and monitoring, the fault judgment. To construct a circuit with many more cells and improved performance, the motor control microchip has more cells.

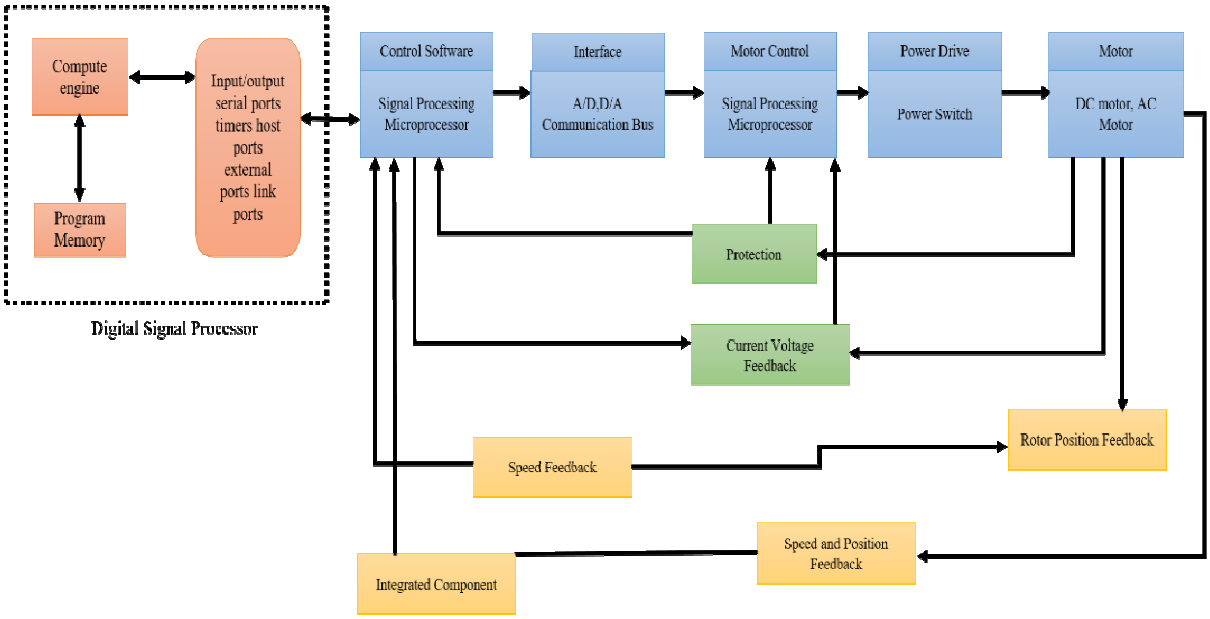

Figure 1: Illustrates the working process of Motor Control System with help of DSP.

3.2. Instrument:

In the segment taken the component of DSP based motor control system such as signal processing microprocessor, power switch, and speed sensor and so on.The term motor control refers to the integration of the technologies of motors, sensors, power electronics, microelectronics, automated control, and computer applications. A specialized motor control chip comes as a result of advancements in microprocessors other signal processors, providing motor motion control systems with intelligence and enabling integration. Establish a closed loop control of a motor, then motor control algorithms controlled mechanical motion, and

inputs the desired motion characteristics correspond with the fundamental principles used to control engine integration framework.

3.2.1. Signal Processing Microprocessor:

The processor is a straightforward chip or logic circuitry that controls the processing unit by responding to both input processes and simple commands. In electronic devices such as cellphones, embedded systems, laptops, workstations, etc., the CPU is a crucial component. Comparator and the control unit are a processor's two most important parts. Depending on the need, many types of processors, such as microcontrollers, microprocessors, DSP, embedded systems, etc., are available on the market. A digital signal processing unit is a particular kind of microprocessor made on integrated circuits made of metal oxide semiconductors. DSPs are widely utilized in a variety of applications, including voice recognition, audio signal processing, digital image processing as well as telecommunication.

3.2.2. Speed Sensor:

The shaft velocity and rotational direction are picked up by the speed sensor. The sensor measures speed from a revolving magnet within an AC and DC motors and is fitted to the terminal cover of the motor. The speed sensor works on the principle of variable reluctance permanent magnet detecting, which involves mounting a cylindrical magnetic materials core with such a coil wire wrapped around it to a stationary center carrier, axle crankcase, or back plate. This creates a magnetic field (flux) that overlaps the spinning exciter ring.To utilize the maximum capability of your tools, you must be able to manage the speed of their motors and machines. Giving yourself complete speed control will guarantee that you encounter little to no tool noise and consistently produce a flawless machined finish.

3.2.3. Power Switch:

An electrical connection from a ground or voltages supply to a load is made possible by a power switch. It conserves energy over several voltage rails and safeguards against harm to subsystems. Additionally, it reduces the size of printed circuit boards (PCBs) and offers increased component safety and inrush current protection. A switch which, when one motor has been switched off, is employed to lockout particular electrical current to make sure it has been totally de-energized. Not intended to stop the stream from flowing. The power circuit, as opposed to the control system, supplies the high levels of voltage and current needed by the motor itself.

3.2.4. Motor Controller:

The Motor Control is a comprehensive collection of tools, software architecture, and documentation created to speed up the creation of C2000 real-time controller-based motor control systems for a variety of three-phase motor control purposes. Devices called motor controllers govern how an electric motor operates. Motor controllers are typically utilized in artificial lift operations to regulate the functioning of the primary mover in combination with control panels or variable-frequency drives.

3.2.5. Software tool:

Extremely effective C compilers, made possible by 32-bit processors, let programmers produce compact object file and leaving optimization to the software program, leaving the engineer to concentrate on innovations rather than software design. Motor control developers can access a library of motor-specific programming collateral that's also freely downloaded through the Internet, spanning a variety of electric motors and both sensor fusion and sensor

less control mechanisms, to further speed the software design cycle. Modern integrated design environment make it simple and quick to program software for system-specific operations. The motor control DSP can operate at full speed thanks to real-time debugging, and the debugging environment collects data via the Debug interface to provide the target processor more visibility.

3.3.Data Collection:

In the segment motor control system with using DSP and their component such as speed, frequency, feedback, voltages, and number rotation per minutes (rpm) in Table 1.The motor operates at base speed, producing rated horsepower under the voltage and frequency specified. Base speed describes how quickly linked equipment will spin at suitable voltage and frequency whenever an output shaft is completely loaded.

Table 1: Illustrates the Component of motor and DSP with their Completes Specification.

S. No.	Component of AC Motor	Specification
1	Speed of Motor for (2/4 pole)	3600/1800 rpm
2	Frequency	50-60 Hz
3	variable Torque	1800/900 rpm
4	Voltages	220-240 volts
5	Current	26.8 amperes
6	Digital Signal Processor	TMS320C30

3.4. Data Analysis:

The control of an AC motor has a significant impact on its performance. DSP controllers make it possible to control without sensors and with improved real-time algorithms. Combining the two results in a system reducing costs by reducing the number of elements and improving silicon design.A strong processor, like a DSP controller, supports system cost reduction through effective control throughout all speed ranges, which implies proper sizing of power device circuitry. performs high-level algorithms because torque ripple is reduced, actually results in less vibration as well as a longer lifespan; allows for the decrease of harmonic currents utilizing improved algorithms; makes requirements simpler to meet; lowers the cost of filters; and eliminates the need for speed or position sensing devices by using sensor-less techniques.

4. RESULTS AND DISCUSSION

In many sophisticated control applications, the modeling of the electric motors with a proper power converters and both speed and position response has gained popularity. A numerically rigorous model of each of the components of the systems is required for the participants' design but also compensation system. Excitation coil permanent magnetic solenoid by power electronically controlled module memory capacitance discharge, finished the closing process, and a permanent magnet lock, is the ideal combination of electromagnetic processes and permanent magnet mechanisms, and necessitates force-trip functionalities as well as vacuum electrical systems really quite close together.More importantly, it greatly improves controllability, decentralizes control of time in microseconds from the original mechanical

device into an electrical impulses control microseconds advancement, from the mechanical energy storage, energy storage structural excursion progress, and from the mechanical trip signal directly trigger activity. It greatly reduces the transmission connections, improves the reliability of response times, accuracy, and having to run. It found that DSP performances for motor controls offers control algorithms. DSPs have had the speed capability to simultaneously monitor and operate the system. A dynamic management algorithm adjusts to changes in the system's behavior in real time.

The modern motor is an electric motor with an electronic control component that naturally unite to form an organically whole, a system. Without the controller, the motor is unable to operate on its own. People naturally want to manage some of these embedded motors. Motor Control to accomplish exact position and velocity, speed control, accelerating control, electromagnetic torque, and quantity of the controlled machinery embedded controller using a specified control algorithm and a controlled mechanical mobility control system.The term Motor Control refers to the integration of the technologies of motors, sensors, power electronics, microelectronics, automated control, and computer applications. Due to advancements in microprocessors and signal processors, specifically, specialized motor control chips have been developed, providing motor motion control systems with intelligence and enabling integrated action.

4.1. Application of DSP in Different Sector:

It serves as the brain of systems for digital signal processing. Special purpose microprocessors known as digital signal processors are designed to process real-time signals. These transmissions have unacceptable delays, such as when a computer controls a satellite. DSPs are currently increasingly common because of their programmability. It enables both hardware and software solutions to the issue, allowing the very same DSP chip to be utilized in a wide range of applications by simply altering the program that is stored in the DSP's memory locations (Figure 2).

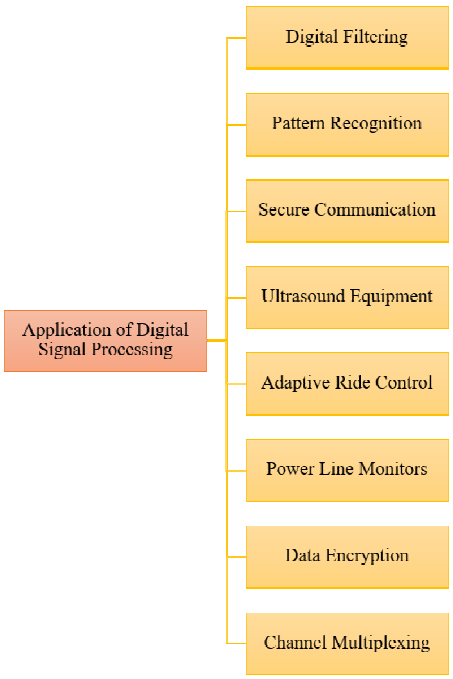

Figure 2: Illustrates the various application of digital signal processing in different sector.

5. CONCLUSION

A deformation detecting gadget, a controller, a separation device, a power amplifier, and a computer system make up the motor control scheme. A crucial component of the motor controlling system is the DSP controller, which is in charge of having to process the motor's displacement feedback signal and producing a control signal that directs the advancement of the motor. The motor is controlled by a DSP controller with an event management module that is especially suited for motor control and features a straightforward hardware and software architecture. The control software is essential for ensuring that the motor correctly performs the desired movement. The full control software, including the main program, the displacement motors for zero readjustment subroutine, multipurpose timer periodic interrupt subroutine, and serial interface communications techniques and subroutine.After the control program's design was complete, the paper performed tests to demonstrate the viability of the control program. The experiments drew motor sports throughout displacement and exercising time into the curve, which was then successfully controlled. Modern DSP-based three-phase ac motor control is still quite successful on the market, both in mature industrial automation industries as well as in more recent developing areas like household appliances, office automation, and automobiles. The management of time-sensitive activities, such as the production of Pulse width modulation or the real-time interfacing to rotor location transducers, is handled by specialized hardware units, which is necessary for the efficient and economical operation of these machinery.On the other hand, a DSP core's quick computational power makes it ideal for handling the entire control algorithm and computing new voltage instructions for the motors in software. Especially compared to earlier hardware methods, embedding the control method in software has all the benefits of simple updating, repeatability, and ease of maintenance.

REFERENCES

[1] C. Li and W. Hai, “Constructing multiwing attractors from a robust chaotic system with non-hyperbolic equilibrium points,” *Automatika*, 2018, doi: 10.1080/00051144.2018.1516273.

[2] A. Ardanuy and A. Comerón, “Compact lidar system using laser diode, binary continuous wave power modulation, and an avalanche photodiode-based receiver controlled by a digital signal processor,” *Opt. Eng.*, 2018, doi: 10.1117/1.oe.57.4.044104.

[3] A. HajiRassouliha, A. J. Taberner, M. P. Nash, and P. M. F. Nielsen, “Suitability of recent hardware accelerators (DSPs, FPGAs, and GPUs) for computer vision and image processing algorithms,” *Signal Process. Image Commun.*, 2018, doi: 10.1016/j.image.2018.07.007.

[4] T. E. Arijaje, S. O. Azi, A. Akinpelu, C. A. Onumejor, M. Omeje, and I. E. Ogunrinola, “Design and Construction of LED Matrix Display,” 2018. doi: 10.1088/1755-1315/173/1/012007.

[5] B. Li, X. Rui, F. Yang, and G. Wang, “Design and implementation of an adaptive Kalman filtering for the launcher of multiple launch rocket system,” *Int. J. Adapt. Control Signal Process.*, 2018, doi: 10.1002/acs.2853.

[6] L. Diao, J. Tang, P. C. Loh, S. Yin, L. Wang, and Z. Liu, “An Efficient DSP-FPGA-Based Implementation of Hybrid PWM for Electric Rail Traction Induction Motor Control,” *IEEE Trans. Power Electron.*, 2018, doi: 10.1109/TPEL.2017.2707639.

[7] B. Perach and S. Weiss, “SiMT-DSP: A massively multithreaded DSP architecture,” *IEEE Trans. Very Large Scale Integr. Syst.*, 2018, doi: 10.1109/TVLSI.2018.2817564.

[8] K. Berestizshevsky and S. Weiss, “Decoupled Branch Predictor for Embedded DSP,” *IEEE Embed. Syst. Lett.*, 2018, doi: 10.1109/LES.2017.2755062.

[9] M. Sahani and P. K. Dash, “Automatic Power Quality Events Recognition Based on Hilbert Huang Transform and Weighted Bidirectional Extreme Learning Machine,” *IEEE Trans. Ind. Informatics*, 2018, doi: 10.1109/TII.2018.2803042.

[10] R. Zhang, Y. Quan, C. Qian, L. Yang, Y. Li, and M. Xing, “Real-time implementation of inverse synthetic aperture radar imaging using field programmable gate array and digital signal processors,” *Rev. Sci. Instrum.*, 2018, doi: 10.1063/1.5025345.

[11] E. Pazouki, Y. Sozer, and J. A. De Abreu-Garcia, "Fault Diagnosis and Fault-Tolerant Control Operation of Nonisolated DC-DC Converters," 2018. doi: 10.1109/TIA.2017.2751547.

[12] J. Li, V. Choutko, and L. Xiao, "Single Event Upset Analysis: On-orbit performance of the Alpha Magnetic Spectrometer Digital Signal Processor Memory aboard the International Space Station," *Nucl. Instruments Methods Phys. Res. Sect. A Accel. Spectrometers, Detect. Assoc. Equip.*, 2018, doi: 10.1016/j.nima.2017.12.035.

[13] M. Puskaric, Z. Car, and N. Bulic, "Magnetic bearing control system based on PI and PID controllers," *Teh. Vjesn.*, 2018, doi: 10.17559/TV-20160726112308.

[14] A. M. Bozorgi and M. Farasat, "Improved Design and Space Vector Modulation of a Z-Source Ultrasparse Matrix Converter: Analysis, Implementation, and Performance Evaluation," *IEEE Trans. Ind. Appl.*, 2018, doi: 10.1109/TIA.2018.2816012.

[15] Q. Fei, Y. Deng, H. Li, J. Liu, and M. Shao, "Speed Ripple Minimization of Permanent Magnet Synchronous Motor Based on Model Predictive and Iterative Learning Controls," *IEEE Access*, vol. 7, pp. 31791–31800, 2019, doi: 10.1109/ACCESS.2019.2902888.

[16] L. Bi, A. Feleke, and C. Guan, "A review on EMG-based motor intention prediction of continuous human upper limb motion for human-robot collaboration," *Biomed. Signal Process. Control*, vol. 51, pp. 113–127, 2019, doi: 10.1016/j.bspc.2019.02.011.

[17] R. Thomazella, W. N. Lopes, P. R. Aguiar, F. A. Alexandre, A. A. Fiocchi, and E. C. Bianchi, "Digital signal processing for self-vibration monitoring in grinding: A new approach based on the time-frequency analysis of vibration signals," *Meas. J. Int. Meas. Confed.*, vol. 145, pp. 71–83, 2019, doi: 10.1016/j.measurement.2019.05.079.

[18] A. Lotfy, M. Kaveh, M. R. Mosavi, and A. R. Rahmati, "An enhanced fuzzy controller based on improved genetic algorithm for speed control of DC motors," *Analog Integr. Circuits Signal Process.*, vol. 105, no. 2, pp. 141–155, 2020, doi: 10.1007/s10470-020-01599-9.

CHAPTER 16

IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN POWER STATION

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ABSTRACT: ***In contrast to the natural intelligence shown by people and animals, artificial intelligence is the intelligence demonstrated by robots. Global difficulties in the energy industry include increasing consumption, efficiency, shifting supply and demand patterns, and a lack of analytics necessary for effective management. In developing market countries, these problems are more serious. The goal of this paper is to highlight the key artificial intelligence (AI) technologies utilized in the power system where conventional approaches will not be able to catch up with all operating and dispatching conditions. In addition, a short explanation of each technology discussed in the chapter's application of the power system is provided. For resolving various issues in power systems, such as control, planning, scheduling, forecasting, etc., AI approaches have gained popularity. Modern huge power networks with even more interconnections developed to accommodate rising load demand may use these strategies to handle challenging jobs. Many aspects of power system engineering have benefited from the use of these methodologies.***

KEYWORDS: ***Artificial Intelligence, Fuzzy Logic, Power Station, Power Systems, Thermal Power.***

1. INTRODUCTION

An electric power system is a collection of electrical parts used to generate, transfer, and consume electricity. Power systems engineering is a branch of electrical engineering that focuses on the production, transmission, distribution, and use of electric power as well as the electrical components related to such systems, such as transformers, motors, and generators. The intelligence shown by machines and software, such as robots and computer programs, is sometimes referred to as artificial intelligence [1]. The phrase is often used to a project that involves creating systems that have human-like cognitive abilities, such as the capacity to reason, locate meaning, generalize, discriminate, learn from the past, and correct errors. A hypothetical machine or computer with artificial general intelligence (AGI) is intelligent if it can effectively complete any intellectual task that a human being [2].

Due to the ever-increasing energy consumption and the expansion of the present electrical transmission networks and lines, the contemporary power system functions near to its limitations. It is important to continually examine the system states in a much more detailed way than previously necessary in order to operate the power system and control system with less conservatism in this condition [3]. Power system planning, operation, diagnostics, and design are now tough challenges that must be solved using sophisticated computer technologies. Among these computer technologies, artificial intelligence has been more popular recently and has been used in a variety of power system applications.

Artificial intelligence (AI) has the ability to improve power system operation, maintenance, control, planning, and plan execution, as well as reduce energy waste, decrease costs, and hasten the adoption of clean renewable energy sources in power grids worldwide. AI is so strongly related to the economical, clean, and renewable energy needed for development [4]. If properly implemented, the introduction of AI-managed smart grids will have a positive impact on the electricity industry. Additionally, AI puts the client back in the spotlight by linking electricity producers, grid managers, and end users so that they may all be linked and better serviced. Additionally, it must be noted that AI is used to lessen the environmental

effects of thermal power plants, enhance their functionality, and allow them to function more effectively in terms of sending electricity to the grid [5].

Electrical grids that enable two-way communication between utilities and customers are powered by AI. Smart grids have an information layer incorporated in them that enables communication between its many parts so they can react more quickly to changes in energy consumption or emergency circumstances [6]. Data gathering, archiving, and analysis are made possible by this information layer, which was made possible by the widespread installation of smart meters and sensors. Machine learning, the Internet of Things, and other approaches are ideally suited for their analysis and usage given the size and variety of these data sets [7]. This analysis may be utilized for a number of things, such as accurate fault finding in meters, predicting the need for maintenance, monitoring the quality of sustainable energy, forecasting renewable energy, and using the most recent developments in ICT (ICT).

The use of AI, data analytics, the Internet of Things (IoT), and other technologies that enable connection between computer devices has already begun in the electricity industry in industrialized nations. These batteries are used to store excess solar or wind energy during periods of low energy demand [8]. AI can thereby increase the dependability of solar and wind energy by analyzing vast volumes of meteorological data pertaining to sun intensity and utilizing this data to forecast and decide when to collect, store, and distribute wind or solar energy. Additionally, AI is included into smart grids to assist in balancing the grid's energy supply. In order to lessen grid congestion and energy curtailment, this technology examines the system both before and after absorbing intermittent units.

Customers may immediately communicate with their control systems, such as thermostats, etc., to monitor their energy use, thanks to smart devices like Amazon Alexa and Google Home. Additionally, consumer electronics and energy management will enable autonomous home meters to apply AI to optimize energy storage and consumption. In order to identify any inefficiencies or lack of transparency, this technology may also be utilized to notice disparities in consumption patterns, if any, the consumer's payment history, and other data [9]. Additionally, it might aid in the efficiency of pricey and time-consuming physical examinations. The consumer will experience reduced bureaucracy, inaccuracies from manual data input, and red tape. The industrial internet of things (IIoT), a new technology that builds on and broadens the effects of digital technology, was created in response to the requirement for connectivity.

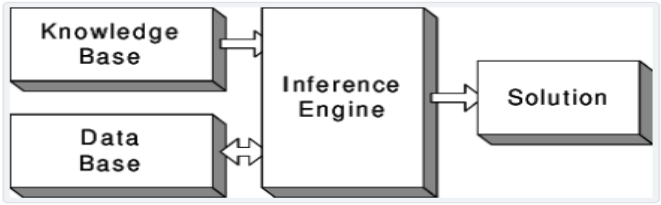

Figure 1: Illustrate the connection between the artificial intelligence and power station [10]**.**

Figure 1 illustrates how an expert system converts the knowledge of a human expert in a narrowly defined topic into a machine implementable form. Expert systems are computer programs that are knowledgeable and skilled in a certain topic. The procedural portion of the program's knowledge is often saved independently, and it may be stored in a variety of ways, including rules, decision trees, models, and frames [11]. They are also known as rule-based or knowledge-based systems. Expert systems employ knowledge and interaction mechanisms to tackle issues that are beyond the scope of human intelligence and expertise. Many power

system applications mirror the capabilities of expert systems in areas including decision-making, knowledge archiving, and problem-solving using logic, heuristics, and judgment. Expert systems are particularly helpful for these issues when a lot of data and information has to be handled quickly [12].

Applications of AI in the Power Industry Along with real-time maintenance and the determination of optimum maintenance plans, fault prediction has been one of the principal uses of artificial intelligence in the energy industry. AI with the right sensors may be helpful to monitor equipment and discover faults before they happen in a sector where equipment failure is widespread and can have serious repercussions [13]. This can help to save resources, money, time, and lives. In order to support the spread of less dependable renewables, geothermal energy, which produces consistent energy production, is being considered as a possible source of baseload power (the bare minimum required to be provided to the electrical grid at any given moment).

The effectiveness and dependability of geothermal power plants have been improved via the application of IoT and AI, according to study by Toshiba ESS. For instance, issues that might possibly cause plants to shut down are predicted using predictive diagnostics, which are made possible by rich data. Using IoT and AI, preventive measures like chemical agent sprays to prevent turbine shutdowns are improved in terms of amount, composition, and time. In a nation like Japan, which has the third-largest geothermal resources in the world, such advancements are crucial, particularly in light of the falling prices of rival renewable sources like solar electricity [14].

Automation in the workplace and at home is increasingly influenced by AI. Every year, more research is done on power systems, and AI is increasingly being used to make them smarter. Power systems are influenced by geographic, meteorological, and other variables. The introduction of new technologies, changes in technology, the transmission and distribution of energy, and other elements are all important to the operation of the electric grid. Every nation and state needs power, thus if energy is required, it must be delivered in a reliable, dependable, or pleasant way [15]. Electrical power systems, electronics, industrial applications and instruments, and construction are just a few of the industries where machine learning is becoming more prevalent and will likely continue to do so. AI is playing a bigger role in daily life, including automation in the home and workplace.

Every year, more research is conducted on power systems, and now, AI is being utilized to make power systems smarter. Power systems are determined by geography, climate, or any other local factors. The adoption of new technologies, the updating and modifying of equipment and technology, the transmission and distribution of energy, and other elements are also important to the power system [16]. Consistency, which was only established using discrete techniques, particularly outdated ways of ML in the power system not being able to satisfy this same possibility of essential loads study and the cost analysis, is the key component of power distribution planning and design described in this work. The expenses of upkeep and operation may rise as a consequence of ML, often known as AI. Huge truly understand this, a ton of study has to be done.

2. DISCUSSION

Artificial intelligence has emerged as one of the most cutting-edge technologies used in a variety of fields in the twenty-first century. The United Arab Emirates was the first nation in the region and the whole globe to introduce an AI strategy, proving that the Federal Government's strategic goals would inevitably include AI. AI has been included into the development plans of many nations, including China, the USA, the UK, and France. The

primary driver for AI adoption is the integration of several industries, including healthcare, energy and renewable energy, finance, water, education, and the environment [17]. The present chapter explores the many elements of AI in power systems. Because the currently used conventional procedures do not contribute to accurate findings or accurately portray the system's actual state. Artificial intelligence is the exhibition of intellectual processes and the capacity for reasoning and thinking as in humans via the use of computers and software development systems. The production, transmission, distribution, and use of electrical power as well as a variety of electrical equipment are all covered under power system engineering. The introduction of renewable energy sources makes it challenging for established methodologies, due to their complexity, to portray various situations. For its calculation, diagnosis, and learning, power system analysis requires the handling of a complex, diverse, and sizable quantity of data. Computers and other advanced technologies make it possible to manage the challenging problems associated with power system planning, operation, design, and troubleshooting [18]. From this point forward, AI helps manage the complex and enormous data handling system and provides an accurate and timely report to help make the best option for addressing power system challenges and improving power systems.

2.1.Power Systems:

A network of electrical devices used to provide, transfer, and utilise electric power makes up an electric power system. Electrical engineering's subfield of power systems engineering deals with the production, distribution, and use of electricity as well as the electrical equipment attached to such systems, such as motors, generators, and transformers [19].

2.2.Artificial Intelligence:

Artificial intelligence is often understood to be the intelligence shown by machines and software, such as robots and computer programs. The phrase is often used when discussing the creation of systems that have the mental faculties and traits that separate humans from other animals, such as the capacity to reason, generalize, make distinctions, draw lessons from the past, and correct errors. In general, it refers to devices or software that have the capacity to make judgments independently of their operator.

2.3.A Power Station:

An industrial facility for the production of electricity is also known as a generating station, power plant, powerhouse, or generating plant. The majority of power plants include one or more generators, which are revolving machines that transform mechanical energy into electrical energy. An electrical current is produced by the movement of a conductor in relation to a magnetic field. The majority of power plants throughout the globe produce electricity by burning fossil fuels including coal, oil, and natural gas [20]. While some still utilize nuclear power, more and more people are turning to cleaner renewable energy sources including solar, wind, wave, and hydroelectric power. A network of electrical devices used to provide, transfer, and utilise electric power makes up an electric power system. There are three different kinds of large power plants that are recognized for producing a lot of electricity: a. thermal power plants; b. hydro power plants and Nuclear power facilities.

2.3.1. Thermal Power Plants:

A power plant that converts heat energy into electric power is called a thermal power station. The turbine is steam-driven in the majority of locations across the globe. Steam is created when water is heated, and the steam turbine it spins then powers an electrical generator. The steam is returned to where it was heated after passing through the turbine and condensing in a

condenser; this process is known as a Rankines cycle [21]. In addition to producing electricity, thermal power plants are also built to create heat energy for desalination of water and district heating, as illustrated in Figure 2. Efforts to decrease CO2 emissions from fossil fuel power plants, which account for a significant portion of all human-made CO2 emissions to the atmosphere, are many and diverse.

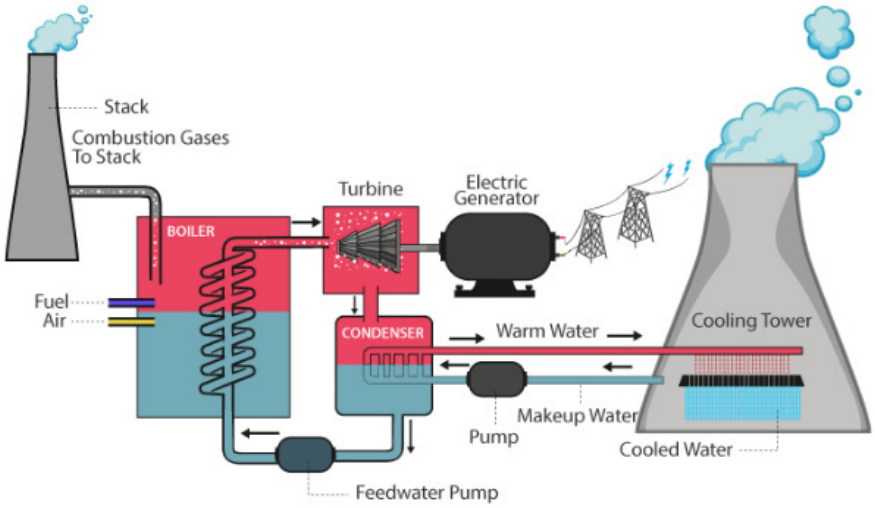

Figure 2: Illustrate the processing of the Thermal Power Plants [22]**.**

2.3.2. Hydro Power Plant:

Hydropower, often known as waterpower, is energy that comes from falling water or quickly moving water that may be used for productive purposes. In a hydroelectric power plant, we utilize the flowing water's gravitational pull to drive a turbine that is connected to an electric generator to generate energy. Due to the usage of water, a sustainable form of energy, to create electricity, this power plant is crucial in safeguarding our finite supply of fossil fuel. A massive turbine's blades are spun by the force of the water being forced from the reservoir through the dam. The generator that generates power while the turbine rotates is attached to it. The water then flows back into the river on the other side of the dam, as seen in Figure 3, after passing through the turbine.

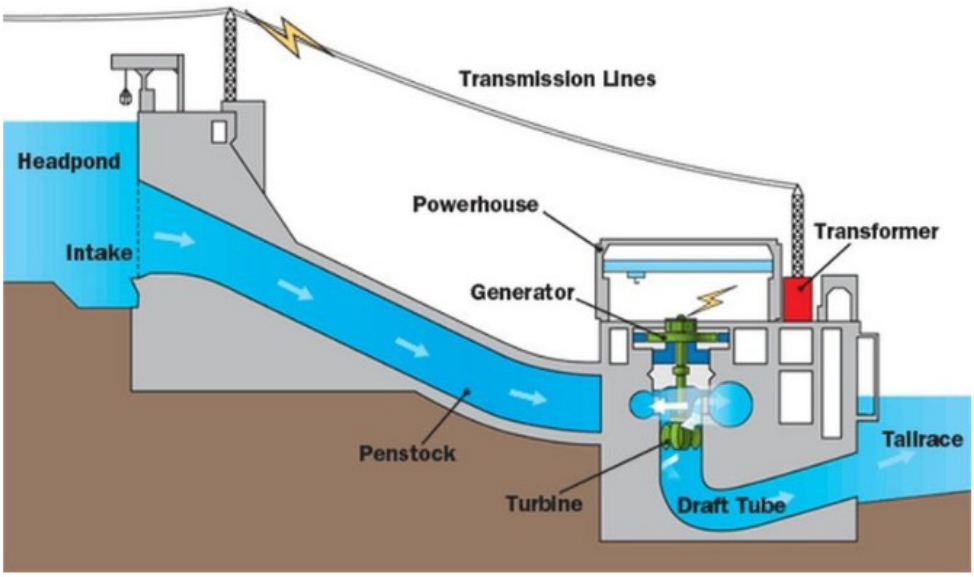

Figure 3:Illustrate the processing of the Hydro Power Plant [23]**.**

2.3.3. Nuclear Power Plant:

A nuclear power plant is a thermal power plant where a nuclear reactor serves as the heat source. Nuclear power stations generate electricity by heating water to create steam, much as plants that burn coal, oil, and natural gas. After that, the steam drives turbines to generate power. Like in typical thermal power plants, the conversion of energy to electrical energy happens indirectly. In a nuclear reactor, the fission causes the reactor coolant to heat up. Depending on the kind of reactor, the coolant might be liquid metal, gas, or even water. The steam generator subsequently receives the reactor coolant, which warms water to create steam. The multistage steam turbine is typically supplied the pressured steam after that. The leftover vapour is condensed in a condenser after the steam turbine has expanded and partly condensed the steam. A secondary side, such as a river or a cooling tower, is linked to the condenser, which is a heat exchanger. The cycle then restarts with the water being pushed back into the steam generator. The Rankine cycle seen in Figure 4 and the water-steam cycle are equivalent.

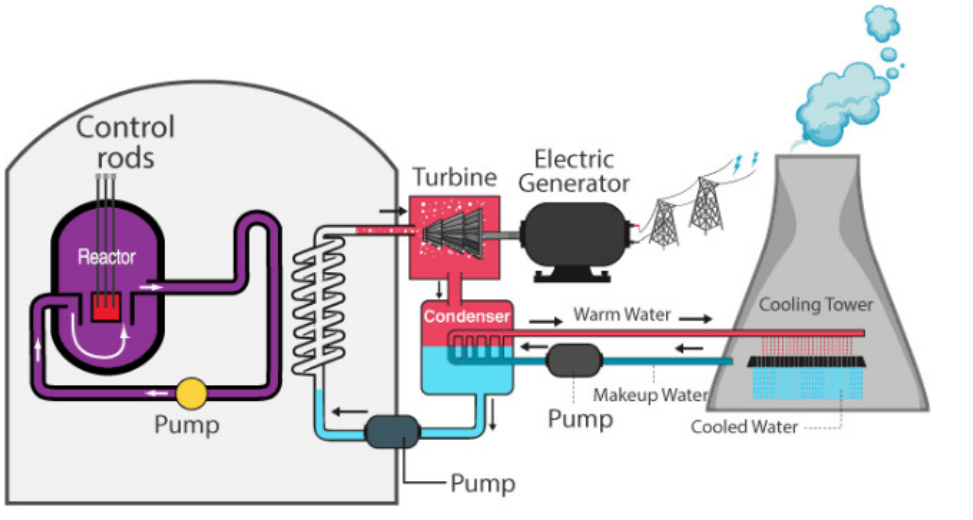

Figure 4:Illustrate the processing of the Nuclear Power Plant [24]**.**

As clean, affordable, and dependable energy is crucial to growth, the application of AI in the power industry is now expanding to developing nations, where it might have a significant influence. By imparting power industry expertise to AI software businesses, the problems may eventually be solved. When appropriately constructed, AI systems may be especially helpful in automating repetitive and organized operations, freeing up people to address tomorrow's power concerns. Energy availability is fundamental to development. Therefore, a significant barrier to growth that affects livelihoods, gender equality, health, education, food security, and poverty reduction is the absence of access to electricity, which affects one billion people, especially in Sub-Saharan Africa and South Asia. One of the Sustainable Development Goals is for everyone to have access to cheap, dependable, and sustainable modern energy (SDGs).

But unless new ideas and cutting-edge technology can get through the many energy-related challenges that afflict developing nations, from a lack of adequate power production to subpar transmission and distribution infrastructure to cost and environmental issues, it will remain simply a goal. Additionally, complicated problems for power generation, transmission, distribution, and consumption in all countries are brought about by the diversification and decentralization of energy production, the introduction of new technologies, and shifting demand patterns. The adoption of clean, renewable energy sources

in power systems throughout the globe might be facilitated and accelerated with the help of artificial intelligence (AI), which also has the potential to reduce energy waste and costs. Power system planning, management, and control may all be enhanced by AI. Thus, the capacity to offer clean, affordable energy that is necessary for development is intimately related to AI technology.

2.4.Artificial Intelligence Techniques:

Artificial Neural Networks: Artificial Neural Networks are thought-process-inspired systems that use a network of neurons to transform a collection of inputs into a set of outputs. As a result of inputs, each neuron generates a single output. When the requirement for pattern categorization and pattern recognition emerges in real-world applications, these systems are utilized.

Application in Power Systems: They are useful for finding answers to issues appearing in power production, distribution, and transmission since they are built to conduct biologically based evaluation of problems as a result of their fundamental architecture. ANN's may find a solution based on the limitations of a realistic transmission system, taking into consideration elements like environmental conditions and other unbalancing aspects.

Fuzzy Logic: Fuzzy systems, often known as fuzzy logic, are logical frameworks for formalizing and standardizing approximative reasoning. With the capacity to generate precise answers from specific or even approximative knowledge and data, it is comparable to human decision-making. Fuzzy logic uses reasoning that is comparable to human thinking. The way the human brain functions is via fuzzy logic, allowing us to employ this technology in robots to make them function something like humans. Fuzzification improves the capacity to represent complicated issues at low or moderate solution costs by enhancing expressive power, generality, and modeling capabilities. Fuzzy logic permits a certain degree of ambiguity during an analysis. Fuzzy logic is helpful in many applications since this ambiguity may describe the information that is accessible and reduce the complexity of the task. Fuzzy logic is appropriate for use in many aspects of power systems when there is ambiguity in the available information.

Application in Power Systems: It is possible to employ fuzzy logic while developing the actual parts of power systems. They can be applied to anything, including tiny circuits and enormous mainframes. They may be used to boost the effectiveness of the parts used in power systems. Due to the fact that most of the data utilized in power system analysis are approximations and assumptions, fuzzy logic may be very helpful in producing results that are reliable, precise, and devoid of ambiguity.

Expert Systems: An expert system converts a human expert's knowledge in a specific, constrained field into a form that can be used by machines. Expert systems are computer programs that are knowledgeable and skilled in a certain topic. The procedural portion of the program's knowledge is often saved independently, and it may be stored in a variety of ways, including rules, decision trees, models, and frames. They are also known as rule-based or knowledge-based systems. Expert systems employ knowledge and interface mechanisms to address issues that are beyond the scope of human intelligence and expertise.

Applications in power systems: Writing the codes for expert systems is easier than actually calculating and predicting the value of parameters used in generation, transmission, and distribution since expert systems are essentially computer programs. Being computer programs, any changes may be made with ease, even after the design has been completed. Virtually, these quantities may be estimated, and more study can be done on density B or

magnetic field strength, which is represented by the symbol 0H, to improve the process' efficiency. When separating compound units, such as "A•m2," use the middle dot.”With the introduction of technologies like AI-managed smart grids, the future of the power industry seems bright. These are electrical networks that enable utility and customer interaction in both directions. Smart grids have an information layer incorporated in them that enables communication between its many parts so they can react more quickly to changes in energy consumption or emergency circumstances. Data gathering, archiving, and analysis are made possible by this information layer, which was made possible by the widespread installation of smart meters and sensors. Synchrophasors, also known as phasor measuring units (PMUs), are another crucial component of the contemporary smart grid. They make it possible to measure and align data in real time from various distant spots on the grid. Better grid management is made possible by the creation of a current, accurate, and integrated picture of the complete power system. These smart-grid components, when combined with robust data analytics, have enhanced the dependability, security, and effectiveness of energy transmission and distribution networks.

AI methods like machine learning are best suited for their analysis and usage due to the enormous amount and varied structures of such data. Numerous uses for this data analysis include defect detection, preventive maintenance, power quality monitoring, and forecasting of renewable energy sources. Smart metering has become more common because to advancements in information and communications technology (ICT), cloud computing, big data analytics, and artificial intelligence. Smart meters are widely used, and sophisticated sensor technology has resulted in the quick generation of enormous volumes of data. New techniques for data storage, transport, and analysis are required. For illustrative purposes, one million smart meters put in a smart grid would produce over 35 billion data at a sampling rate of four times per hour. 8 Although EM countries have not yet adopted smart grids to the same extent as developed economies, a few of EM nations have started the process. These include, among others, Brazil, China, nations of the Gulf Cooperation Council (GCC), Malaysia, South Africa, Thailand, and Vietnam.

2.5.Current Application Of Ai In Power Systems:

Many issues in power systems cannot be resolved using traditional methods since they depend on conditions that aren't always attainable. Artificial intelligence approaches are the sole and apparent solution under these circumstances. Application areas for AI in power systems include:

i. Human employees have long been replaced by machines for hazardous and highly specialized tasks, such as live maintenance of high-voltage transmission lines.
ii. Access to cramped areas like cable viaducts and cooling pipelines, operation in risky conditions like radioactive places in nuclear reactors, and accurate placement of measuring equipment.
iii. Expert systems use the interface mechanism and knowledge to address issues that are either too complex or impossible for human ability and intelligence to address.

3. CONCLUSION

This paper goal is to showcase the key artificial intelligence (AI) technologies that are employed in the power system to handle operational and dispatching tasks when conventional approaches fall short. Additionally, a short summary of each technology covered in the chapter along with its precise application of the power system is provided. Additionally, by regulating voltage, stability, power flow, and load frequency, these techniques enhance the

efficiency and productivity of the power system. Additionally, it enables network control over things like size, location, and device and equipment management. The automation of the power system makes sure to enable network security, management, and problem diagnostics. To employ AI for planning, monitoring, and control of the power system, the right AI approach must be found. The paper will conclude by briefly highlighting the sustainable aspects of employing AI in power systems which helps for better understanding related to AI.

REFERENCES

[1] H. Yousuf, A. Y. Zainal, M. Alshurideh, and S. A. Salloum, *Artificial intelligence models in power system analysis*, vol. 912. Springer International Publishing, 2021. doi: 10.1007/978-3-030-51920-9_12.

[2] B. Makala and T. Bakovic, "Artificial Intelligence in the Power Sector," *Int. Financ. Corp.*, pp. 1–8, 2020.

[3] R. P. Nath and V. N. Balaji, "Artificial Intelligence in Power Systems," *Int. J. Recent Trends Eng. Res.*, vol. 4, no. 4, pp. 262–267, 2018, doi: 10.23883/ijrter.2018.4234.eywih.

[4] S. K. Dash and M. N. Mohanty, "Adopting artificial intelligence in power stations," *Int. J. Psychosoc. Rehabil.*, 2019, doi: 10.37200/IJPR/V23I5/PR190587.

[5] M. Goel, "Artificial Intelligence in Power Station," *Int. J. Res. Appl. Sci. Eng. Technol.*, 2019, doi: 10.22214/ijraset.2019.5518.

[6] A. Kumar D R and M. Mohan B M, "Artificial Intelligence in Power Station," *Int. J. Eng. Tech. Res.*, 2016.

[7] M. Dabbaghjamanesh, A. Moeini, and A. Kavousi-Fard, "Reinforcement Learning-Based Load Forecasting of Electric Vehicle Charging Station Using Q-Learning Technique," *IEEE Trans. Ind. Informatics*, 2021, doi: 10.1109/TII.2020.2990397.

[8] W. jing Niu, Z. kai Feng, B. fei Feng, Y. shan Xu, and Y. wu Min, "Parallel computing and swarm intelligence based artificial intelligence model for multi-step-ahead hydrological time series prediction," *Sustain. Cities Soc.*, 2021, doi: 10.1016/j.scs.2020.102686.

[9] H. Sharadga, S. Hajimirza, and R. S. Balog, "Time series forecasting of solar power generation for large-scale photovoltaic plants," *Renew. Energy*, 2020, doi: 10.1016/j.renene.2019.12.131.

[10] A. Khosravi, M. Malekan, J. J. G. Pabon, X. Zhao, and M. E. H. Assad, "Design parameter modelling of solar power tower system using adaptive neuro-fuzzy inference system optimized with a combination of genetic algorithm and teaching learning-based optimization algorithm," *J. Clean. Prod.*, 2020, doi: 10.1016/j.jclepro.2019.118904.

[11] N. Aggarwal, "Study of Artificial Intelligence and its Applications," *Int. J. Res. Appl. Sci. Eng. Technol.*, 2019, doi: 10.22214/ijraset.2019.4620.

[12] H. Yu and G. Shao, "Artificial Intelligence Control for Reactive Power of Electric Drive System of Pump Station," in *Proceedings - 2nd International Conference on Computer Network, Electronic and Automation, ICCNEA 2019*, 2019. doi: 10.1109/ICCNEA.2019.00103.

[13] T. Shi, D. Hu, X. Ren, Z. Huang, Y. Zhang, and J. Yang, "Investigation on the Lightning Location and Warning System Using Artificial Intelligence," *J. Sensors*, 2021, doi: 10.1155/2021/6108223.

[14] Y. Wang, B. Seo, B. Wang, N. Zamel, K. Jiao, and X. C. Adroher, "Fundamentals, materials, and machine learning of polymer electrolyte membrane fuel cell technology," *Energy and AI*. 2020. doi: 10.1016/j.egyai.2020.100014.

[15] D. Ghosh, M. A. Bin Muslim, J. Ajay Daniel, and V. N. Ganesh, "Integration of renewable resources for electric vehicles and implementation of artificial intelligence," *Int. J. Recent Technol. Eng.*, 2019.

[16] Y. Jin, Y. Ying, J. Li, and H. Zhou, "Gas path fault diagnosis of gas turbine engine based on knowledge data-driven artificial intelligence algorithm," *IEEE Access*, 2021, doi: 10.1109/ACCESS.2021.3101647.

[17] O. Feddaoui, R. Toufouti, D. Labed, and S. Meziane, "Control of an Isolated Microgrid Including Renewable Energy Resources," *Serbian J. Electr. Eng.*, 2020, doi: 10.2298/SJEE2003297F.

[18] D. B. De Alencar, C. De Mattos Affonso, R. C. L. De Oliveira, J. L. M. Rodríguez, J. C. Leite, and J. C. R. Filho, "Different Models for Forecasting Wind Power Generation: Case Study," *Energies*, 2017, doi: 10.3390/en10121976.

[19] T. Mahmoud, Z. Y. Dong, and J. Ma, "Advanced method for short□term wind power prediction with multiple observation points using extreme learning machines," *J. Eng.*, 2018, doi: 10.1049/joe.2017.0338.

[20] J. Wright, "Suspect AI: Vibraimage, Emotion Recognition Technology and Algorithmic Opacity," *Sci. Technol. Soc.*, 2021, doi: 10.1177/09717218211003411.

[21] C. Chen, J. Mao, X. Liu, S. Tian, and L. Song, "Modelling and combustion optimization of coal-fired heating boiler based on thermal network," *Therm. Sci.*, 2021, doi: 10.2298/TSCI2104133C.

[22] A. Sahragard, H. Falaghi, M. Farhadi, A. Mosavi, and A. Estebsari, "Generation expansion planning in the presence of wind power plants using a genetic algorithm model," *Electron.*, 2020, doi: 10.3390/electronics9071143.

[23] X. Xu, Q. Chen, M. Ren, L. Cheng, and J. Xie, "Combustion optimization for coal fired power plant boilers based on improved distributed ELM and distributed PSO," *Energies*, 2019, doi: 10.3390/en12061036.

[24] P. S. G. de Mattos Neto, J. F. L. de Oliveira, D. S. de Oliveira Santos Júnior, H. V. Siqueira, M. H. da Nóbrega Marinho, and F. Madeiro, "A hybrid nonlinear combination system for monthly wind speed forecasting," *IEEE Access*, 2020, doi: 10.1109/ACCESS.2020.3032070.

CHAPTER 17

ARTIFICIAL NEURAL NETWORKS (ANN) IN PROCESS CONTROL

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ABSTRACT: ***An artificial neural network (ANN) generally consists of hundreds to millions of units, also known as artificial neurons, organized in a hierarchy of layers. To make sense of the data it is fed, ANN utilize a variety of mathematical processing levels The problem due lack of process control in industry such aspoor quality, a high return ratio, a higher failure rate, and process management problems all occur together. Hence the author focuses on the implementation of ANN in process control of industry whichprovides help in maintaining productivity, yield, quality, and energy efficiency, as well as ensuring that working procedures are carried out securely and profitably. In this paper author discuss the topology of neural network, and process modelling with ANN. It concludes that,the strength of ANN lies in its capacity to estimate any arbitrary function mechanism using data input to the networks. In the future,more technical fields are discovering uses for neural networks. The majority of the first applications will found in the fields of modeling and pattern recognition.***

KEYWORDS:*Artificial Neutral Networks, Learning, Model, Neurons, Process Control,*

1. INTRODUCTION

In order to simulate how the human brain functions, artificial neural networks (ANNs),a form of artificial intelligence and a method for interpreting communication were created. It is made up of several, intricately intertwined processing units, known as neurons that cooperate to address certain issues. [1], [2]. The weights and architecture of the connections determine the performance. The training process is a type of learning that modifies the human mind for a certain function, such as data categorization or pattern recognition [3], [4]. Neuronal connections are changed as a result of learning[1],[2]. Neural networks (NN) can vary in terms of how their neurons are linked, the precise calculations they do, how they communicate activity patterns all through the network, and how quickly they learn.

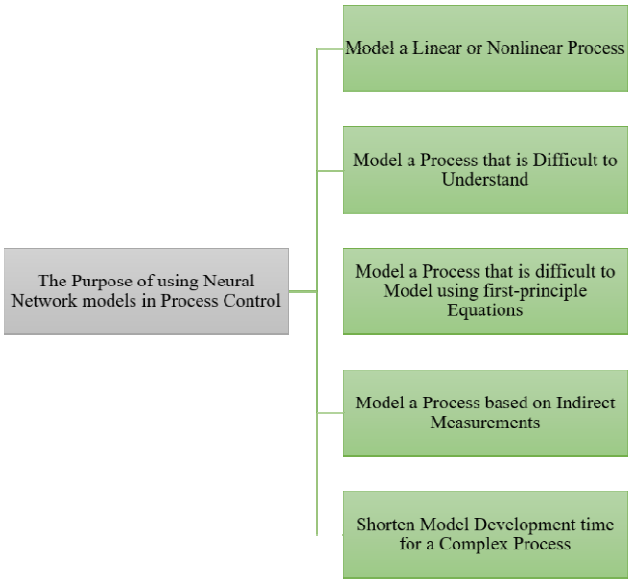

Figure 1: Illustrates the Purpose of using Neural Network models in Process Control [3]**.**

ANNs have been used to solve a growing number of challenging real-world situations [7], [8]. Their greatest strength is in tackling issues that are too difficult for traditional technologies, issues for which there is no algorithm answer or one that is too sophisticated to be found [4],[5]. The ANNs can recognize patterns and signal properties even when there are noisy signals present. They can also learn from a limited number of unusual events and generalization their findings. ANNs can represent nonlinear systems because they are intrinsically nonlinear. The purpose of using neural network models stem from their ability to in Figure 1.

The present paper is a study about the ANN network to process control in many industry. This study is divided into several sections, the first of which is an introduction, followed by a review of the literature and suggestions based on previous research. The next section is the discussion and the last section is the conclusion of this paper which is declared and gives the result as well as the future scope.

2. LITERATURE REVIEW

Guangyu Robert Yang and Xiao-Jing Wang [6] has explained how ANNs are crucial machine learning technologies that are receiving more and more attention in the field of neuroscience. The author explains how to adapt the analysis, architecture, and learning of ANNs to better handle a variety of difficulties in brain research with an emphasis on bringing this mathematical formulation closer to neurobiology. The author of that instructional primer introduces ANNs and shows how they have been successfully used to investigate neuroscientific issues. It was found that machine learning may be used to analyze the massive amounts of large data generated by innovative neuro technology in the areas of brain connect omics, transcriptomic, and neurophysiology. Finally, it may be said that ANNs are a popular type of model system within neuroscience.

Naceureddine Bekkari and Aziez Zeddouri [7] has explained how modeling wastewater treatment plants (WWTP) is a crucial tool for regulating a process's functioning and forecasting how well it would work in the presence of significant influent changes. The main aim to anticipate the wastewater Biological Oxygen Demand performances of Touggourt WWTP more than a ten-month period using an ANN approach with feed-forward back-propagation (CODeff). It is required to build the assessment method of water quality criteria in order to produce any functional evaluation for water resources planning or management. An architectural networks, hyperbolic sigmoid tangent activating parameters at the hidden layer, linear activation parameters at the output layer, and the Levenberg-Marquardt technique as the supervised learning produced the best results. In conclusion, the ANN modeling technique can offer a useful tool for simulating, regulating, and forecasting WWTP performance.

Mahmoud I. Awad [8] et al. have explained a response function or profiles of interest is used to characterize a system's typical behavior, and fault diagnosis is the discovery of any divergence from that normal behavior. In that study, a data-driven method based on multidimensional statistical process control and ANN characterization is presented for fault identification in complex systems. In that method, a system's quality is assessed based on how well one interpretivist approach can be described using an ANN model in relation to the other variables. It was observed that Hotelling T2 control charts were used to track the ANN model's vectors of weights and biases. Finally, it allows decision-makers lead flexibility and time to control structural system circumstances, giving them a considerable competitive and financial edge.

Joseph C. Chen et al. have explained how thermoplastic items with complicated geometry and close dimensional accuracy are frequently mass-produced via injection molding.With the assistance of in-mold temperatures and pressure transducers, the author has created an ANN-based continuous fault detection method. Both the multilinear linear regression (MLR) and ANN procedures was created using real-time data, despite the fact that the ANN model outperformed significantly better than the Logistic regression. The ANN approach improves accuracy of roughly 98.34% and a considerable determination coefficient (R2) around 91.37%. Finally, various quality features of injection moldings may be simply modified for the ANN-based continuous fault detection system.

Oludare Isaac Abiodun [9] et al. have explained an overview of real-world uses for neural networks. The research has presented ANN application issues, contributions, performance comparisons, and approach criticisms. It rates ANN contributions, contrasts results, and criticizes approaches. It was found that artificial neural networks with feedforward and feedback propagating were more effective when applied to solving human issues. In conclusion, future research can concentrate on merging ANN models within one network-wide application rather than using a single technique.

The above study shows the how MWTP is a crucial tool for regulating a process's functioning and forecasting how well it would work in the presence of significant influent changes. In this study, the author discusses the neural networks architectures for process control.

3. DISCUSSION

A wide range of issue fields, including computer science, finance, medical, engineering, mathematics, etc., have seen the effective use of ANN. The capacity of neural networks to approximate arbitrary functions is the primary justification. Numerous findings over the past 30 years demonstrate that feedforward networks, a type of ANN, with a single hidden layer may approach any function at any time.

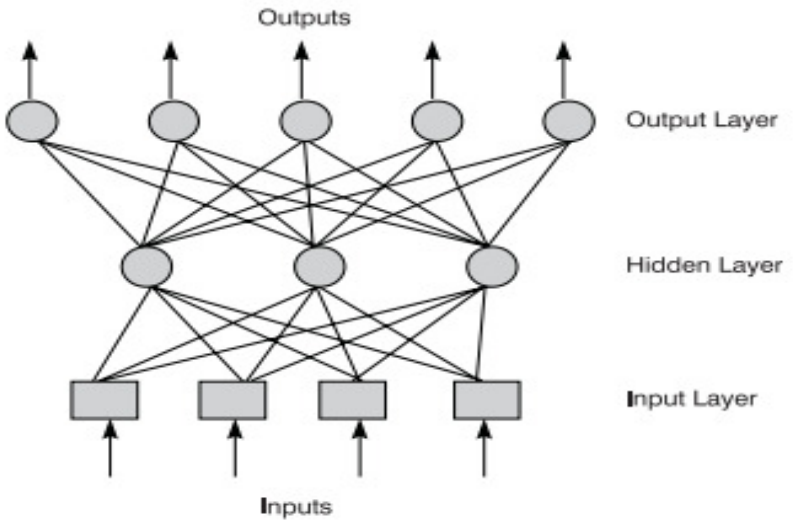

Figure 2: Illustrates the Schematic Diagram of a Typical Neural Network [3]**.**

Architecture or topologies is a crucial component of neural network design since it is directly tied to generalization abilities.In certain instances, utilizing a fully connected networks and a set of provided methods, the total number of neurons is determined by registering as many as 152 convergent functions, subsequently simulating every one of these functions to determine

the number of neurons that would cause the least amount of error. The function that creates the fewest errors out of the 152 functions is ultimately selected. The deep neural network's number of neurons and hidden layers may be searched using the hyper-parameter search method either manually or automatically.A schematic representation of a typical neural network is shown in Figure 2. The connectivity lines are the pathways via which information moves between the neurons, as well as the circles are indeed the processing neurons. The neurons in the boxes are merely storage units for the net's inputs. Each processing neuron carries out a calculation that transforms inputs into outputs and contains a modest amount of memory. The transfer function of the neurons is the name of the calculation. The transfer function is made up of algebraic or difference equations and can be either nonlinear or linear. There are three layers of neurons within the network depicted in the figure: input, hidden, and output.

3.1. Neural Networks Architectures for Process Control:

There are many different forms of networks, but nodes are their common element in all of them. Links between layers the nodes is the smallest component of a network. Every node takes signals from connections, processes them using a combination functional, and then uses a transfer function to transform them into an output signal. Weighted linkages join each of these nodes together. These weights, which may be modified by various learning rules, serve as the neural network's long-term memory. Depending on the issue at hand, several network topologies plus learning techniques are employed.Determining a set of parameters or weights, for the neural network during learning or training entails producing the desired behavior. Several network designs are detailed in the section that follows. By looking at their topologies, networks may be split into two primary categories: Feedforward Networks and Recurrent Networks.

3.1.1. Feedforward Networks:

It is a non-recurrent networks with processing units organized into layers, all of which are connected to the nodes of the layers below. There are various weights attached to the connection. The signal can only move in one direction, between inputs to output, due to the absence of feedback loop. The most popular model up to this point has been feedforward neural networks. The multi-layer networks is their most prevalent configuration. In essence, they provide a static mappings of given inputs to outputs. It can be demonstrated that a network containing two hidden layers may accurately approximate any non-linear function.The backpropagation algorithm, which really is essentially a call to the gradient descent technique, is typically used to identify connection weights, i.e. learn. The discrete time histories of system inputs and outputs may be utilized as network input variable target values to create multilayer feedforward neural networks (FNN) for simulating system dynamics. Similar to nonlinear input-output models, which have been frequently used during control engineering and telecommunications equipment, the network functions as a nonlinear mapping. The learning procedure uses repeated training patterns made up of input vectors and associated target values to phonate the mapping.

3.1.2. Recurrent Networks:

When feedback interconnections are added, a neural network transforms into a dynamic system. In the instance of continuous-time networks, differential equations for nodes may be used to explain network activities, whereas differential equations can be utilized in the instance of discrete-time networks. Recurrent networks were utilized in a variety of models and learning techniques. Asynchronous computation is used in the construction of discrete time recurrent networks, which means that all new outputs are computed after the operations

of all nodes have been assessed and used the networks as well as the neurons' most recent inputs and outputs. The architecture of fully linked recurrent neural networks is arguably the most open.They may represent any basic repeating DT structure, including feedforward structures. However, because of the network's topology, a discrete temporal delay appears (the minimal delay depends on how the method is actually implemented). This temporal delay enables the detection of process delays, typically referred to as a priori in feedforward systems, which, if there are enough neurons, may be readily addressed in recurrent networks.

3.2. Process Modelling via Artificial Neural Networks:

There have been several ANN designs developed, but the "feedforward" ANN (FANN) is the one that is most often used. Cybenko asserted that a FANN made up of two hidden layers as well as a fixed continuously nonlinearity may arbitrarily well approximation any continuous function on the compact set.According to this work, a FANN may be used to work with different types of nonlinear interactions. This remark consequently has a lot of consequences. Due to this, only FANNs will be the subject of further debate. Nodes, which resemble neuronal structures, make up a FANN. Layers are used to arrange these nodes.

3.3. Network Training and Validation:

The architecture of the network must be determined before employing the neural network technique to create a process model.When establishing a connection to a network with a certain topology, the established convention is applied. If a FANN includes three input neurons, two hidden regions with five to nine neurons apiece, and two output neurons, it is referred to here as network.The presence of two neurons in each layer, ten neurons through one hidden layer, and one neuronal throughout the output layer qualifies a FANN as a networks. These input-output data pairs are repeatedly introduced to the network after its inputs, outputs, and topologies have been established. When entering the network, data were scaled there at input feature vertices to give a well-conditioned problem.

Therefore, once the data has now been carried forward across the network, the internal weights are modified to decrease the squared error between the outputs that were measured and those that were produced by the network. The mistake can be minimized by implementing any suitable optimization technique. The spread of back mistakes, as one example. This contribution's main focus is on the chemotaxis methodology; it includes details on the procedures and a comparison of them to the back - propagation learning technique.Information data is divided into testing and training sets during network training. It follows the "train-test-validate" technique. Classification models are used to determine the network weights, whereas test data collections are used to evaluate the network technique.

3.4. Internal model control (IMC):

A process model is created that makes an output forecast model-based control strategy. The inverse of the model is the controller Q(s). Consequently, the model inversion is really not physically realizable for the majority of situations of practical significance. For instance, the inverse model would need to know the future inputs if the process included a temporal delay. Every system with non-minimum phase properties would have an unstable or unfeasible inverse. The controller is chosen to provide the class of linear controllers with the lowest squared error. Unfortunately, one such design is not resilient in the sense that inaccuracies in the expected parameters may result in a severe deterioration or even the possibility of an unstable management.To solve this issue, the model inverse is given a filter Fe(s), resulting in an optimum controller with resilient behavior in the presence of model uncertainty. The models employed in IMC are often linear approximations of a real system, which is typically

nonlinear. Therefore, whenever the process changes operational circumstances, it has a significant downside. The linear approximation's characteristics from the prior state are frequently incorrect in the current state. Even if the control is steady, it still falls short of ideal. As opposed to a linear IMC, a neural network model captures the nonlinearities of the operation and should therefore be valid across a wider working range.

3.5. Manufacturing Process Control:

The disadvantage that most industrial processes experience is that their operational parameters are often fixed and do not allow for online modifications. Whenever processing parameters are prone to change and there are outside disruptions, as is typically the case in industrial processes, the preset numbers should indeed be changed.As was previously said, the manufacturing procedure is time, unpredictable, intricate, and unexpected. Variability and lack of certainty can be reduced when they are brought on by factors that appear to be under our control, such as erroneous machine configurations, inconsistent commodity measurement techniques and concentration, inaccurate measurements, and deterioration of procedure device equipment, the exception being non - linearity and rather than complexity. Enhancing process conditions and, consequently, product quality would result from reducing their influence. However, it might be challenging to quantify these controlled characteristics live, making it challenging to evaluate the effects of them.To respond to changes in the environment in this condition, operational parameters must be changed or managed continuously online, which calls for accurate, trustworthy models of the process. This is due to the fact that, absent accurate knowledge of the process parameters, the efficiency of the control scheme which has been developed based on this uncertainty cannot be maintained to an acceptable degree. A controller, an actuator, a sensor component, and a feedback component make up a general management system incorporating feedback. The controller receives the measured and predicted signals from the feedback component.

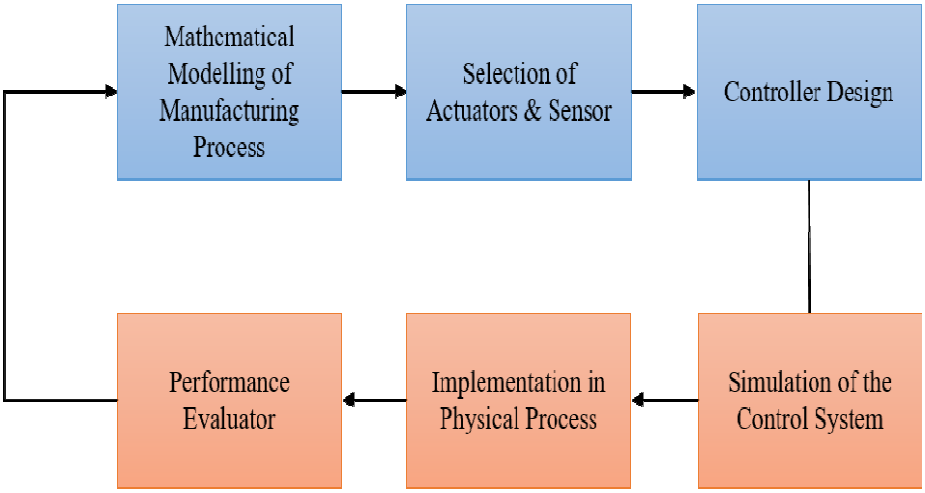

Figure 3: Illustrates the method of providing feedback for creating a process controller with assistance ANN [10]**.**

In accordance to the error characteristics, the controller's duty is to change its command signal. As just a result, the performance of the controller has a significant impact on how effectively the controlling system for the design and manufacturing functions overall. The effectiveness of the actuators and sensor that will be employed for control is equally crucial. Even when the controller was constructed in a way that best reflected the processing parameters, the control performance could not be assured unless these were properly developed or chosen.The biggest challenge in industrial controller design is the lack of

frequently available reliable process dynamics models. The absence of physical models makes it challenging to develop a process controller, and using traditional control approaches is essentially unworkable. These are two generally acknowledged techniques for creating process controllers in this context. One is to make some assumptions about the process mechanisms and phenomena and then approximating the precise dynamics of the mathematical formula.It is possible to develop all model-based control approaches, including adaptive, optimum, predictive, durable, and many more, using the process model which has basically been developed in this way. These techniques include classic controllers such time-delay control.

3.6. Application of Process Control:

The several application of process control in different field are categorized as:

3.6.1. Machining Process:

Given that it enables process parameters to somehow be altered in real time in response to drastically fluctuating process circumstances, adaptive control has in fact been seen as a particularly promising techniques in the field of machining. To do this successfully, a process model is required for the method's continuous feedback control. As a result, Azouzi and Guillot created a monitoring system based on neural networks. Dimensional deviation (DD) and surface finish were two product attributes that are calculated and controlled using two network approaches (Ra). The goal of this method neurological paradigm is to offer a new mathematical model for the elements needed for optimization, which reduces the cost of machining. One such model indicates the = [DD, Ra] evolves by estimating the DD and Ra.

The quality model output ~ x (t) = [DD, Ra].

This method makes use of a hybrid network model made up of a multilayer perceptron and a Kohonen combination of features. The necessity to stop memory degradation caused by dispersed gathering and dissemination inside the majority of contemporary feedforward neural networks drives the implementation of this type of network structure. This feedforward neural model frequently only properly depicts the process behavior adjacent to the most operational computational input, partially ignoring the process activity in remote locations.

3.6.2. Arc Welding Process:

High-strength welds would be produced using automated welding.Several research efforts have been launched in order to accomplish this. Online management of the weld form, including breadth and penetration, is one of these efforts. The shape, breadth, and penetration of a weld pool typically impact the quality and endurance of the weld. Because these geometrical factors are difficult to monitor while welding, a substitute has been utilized that monitors surface temperatures close to the torch area because surface temperature distributions is a good indicator of the geometry of a weld pool.Lim and Cho can determine the size of an immediate weld pool using this temperature data, which is not possible otherwise. The weld pool size is shown by PS on the process control system, while Ti represents the ith location's temperatures.To learn from feedback failures, the technique only employs two neural networks: one for calculating the size of a molten material and another one for the feedback forwarding controller. The error backward propagating approach is used to train the multilayer perceptron connections. The total input T is defined by since this architecture primarily uses the inverse kinematics of something like a welding operation:

$$u_T(t) = u_N(t) + u_f(t)$$

Where f seems to be the feedback control input while N is the network-generated control signal. In actuality, any of the traditional controllers might be utilized. The following weight adaption equations are used to adjust the NN controller's weights:

$$w_{lk}(t+1) = w_{lk}(t) + \eta\delta_1(t)o_k(t)$$

$$\delta_1 = u_f(t)f(net_1(t))$$

3.6.3. Semiconductor Manufacturing:

Many operating input and output and many output variables interact intricately throughout semiconductor manufacturing operations. Particularly poorly understood is the extremely nonlinear low-pressure plasma etching technique known as reactive ion etching, or RIE. In this case, an emulator (identification) as well as an inverse neural modeling controller make up the neural network control scheme. The command structure. For the sake of simulation, it is assumed that a q-step ahead models, as defined by:

$$u(t) = g(p_f(t))$$

The chamber pressure vectors at sampling interval t consists of,where g represents the relationship between the u and pf's functional parts:

$$p_f(t) = \{p_f(k+t), \ldots., p_f(1+t), p_f(t)\}$$

The g function is written away by:

$$g(p_f) = \sum_{i=1}^{B} a_i\, w_i$$

The weight wi is determined by using the unipolar binary number Ai:

$w_i(t+1) = w_i(t) + Dw_i$, i=1, 2…N

4. CONCLUSION

An increasingly prominent method for modeling issues is artificial neural networks. Without making any a priori assumptions about the model form, models can be produced.Then, these models might be used in a range of model-based processes control methods. Internal model manipulation is very well suited for neural network implementation. The both systematic approach and the inverse systems approach may be learned by a neural network. Although neural networks have now been utilized for many years for process control systems, they are still uncommon in industry. With tremendous success, this technique has been used in a variety of sectors.The technology can be more extensively implemented without mystery to resolve a number of the most troublesome process control issues with the right training to raise the curtain on the technology. The idea of the measurement and control space is crucial to creating neural network models. The multidimensional boundaries known as measurement space are established by that of the measurement range from each input, which represents one dimension. The input vector is a collection of inputs. Control space is a subset of measurement space, as well as the training's input vector data records' point vector distributions determines its bounds and form. It suggests that models may be built from data using artificial neural networks. Neural networks have demonstrated to be particularly resilient to modeling mistakes in early findings of its usage in process control. Once one process model is established, it may be applied in a variety of ways to enhance the functioning of the process.

REFERENCES

[1] X. Hua, W. Wang, Y. Wang, and M. Ren, "Bus arrival time prediction using mixed multi-route arrival time data at previous stop," *Transport*, 2018, doi: 10.3846/16484142.2017.1298055.

[2] M. Zheng *et al.*, "Globally fixed-Time synchronization of coupled neutral-Type neural network with mixed time-varying delays," *PLoS One*, 2018, doi: 10.1371/journal.pone.0191473.

[3] F. Otero, "Use of neural networks in process engineering thermodynamics, diffusion, and process control and simulation applications," *CT y F - Ciencia, Tecnol. y Futur.*, vol. 1, no. 4, pp. 49–64, 1998.

[4] S. Ma and Y. Kang, "Exponential synchronization of delayed neutral-type neural networks with Lévy noise under non-Lipschitz condition," *Commun. Nonlinear Sci. Numer. Simul.*, 2018, doi: 10.1016/j.cnsns.2017.10.012.

[5] M. Zheng *et al.*, "Finite-time generalized projective lag synchronization criteria for neutral-type neural networks with delay," *Chaos, Solitons and Fractals*, 2018, doi: 10.1016/j.chaos.2018.01.009.

[6] G. R. Yang and X. J. Wang, "Artificial Neural Networks for Neuroscientists: A Primer," *Neuron*, vol. 107, no. 6, pp. 1048–1070, 2020, doi: 10.1016/j.neuron.2020.09.005.

[7] N. Bekkari and A. Zeddouri, "Using artificial neural network for predicting and controlling the effluent chemical oxygen demand in wastewater treatment plant," *Manag. Environ. Qual. An Int. J.*, vol. 30, no. 3, pp. 593–608, 2019, doi: 10.1108/MEQ-04-2018-0084.

[8] M. I. Awad, M. AlHamaydeh, and A. Faris, "Fault detection via nonlinear profile monitoring using artificial neural networks," *Qual. Reliab. Eng. Int.*, vol. 34, no. 6, pp. 1195–1210, 2018, doi: 10.1002/qre.2318.

[9] O. I. Abiodun, A. Jantan, A. E. Omolara, K. V. Dada, N. A. E. Mohamed, and H. Arshad, "State-of-the-art in artificial neural network applications: A survey," *Heliyon*, vol. 4, no. 11, p. e00938, 2018, doi: 10.1016/j.heliyon.2018.e00938.

[10] H. S. Cho, "Suck Cho, Hyung 'Neural Network Applications to Manufacturing Processes: Monitoring and Control,'" *Control*, vol. 25, p. 34, 2001.

CHAPTER 18

IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN POWER STATION

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ABSTRACT: ***In contrast to the natural intelligence shown by people and animals, artificial intelligence is the intelligence demonstrated by robots. Global difficulties in the energy industry include increasing consumption, efficiency, shifting supply and demand patterns, and a lack of analytics necessary for effective management. In developing market countries, these problems are more serious. The goal of this paper is to highlight the key artificial intelligence (AI) technologies utilized in the power system where conventional approaches will not be able to catch up with all operating and dispatching conditions. In addition, a short explanation of each technology discussed in the chapter's application of the power system is provided. For resolving various issues in power systems, such as control, planning, scheduling, forecasting, etc., AI approaches have gained popularity. Modern huge power networks with even more interconnections developed to accommodate rising load demand may use these strategies to handle challenging jobs. Many aspects of power system engineering have benefited from the use of these methodologies.***

KEYWORDS: ***Artificial Intelligence, Fuzzy Logic, Power Station, Power Systems, Thermal Power.***

4. INTRODUCTION

An electric power system is a collection of electrical parts used to generate, transfer, and consume electricity. Power systems engineering is a branch of electrical engineering that focuses on the production, transmission, distribution, and use of electric power as well as the electrical components related to such systems, such as transformers, motors, and generators. The intelligence shown by machines and software, such as robots and computer programs, is sometimes referred to as artificial intelligence [1]. The phrase is often used to a project that involves creating systems that have human-like cognitive abilities, such as the capacity to reason, locate meaning, generalize, discriminate, learn from the past, and correct errors. A hypothetical machine or computer with artificial general intelligence (AGI) is intelligent if it can effectively complete any intellectual task that a human being [2].

Due to the ever-increasing energy consumption and the expansion of the present electrical transmission networks and lines, the contemporary power system functions near to its limitations. It is important to continually examine the system states in a much more detailed way than previously necessary in order to operate the power system and control system with less conservatism in this condition [3]. Power system planning, operation, diagnostics, and design are now tough challenges that must be solved using sophisticated computer technologies. Among these computer technologies, artificial intelligence has been more popular recently and has been used in a variety of power system applications.

Artificial intelligence (AI) has the ability to improve power system operation, maintenance, control, planning, and plan execution, as well as reduce energy waste, decrease costs, and hasten the adoption of clean renewable energy sources in power grids worldwide. AI is so strongly related to the economical, clean, and renewable energy needed for development [4]. If properly implemented, the introduction of AI-managed smart grids will have a positive impact on the electricity industry. Additionally, AI puts the client back in the spotlight by linking electricity producers, grid managers, and end users so that they may all be linked and better serviced. Additionally, it must be noted that AI is used to lessen the environmental

effects of thermal power plants, enhance their functionality, and allow them to function more effectively in terms of sending electricity to the grid [5].

Electrical grids that enable two-way communication between utilities and customers are powered by AI. Smart grids have an information layer incorporated in them that enables communication between its many parts so they can react more quickly to changes in energy consumption or emergency circumstances [6]. Data gathering, archiving, and analysis are made possible by this information layer, which was made possible by the widespread installation of smart meters and sensors. Machine learning, the Internet of Things, and other approaches are ideally suited for their analysis and usage given the size and variety of these data sets [7]. This analysis may be utilized for a number of things, such as accurate fault finding in meters, predicting the need for maintenance, monitoring the quality of sustainable energy, forecasting renewable energy, and using the most recent developments in ICT (ICT).

The use of AI, data analytics, the Internet of Things (IoT), and other technologies that enable connection between computer devices has already begun in the electricity industry in industrialized nations. These batteries are used to store excess solar or wind energy during periods of low energy demand [8]. AI can thereby increase the dependability of solar and wind energy by analyzing vast volumes of meteorological data pertaining to sun intensity and utilizing this data to forecast and decide when to collect, store, and distribute wind or solar energy. Additionally, AI is included into smart grids to assist in balancing the grid's energy supply. In order to lessen grid congestion and energy curtailment, this technology examines the system both before and after absorbing intermittent units.

Customers may immediately communicate with their control systems, such as thermostats, etc., to monitor their energy use, thanks to smart devices like Amazon Alexa and Google Home. Additionally, consumer electronics and energy management will enable autonomous home meters to apply AI to optimize energy storage and consumption. In order to identify any inefficiencies or lack of transparency, this technology may also be utilized to notice disparities in consumption patterns, if any, the consumer's payment history, and other data [9]. Additionally, it might aid in the efficiency of pricey and time-consuming physical examinations. The consumer will experience reduced bureaucracy, inaccuracies from manual data input, and red tape. The industrial internet of things (IIoT), a new technology that builds on and broadens the effects of digital technology, was created in response to the requirement for connectivity.

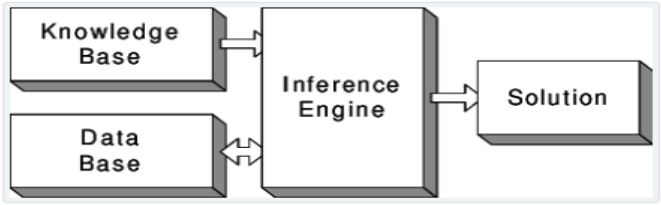

Figure 1: Illustrate the connection between the artificial intelligence and power station [10]**.**

Figure 1 illustrates how an expert system converts the knowledge of a human expert in a narrowly defined topic into a machine implementable form. Expert systems are computer programs that are knowledgeable and skilled in a certain topic. The procedural portion of the program's knowledge is often saved independently, and it may be stored in a variety of ways, including rules, decision trees, models, and frames [11]. They are also known as rule-based or knowledge-based systems. Expert systems employ knowledge and interaction mechanisms to tackle issues that are beyond the scope of human intelligence and expertise. Many power

system applications mirror the capabilities of expert systems in areas including decision-making, knowledge archiving, and problem-solving using logic, heuristics, and judgment. Expert systems are particularly helpful for these issues when a lot of data and information has to be handled quickly [12].

Applications of AI in the Power Industry Along with real-time maintenance and the determination of optimum maintenance plans, fault prediction has been one of the principal uses of artificial intelligence in the energy industry. AI with the right sensors may be helpful to monitor equipment and discover faults before they happen in a sector where equipment failure is widespread and can have serious repercussions [13]. This can help to save resources, money, time, and lives. In order to support the spread of less dependable renewables, geothermal energy, which produces consistent energy production, is being considered as a possible source of baseload power (the bare minimum required to be provided to the electrical grid at any given moment).

The effectiveness and dependability of geothermal power plants have been improved via the application of IoT and AI, according to study by Toshiba ESS. For instance, issues that might possibly cause plants to shut down are predicted using predictive diagnostics, which are made possible by rich data. Using IoT and AI, preventive measures like chemical agent sprays to prevent turbine shutdowns are improved in terms of amount, composition, and time. In a nation like Japan, which has the third-largest geothermal resources in the world, such advancements are crucial, particularly in light of the falling prices of rival renewable sources like solar electricity [14].

Automation in the workplace and at home is increasingly influenced by AI. Every year, more research is done on power systems, and AI is increasingly being used to make them smarter. Power systems are influenced by geographic, meteorological, and other variables. The introduction of new technologies, changes in technology, the transmission and distribution of energy, and other elements are all important to the operation of the electric grid. Every nation and state needs power, thus if energy is required, it must be delivered in a reliable, dependable, or pleasant way [15]. Electrical power systems, electronics, industrial applications and instruments, and construction are just a few of the industries where machine learning is becoming more prevalent and will likely continue to do so. AI is playing a bigger role in daily life, including automation in the home and workplace.

Every year, more research is conducted on power systems, and now, AI is being utilized to make power systems smarter. Power systems are determined by geography, climate, or any other local factors. The adoption of new technologies, the updating and modifying of equipment and technology, the transmission and distribution of energy, and other elements are also important to the power system [16]. Consistency, which was only established using discrete techniques, particularly outdated ways of ML in the power system not being able to satisfy this same possibility of essential loads study and the cost analysis, is the key component of power distribution planning and design described in this work. The expenses of upkeep and operation may rise as a consequence of ML, often known as AI. Huge truly understand this, a ton of study has to be done.

5. DISCUSSION

Artificial intelligence has emerged as one of the most cutting-edge technologies used in a variety of fields in the twenty-first century. The United Arab Emirates was the first nation in the region and the whole globe to introduce an AI strategy, proving that the Federal Government's strategic goals would inevitably include AI. AI has been included into the development plans of many nations, including China, the USA, the UK, and France. The

primary driver for AI adoption is the integration of several industries, including healthcare, energy and renewable energy, finance, water, education, and the environment [17]. The present chapter explores the many elements of AI in power systems. Because the currently used conventional procedures do not contribute to accurate findings or accurately portray the system's actual state. Artificial intelligence is the exhibition of intellectual processes and the capacity for reasoning and thinking as in humans via the use of computers and software development systems. The production, transmission, distribution, and use of electrical power as well as a variety of electrical equipment are all covered under power system engineering. The introduction of renewable energy sources makes it challenging for established methodologies, due to their complexity, to portray various situations. For its calculation, diagnosis, and learning, power system analysis requires the handling of a complex, diverse, and sizable quantity of data. Computers and other advanced technologies make it possible to manage the challenging problems associated with power system planning, operation, design, and troubleshooting [18]. From this point forward, AI helps manage the complex and enormous data handling system and provides an accurate and timely report to help make the best option for addressing power system challenges and improving power systems.

5.1.Power Systems:

A network of electrical devices used to provide, transfer, and utilise electric power makes up an electric power system. Electrical engineering's subfield of power systems engineering deals with the production, distribution, and use of electricity as well as the electrical equipment attached to such systems, such as motors, generators, and transformers [19].

5.2.Artificial Intelligence:

Artificial intelligence is often understood to be the intelligence shown by machines and software, such as robots and computer programs. The phrase is often used when discussing the creation of systems that have the mental faculties and traits that separate humans from other animals, such as the capacity to reason, generalize, make distinctions, draw lessons from the past, and correct errors. In general, it refers to devices or software that have the capacity to make judgments independently of their operator.

5.3.A Power Station:

An industrial facility for the production of electricity is also known as a generating station, power plant, powerhouse, or generating plant. The majority of power plants include one or more generators, which are revolving machines that transform mechanical energy into electrical energy. An electrical current is produced by the movement of a conductor in relation to a magnetic field. The majority of power plants throughout the globe produce electricity by burning fossil fuels including coal, oil, and natural gas [20]. While some still utilize nuclear power, more and more people are turning to cleaner renewable energy sources including solar, wind, wave, and hydroelectric power. A network of electrical devices used to provide, transfer, and utilise electric power makes up an electric power system. There are three different kinds of large power plants that are recognized for producing a lot of electricity: a. thermal power plants; b. hydro power plants and Nuclear power facilities.

5.3.1. Thermal Power Plants:

A power plant that converts heat energy into electric power is called a thermal power station. The turbine is steam-driven in the majority of locations across the globe. Steam is created when water is heated, and the steam turbine it spins then powers an electrical generator. The steam is returned to where it was heated after passing through the turbine and condensing in a

condenser; this process is known as a Rankines cycle [21]. In addition to producing electricity, thermal power plants are also built to create heat energy for desalination of water and district heating, as illustrated in Figure 2. Efforts to decrease CO2 emissions from fossil fuel power plants, which account for a significant portion of all human-made CO2 emissions to the atmosphere, are many and diverse.

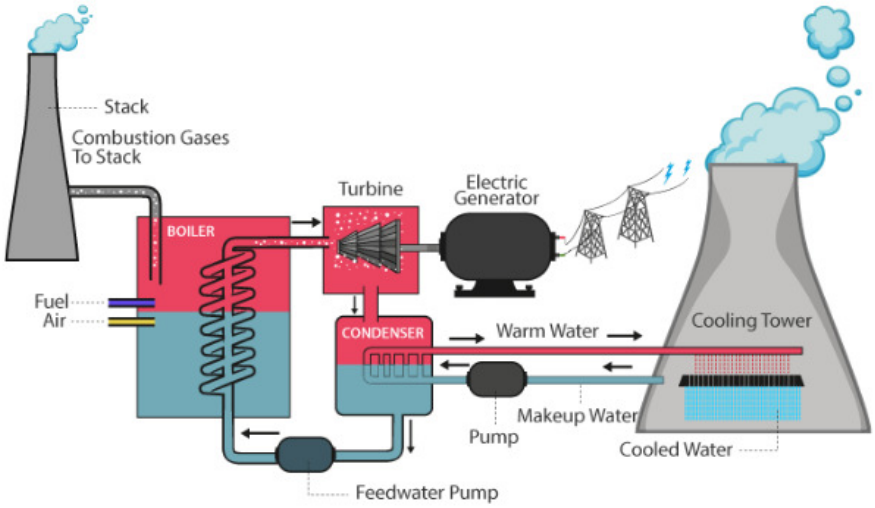

Figure 2: Illustrate the processing of the Thermal Power Plants [22]**.**

5.3.2. Hydro Power Plant:

Hydropower, often known as waterpower, is energy that comes from falling water or quickly moving water that may be used for productive purposes. In a hydroelectric power plant, we utilize the flowing water's gravitational pull to drive a turbine that is connected to an electric generator to generate energy. Due to the usage of water, a sustainable form of energy, to create electricity, this power plant is crucial in safeguarding our finite supply of fossil fuel. A massive turbine's blades are spun by the force of the water being forced from the reservoir through the dam. The generator that generates power while the turbine rotates is attached to it. The water then flows back into the river on the other side of the dam, as seen in Figure 3, after passing through the turbine.

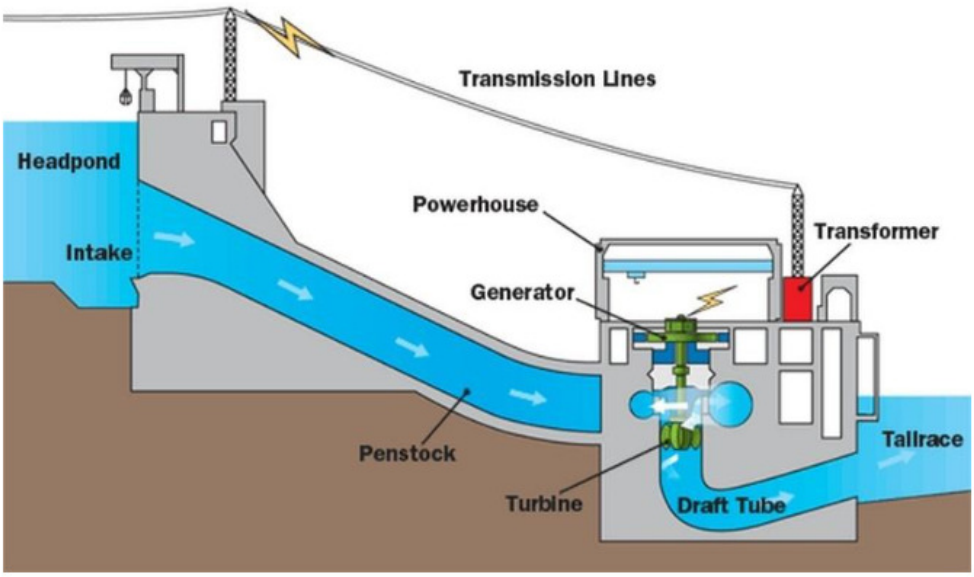

Figure 3:Illustrate the processing of the Hydro Power Plant [23]**.**

5.3.3. Nuclear Power Plant:

A nuclear power plant is a thermal power plant where a nuclear reactor serves as the heat source. Nuclear power stations generate electricity by heating water to create steam, much as plants that burn coal, oil, and natural gas. After that, the steam drives turbines to generate power. Like in typical thermal power plants, the conversion of energy to electrical energy happens indirectly. In a nuclear reactor, the fission causes the reactor coolant to heat up. Depending on the kind of reactor, the coolant might be liquid metal, gas, or even water. The steam generator subsequently receives the reactor coolant, which warms water to create steam. The multistage steam turbine is typically supplied the pressured steam after that. The leftover vapour is condensed in a condenser after the steam turbine has expanded and partly condensed the steam. A secondary side, such as a river or a cooling tower, is linked to the condenser, which is a heat exchanger. The cycle then restarts with the water being pushed back into the steam generator. The Rankine cycle seen in Figure 4 and the water-steam cycle are equivalent.

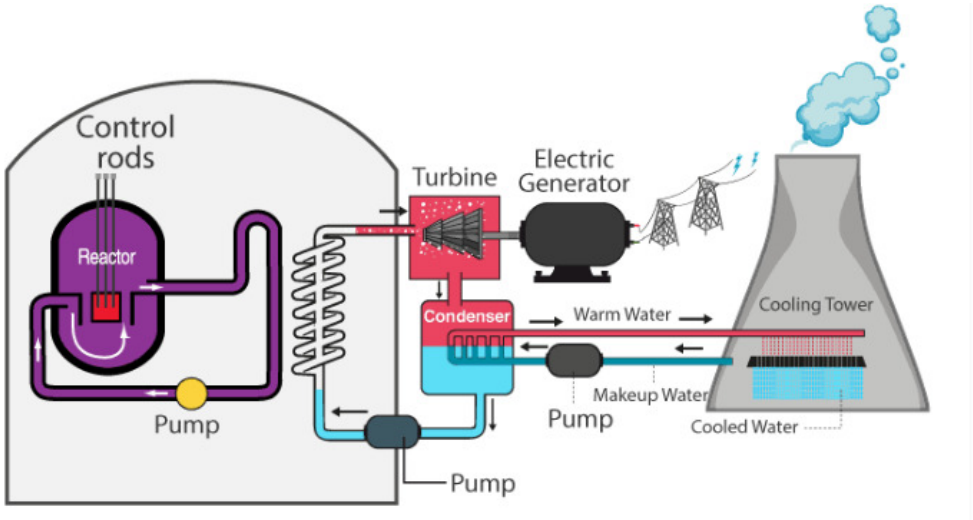

Figure 4:Illustrate the processing of the Nuclear Power Plant [24]**.**

As clean, affordable, and dependable energy is crucial to growth, the application of AI in the power industry is now expanding to developing nations, where it might have a significant influence. By imparting power industry expertise to AI software businesses, the problems may eventually be solved. When appropriately constructed, AI systems may be especially helpful in automating repetitive and organized operations, freeing up people to address tomorrow's power concerns. Energy availability is fundamental to development. Therefore, a significant barrier to growth that affects livelihoods, gender equality, health, education, food security, and poverty reduction is the absence of access to electricity, which affects one billion people, especially in Sub-Saharan Africa and South Asia. One of the Sustainable Development Goals is for everyone to have access to cheap, dependable, and sustainable modern energy (SDGs).

But unless new ideas and cutting-edge technology can get through the many energy-related challenges that afflict developing nations, from a lack of adequate power production to subpar transmission and distribution infrastructure to cost and environmental issues, it will remain simply a goal. Additionally, complicated problems for power generation, transmission, distribution, and consumption in all countries are brought about by the diversification and decentralization of energy production, the introduction of new technologies, and shifting demand patterns. The adoption of clean, renewable energy sources

in power systems throughout the globe might be facilitated and accelerated with the help of artificial intelligence (AI), which also has the potential to reduce energy waste and costs. Power system planning, management, and control may all be enhanced by AI. Thus, the capacity to offer clean, affordable energy that is necessary for development is intimately related to AI technology.

5.4.Artificial Intelligence Techniques:

Artificial Neural Networks: Artificial Neural Networks are thought-process-inspired systems that use a network of neurons to transform a collection of inputs into a set of outputs. As a result of inputs, each neuron generates a single output. When the requirement for pattern categorization and pattern recognition emerges in real-world applications, these systems are utilized.

Application in Power Systems: They are useful for finding answers to issues appearing in power production, distribution, and transmission since they are built to conduct biologically based evaluation of problems as a result of their fundamental architecture. ANN's may find a solution based on the limitations of a realistic transmission system, taking into consideration elements like environmental conditions and other unbalancing aspects.

Fuzzy Logic: Fuzzy systems, often known as fuzzy logic, are logical frameworks for formalizing and standardizing approximative reasoning. With the capacity to generate precise answers from specific or even approximative knowledge and data, it is comparable to human decision-making. Fuzzy logic uses reasoning that is comparable to human thinking. The way the human brain functions is via fuzzy logic, allowing us to employ this technology in robots to make them function something like humans. Fuzzification improves the capacity to represent complicated issues at low or moderate solution costs by enhancing expressive power, generality, and modeling capabilities. Fuzzy logic permits a certain degree of ambiguity during an analysis. Fuzzy logic is helpful in many applications since this ambiguity may describe the information that is accessible and reduce the complexity of the task. Fuzzy logic is appropriate for use in many aspects of power systems when there is ambiguity in the available information.

Application in Power Systems: It is possible to employ fuzzy logic while developing the actual parts of power systems. They can be applied to anything, including tiny circuits and enormous mainframes. They may be used to boost the effectiveness of the parts used in power systems. Due to the fact that most of the data utilized in power system analysis are approximations and assumptions, fuzzy logic may be very helpful in producing results that are reliable, precise, and devoid of ambiguity.

Expert Systems: An expert system converts a human expert's knowledge in a specific, constrained field into a form that can be used by machines. Expert systems are computer programs that are knowledgeable and skilled in a certain topic. The procedural portion of the program's knowledge is often saved independently, and it may be stored in a variety of ways, including rules, decision trees, models, and frames. They are also known as rule-based or knowledge-based systems. Expert systems employ knowledge and interface mechanisms to address issues that are beyond the scope of human intelligence and expertise.

Applications in power systems: Writing the codes for expert systems is easier than actually calculating and predicting the value of parameters used in generation, transmission, and distribution since expert systems are essentially computer programs. Being computer programs, any changes may be made with ease, even after the design has been completed. Virtually, these quantities may be estimated, and more study can be done on density B or

magnetic field strength, which is represented by the symbol 0H, to improve the process' efficiency. When separating compound units, such as "A•m2," use the middle dot.”With the introduction of technologies like AI-managed smart grids, the future of the power industry seems bright. These are electrical networks that enable utility and customer interaction in both directions. Smart grids have an information layer incorporated in them that enables communication between its many parts so they can react more quickly to changes in energy consumption or emergency circumstances. Data gathering, archiving, and analysis are made possible by this information layer, which was made possible by the widespread installation of smart meters and sensors. Synchrophasors, also known as phasor measuring units (PMUs), are another crucial component of the contemporary smart grid. They make it possible to measure and align data in real time from various distant spots on the grid. Better grid management is made possible by the creation of a current, accurate, and integrated picture of the complete power system. These smart-grid components, when combined with robust data analytics, have enhanced the dependability, security, and effectiveness of energy transmission and distribution networks.

AI methods like machine learning are best suited for their analysis and usage due to the enormous amount and varied structures of such data. Numerous uses for this data analysis include defect detection, preventive maintenance, power quality monitoring, and forecasting of renewable energy sources. Smart metering has become more common because to advancements in information and communications technology (ICT), cloud computing, big data analytics, and artificial intelligence. Smart meters are widely used, and sophisticated sensor technology has resulted in the quick generation of enormous volumes of data. New techniques for data storage, transport, and analysis are required. For illustrative purposes, one million smart meters put in a smart grid would produce over 35 billion data at a sampling rate of four times per hour. 8 Although EM countries have not yet adopted smart grids to the same extent as developed economies, a few of EM nations have started the process. These include, among others, Brazil, China, nations of the Gulf Cooperation Council (GCC), Malaysia, South Africa, Thailand, and Vietnam.

5.5.Current Application Of Ai In Power Systems:

Many issues in power systems cannot be resolved using traditional methods since they depend on conditions that aren't always attainable. Artificial intelligence approaches are the sole and apparent solution under these circumstances. Application areas for AI in power systems include:

iv. Human employees have long been replaced by machines for hazardous and highly specialized tasks, such as live maintenance of high-voltage transmission lines.
v. Access to cramped areas like cable viaducts and cooling pipelines, operation in risky conditions like radioactive places in nuclear reactors, and accurate placement of measuring equipment.
vi. Expert systems use the interface mechanism and knowledge to address issues that are either too complex or impossible for human ability and intelligence to address.

6. CONCLUSION

This paper goal is to showcase the key artificial intelligence (AI) technologies that are employed in the power system to handle operational and dispatching tasks when conventional approaches fall short. Additionally, a short summary of each technology covered in the chapter along with its precise application of the power system is provided. Additionally, by regulating voltage, stability, power flow, and load frequency, these techniques enhance the

efficiency and productivity of the power system. Additionally, it enables network control over things like size, location, and device and equipment management. The automation of the power system makes sure to enable network security, management, and problem diagnostics. To employ AI for planning, monitoring, and control of the power system, the right AI approach must be found. The paper will conclude by briefly highlighting the sustainable aspects of employing AI in power systems which helps for better understanding related to AI.

REFERENCES

[1] H. Yousuf, A. Y. Zainal, M. Alshurideh, and S. A. Salloum, *Artificial intelligence models in power system analysis*, vol. 912. Springer International Publishing, 2021. doi: 10.1007/978-3-030-51920-9_12.

[2] B. Makala and T. Bakovic, "Artificial Intelligence in the Power Sector," *Int. Financ. Corp.*, pp. 1–8, 2020.

[3] R. P. Nath and V. N. Balaji, "Artificial Intelligence in Power Systems," *Int. J. Recent Trends Eng. Res.*, vol. 4, no. 4, pp. 262–267, 2018, doi: 10.23883/ijrter.2018.4234.eywih.

[4] S. K. Dash and M. N. Mohanty, "Adopting artificial intelligence in power stations," *Int. J. Psychosoc. Rehabil.*, 2019, doi: 10.37200/IJPR/V23I5/PR190587.

[5] M. Goel, "Artificial Intelligence in Power Station," *Int. J. Res. Appl. Sci. Eng. Technol.*, 2019, doi: 10.22214/ijraset.2019.5518.

[6] A. Kumar D R and M. Mohan B M, "Artificial Intelligence in Power Station," *Int. J. Eng. Tech. Res.*, 2016.

[7] M. Dabbaghjamanesh, A. Moeini, and A. Kavousi-Fard, "Reinforcement Learning-Based Load Forecasting of Electric Vehicle Charging Station Using Q-Learning Technique," *IEEE Trans. Ind. Informatics*, 2021, doi: 10.1109/TII.2020.2990397.

[8] W. jing Niu, Z. kai Feng, B. fei Feng, Y. shan Xu, and Y. wu Min, "Parallel computing and swarm intelligence based artificial intelligence model for multi-step-ahead hydrological time series prediction," *Sustain. Cities Soc.*, 2021, doi: 10.1016/j.scs.2020.102686.

[9] H. Sharadga, S. Hajimirza, and R. S. Balog, "Time series forecasting of solar power generation for large-scale photovoltaic plants," *Renew. Energy*, 2020, doi: 10.1016/j.renene.2019.12.131.

[10] A. Khosravi, M. Malekan, J. J. G. Pabon, X. Zhao, and M. E. H. Assad, "Design parameter modelling of solar power tower system using adaptive neuro-fuzzy inference system optimized with a combination of genetic algorithm and teaching learning-based optimization algorithm," *J. Clean. Prod.*, 2020, doi: 10.1016/j.jclepro.2019.118904.

[11] N. Aggarwal, "Study of Artificial Intelligence and its Applications," *Int. J. Res. Appl. Sci. Eng. Technol.*, 2019, doi: 10.22214/ijraset.2019.4620.

[12] H. Yu and G. Shao, "Artificial Intelligence Control for Reactive Power of Electric Drive System of Pump Station," in *Proceedings - 2nd International Conference on Computer Network, Electronic and Automation, ICCNEA 2019*, 2019. doi: 10.1109/ICCNEA.2019.00103.

[13] T. Shi, D. Hu, X. Ren, Z. Huang, Y. Zhang, and J. Yang, "Investigation on the Lightning Location and Warning System Using Artificial Intelligence," *J. Sensors*, 2021, doi: 10.1155/2021/6108223.

[14] Y. Wang, B. Seo, B. Wang, N. Zamel, K. Jiao, and X. C. Adroher, "Fundamentals, materials, and machine learning of polymer electrolyte membrane fuel cell technology," *Energy and AI*. 2020. doi: 10.1016/j.egyai.2020.100014.

[15] D. Ghosh, M. A. Bin Muslim, J. Ajay Daniel, and V. N. Ganesh, "Integration of renewable resources for electric vehicles and implementation of artificial intelligence," *Int. J. Recent Technol. Eng.*, 2019.

[16] Y. Jin, Y. Ying, J. Li, and H. Zhou, "Gas path fault diagnosis of gas turbine engine based on knowledge data-driven artificial intelligence algorithm," *IEEE Access*, 2021, doi: 10.1109/ACCESS.2021.3101647.

[17] O. Feddaoui, R. Toufouti, D. Labed, and S. Meziane, "Control of an Isolated Microgrid Including Renewable Energy Resources," *Serbian J. Electr. Eng.*, 2020, doi: 10.2298/SJEE2003297F.

[18] D. B. De Alencar, C. De Mattos Affonso, R. C. L. De Oliveira, J. L. M. Rodríguez, J. C. Leite, and J. C. R. Filho, "Different Models for Forecasting Wind Power Generation: Case Study," *Energies*, 2017, doi: 10.3390/en10121976.

[19] T. Mahmoud, Z. Y. Dong, and J. Ma, "Advanced method for short□term wind power prediction with multiple observation points using extreme learning machines," *J. Eng.*, 2018, doi: 10.1049/joe.2017.0338.

[20] J. Wright, "Suspect AI: Vibraimage, Emotion Recognition Technology and Algorithmic Opacity," *Sci. Technol. Soc.*, 2021, doi: 10.1177/09717218211003411.

[21] C. Chen, J. Mao, X. Liu, S. Tian, and L. Song, "Modelling and combustion optimization of coal-fired heating boiler based on thermal network," *Therm. Sci.*, 2021, doi: 10.2298/TSCI2104133C.

[22] A. Sahragard, H. Falaghi, M. Farhadi, A. Mosavi, and A. Estebsari, "Generation expansion planning in the presence of wind power plants using a genetic algorithm model," *Electron.*, 2020, doi: 10.3390/electronics9071143.

[23] X. Xu, Q. Chen, M. Ren, L. Cheng, and J. Xie, "Combustion optimization for coal fired power plant boilers based on improved distributed ELM and distributed PSO," *Energies*, 2019, doi: 10.3390/en12061036.

[24] P. S. G. de Mattos Neto, J. F. L. de Oliveira, D. S. de Oliveira Santos Júnior, H. V. Siqueira, M. H. da Nóbrega Marinho, and F. Madeiro, "A hybrid nonlinear combination system for monthly wind speed forecasting," *IEEE Access*, 2020, doi: 10.1109/ACCESS.2020.3032070.

CHAPTER 19

MICROPROCESSOR BASED MOTOR SPEED CONTROL OF DIRECT CURRENT (DC) MOTOR

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ABSTRACT:Controlling the direction and speed of a DC motor is known as DC motor control. Since controlling DC motors is simpler than controlling other types of motors, they are frequently employed in speed and direction control. The problem arises in DC motors related to their parameters such asvoltage electrical supply, rated current, temperature, uncontrolled frequency, and torque speed. Hence the author focuses on designing of microprocessor-based motor speed control (DC) motor and Recognition of the motor, electronic implementation of a compensator, and accurate assessment of the DC motor's control system. It found thatwith the help of a microprocessor, the drive's intended speed tracking control performance may be maintained across a large working range, and good speed loading controlling performance can also be attained. It concludes thatthe power circuits and also the control loops are proposed to achieve the condition for reducing the losses of a dc motor. In the future,the microprocessor's versatility makes it simple to implement dc motor power and efficiency regulation.

KEYWORDS: Circuit, DC Motor, Microprocessor, Power, Speed Control.

1. INTRODUCTION

A DC motor's speed can be adjusted manually by the user or automatically via a control mechanism. This differs from speed regulation, which attempts to keep the speed constant (or "controlled") in the face of a natural variation in speed brought on by a change inside the load on the shaft.The speed of a DC motor (N) is equal to:

$$N = \frac{V - I_a R_a}{k\emptyset}$$

The speed method of control is useful in a variety of situations, including regulating the motion of robotic vehicles, the motion of motors for paper mills, and the motion of motors for elevators that employ various types of DC motors [1],[2]. One of the DC motor's most beneficial characteristics is speed control. The motor that transforms direct electricity into mechanical work is known as a DC motor. The Lorentz Law, which says that a current-carrying conductor experiences a force when it is put in a magnetic and electrical field, serves as the foundation for its operations [3],[4]. In general, a high-performance motorized drive system G has to respond to speed commands with effective tracking and load regulating, as well as the achievements, should be unaffected by drive system uncertainty [5],[6].Typically, plant parameter fluctuations, external load disturbances, and unmolded and unpredictable dynamics of the plant make up the uncertainty [7],[8]. Many control strategies have been created in recent years to enable field-oriented induction machine drives to take the role of dc motor drives for a variety of industrial purposes.

The nonlinear system control, model predictive control, and robust control are strategies for addressing plant uncertainty [9],[10]. However, they either have highly complicated theoretical underpinnings or are exceedingly challenging to put into practice [11],[12]. It is simple to derive and put into practice the robust control strategy based on the direct

cancellation of uncertainty presented in Figure 1. However, if system dead-time, as well as other uncertainties, are present, a comparable endless gain loop prevents it from being effectively implemented [13],[14]. It's crucial to conserve energy with electric motor drives in terms of energy conservation.There are two ways to reduce the energy used by electric motors. Designing an energy-efficient motor is one thing; driving a standard motor efficiently is quite another. The efficiency of motors typically peaks between 75 and 100 percent load capacity and declines significantly below that. Consequently, a lot of writers have focused on ways to increase efficiency while dealing with light loads.

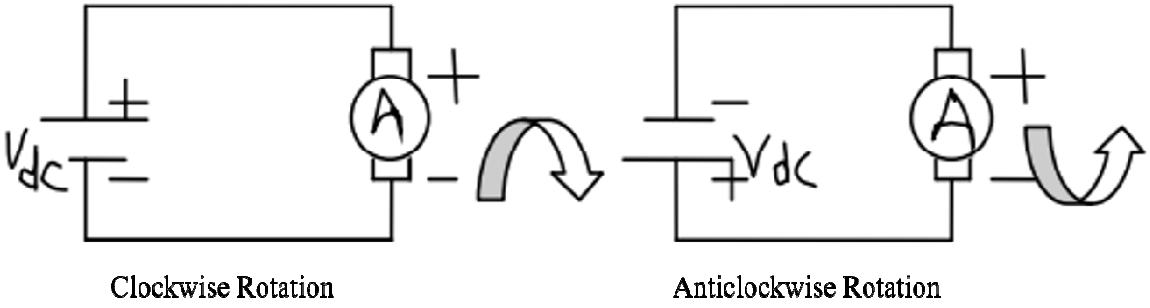

Figure 1: Illustrates the direct control of the DC motor which means every DC motor has two terminals out [15]**.**

1.1. Operating Principle of DC Motors:

The Faraday principle of electromagnetism, which asserts that a current-carrying conductor feels a force whenever put in a magnetic field, underlies the operation of DC motors. The velocity of this conductor is always moving in a perpendicular direction towards the magnetic field and the current according to Fleming's Left-hand principle governing electric motors. Mathematically,

It can express this force as

$$F = BIL$$

Where,

F= is force,

B= is the magnetic field,

I =stand for current,

L= is the length of the conductor.

The present study focuses on controlling the direction and speed of a DC motor is known as DC motor control. Since controlling DC motors is simpler than controlling other types of motors, they are frequently employed in speed and direction control. This research is characterized into several sections where the first is an introduction and the second section is a literature review and suggestions of previous studies in terms of speed control of induction motors with help of microprocessors. Furthermore, the methodological section of this study is mentioned where the data is examined in the different sub-sections. After that, the results and discussion part are discussed where results are compared with the existing data followed by the methods applied in this research. Lastly, the conclusion of this research is declared where the research gives outcomes as well as future scopes.

2. LITERATURE REVIEW

Mr. R. Vinothkanna [16] has explained that the permeability of space appears to be one of the most important considerations when developing a control system. The main objective of the study is to decrease the amount of space required for a motor control system by creating wireless communication between the motor controller component and the control unit. The wire and module of the control circuit require fewer space thanks to the arrangement. The devices were found to be just 50% successful when an impediment is present between both the receiver and the transmitter units and only dependable up to 80% of the declared range while no impediment is present. The reliability of the model might also be improved by a confirmation audible or signal emanating from the transmission end when it is in use.

Serhii Buriakovskyi et al. [17] have explained how a set of rollers and a motor serve as the physical representation of a switching reluctance drive. As a continuation of the author's efforts to create a control strategy for a four-phase switching reluctance motor, the fuzzy-regulator synthesizing technique is described (SRM). To assure a smooth motor with wheel-set acceleration, the tests sought to record the frequencies of the major transient dimensions and assess the drive at different mechanical speeds. The results showed that the computer developed a full-drive control by selecting the speed controller, frequencies, smoothness, proper orientation of control, as well as the algorithm for a smooth start-up and by ensuring that the required beginning force was there. In conclusion,the capability of the drive is increased by using a microprocessor CS, which also makes it possible to employ next-generation proximity sensors and prevents the engines from being overloaded when working.

Rafal Szczepanski [18] et al. have Explained, the state feedback controller's main drawback is related to the time-consuming and arduous calibration method, despite its resilience and efficient disturbance avoidance. It is advised to apply an optimization approach in that study to automatically tune state feedback controller parameters (SFC) for the two-mass system (TMS). The optimal SFC coefficients are obtained using the Artificial Bee Colony technique (ABC). The control strategy's ABC algorithm-optimized structural characterization is also displayed. The SFC coefficients obtained using the recommended automated approach were shown to have an equivalent dynamic response to the coefficients obtained analytically, albeit being considerably lower.The experimental examination shows that the coefficients generated by the analytical approach result in dangerous amplification of the measurement noise and unsatisfactory chattering of something like the control signal. Last but not least, it appears that the recommended auto-tuning approach is more suitable for attaining both high-performance control for TMS and its safe operation.

Mohammad Divandari [19] et al. have proposed a brand-new switching reluctance motor (SRM) powering a fast terminal sliding mode control (FTSMC) method-based speed-control system. To evaluate the effectiveness of the proposed method, it is compared to the proportional-integral and conventional sliding mode control (SMC) strategies within both the time and frequency domains dimensions. The recommended FFTSMC outcomes are attained using a dual-channel, three-phase, 12/8-pole, 2.5 A, and 120 V SRM. The experimental treatment for the SRM drive demonstrates that the speed-control commute is made up of the following constituents: a gate start driving, DC power connection (120 V), three-phase fellow synchronous bridge transformer, trying to measure device voltage and current boards panel (with Hall-effect sensors), rotating shaft compression codec (1024 pressure conditions per rebellion), and also digital signal processor (DSP) board. Finally,applying the recommended speed-control strategy while the switching reluctance motor runs in an unfavorable environment might be an interesting topic in the future.

The above study shows. In this research, the design.

Research Question:

- How to design microprocessor-based speed control of DC motors?
- What are the parameters for speed control of DC motors?

3. METHODOLOGY

3.1. Research Design:

In the research, the author will take the component used for controlling the speed of the motor to the reference/standard speed in Figure 2.The motor drive system often has two dynamism in its electrical and mechanical reactions and is a standard model or higher order technology. In the form of a block diagram, the procedure for getting a variable dc voltage from the ac source again for the DC motor. The Synchronous Transport Component microcontroller detects and feeds the motor speed signal, armature voltage, armature voltage, and current flowing, but also the motor speed signal towards the data collection system. The signals are supplied to the computer for monitoring and interpretation after being digitalized by the data-gathering system.Before restarting the motor, the user-friendly, menu-driven computer software verifies that there is enough motor field power and requests the specified speed. The computer calculates an error signal equivalent to the discrepancy between the motor's average speed and target speed whenever the field current has been increased by 0.1 A. The next step is to produce a delayed signal whose delay time is proportionate to the error signal's size. The data collection system receives the delay signal and transforms it into analog form.Regarding the zero crossings of both the 50 Hz DC power supply, this signal is mentioned. The analog-to-digital converter, which operates the motor speed at the rated value, is connected to the reference speed there at the end.

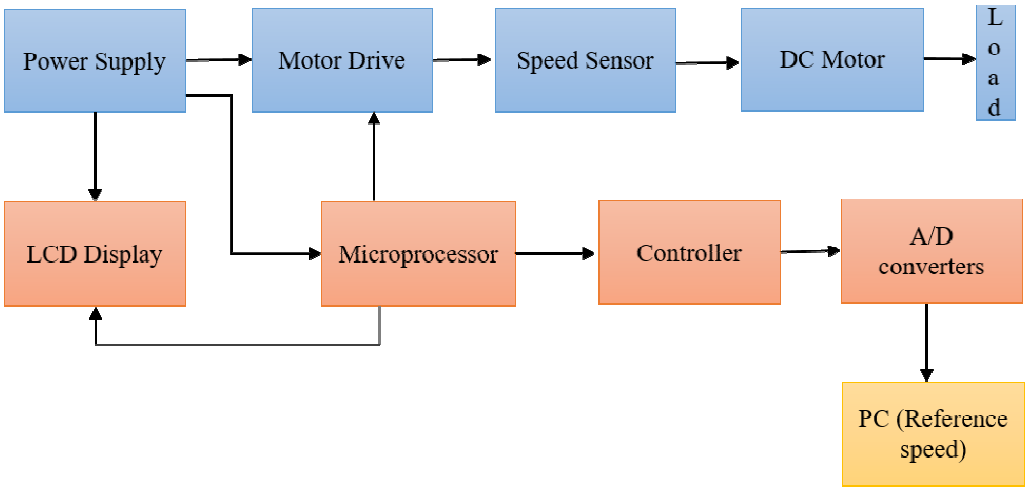

Figure 2: Illustrates the Speed Control of the DC Motor with help of a Microprocessor.

3.2. Instrument:

The purpose of this project would be to design and build a circuit that will enable microprocessor-based motor speed control. Push switches, which are labeled as vertical and horizontal buttons throughout this circuit, are used to start interrupt signals that cause the microcontroller to change the speed of the DC motor. A speed sensor attached to the motor shaft monitored this change in speed, and the results were consistent with what they expected. The component used in the system are categorized as:

3.2.1. Speed Sensor (DC Tacho-Generator):

A transducer called a tachogenerator directly transforms rotational speed into an electrical output. They are frequently employed to regulate the speed of spinning machinery. The DC motor is connected to the tachogenerator. The output voltage of a tachogenerator is determined by the speed that a DC motor can reach. The tacho generators voltage output (e0) is calculated as follows:

$$e_0 = \frac{n_p n_c \omega\varphi * 10^{-8}}{60 n_{pp}}$$

Where, n_p= Number of poles, n_c= Number of Conductors in the armature, $\omega\varphi$=flux per pole, n_{pp}=parallel brush between positive and negative brushes, ω=rpm to be measured.

3.2.2. DC Motor:

A stator, rotor, plus commutator are the basic components of a DC motor. The rotor, also known as the armature, is the spinning portion of the motor and includes wires that are inserted into the armature holes throughout which electricity travels. The stator is the motor's housing and contains magnets. Variations in the supplied operating voltage can be used to regulate these DC machines' speed.

3.2.3. Power Supply:

Circuit planning a microcontroller unit, an electromechanical relay, or several loads, including single-phase actuators, lights, valves, etc., are included in the majority of electrical household products. Either a controlled power source or direct electricity is used to run them. A power source that regulates its average output voltage to a predetermined value is called a power supply. Despite fluctuations either in the load current or even the voltage provided by the power appliances' source of energy, the regulated value of voltage is maintained practically constant. They are much more effective, use less energy, are smaller, and weigh less.

3.2.4. Microprocessor :

A microprocessor is a type of computer processor in which the logic and control for data acquisition are housed on a single integrated circuit or a few interconnected integrated circuits. The arithmetic, logical, and control circuitry needed to carry out the tasks of a computer’s central processing unit are all included within the microprocessor. Although general computer applications that call for more complicated and adaptable computing processes benefit more from using the microprocessor.

3.2.5. LCD (Liquid Crystal Display):

It is a particular kind of flat panel screen that runs mostly on liquid crystals. Since they are often used in cellphones, televisions, computers, and instrument panels, LEDs offer a wide range of applications for consumers and enterprises. Regarding the technology that was replaced, LCDs represented a significant advancement. Compared to cathode ray tube technology, LCDs allowed screens to be significantly thinner. As opposed to LED and gas-display displays, LCDs operate on the idea of blocking light instead of generating it, which results in a significant reduction in power consumption. An LCD's liquid crystals use a backlight to create a picture in which an LED emits light.

3.2.6. Analogue-to-Digital Converter (ADCs):

It enables digital logic circuits like Arduino boards, microprocessor electronics, and other similar circuits to interact with the outside world. Many electronic systems are integrated with their surroundings by monitoring the analog signals from such transducers, which are continually changing values that originate from numerous sources including sensors that can monitor sound, light, temperatures, or mobility.

3.3. Data Collection:

The need for considerably better control efficiency and higher supervisory capabilities in motor control systems has made microprocessor-based digital control technology vital. In the data accumulation in which the taken parameters of motor control by the microprocessor-based in Table 1.

Table 1: Illustrates the Configuration of the tentative setup of the Microcontroller-based adjustable-speed DC-Motor Drive System.

S.NO.	Parameters	Specification
1	Rated Power	35 kilo-watt
2	Rated Voltage	220 voltage
3	Rated Current	168 ampere
4	Rated Speed	1800 rpm
5	Phase (φ)	0.58 V second/radian
6	Inductance (L)	9.5 mH
7	Torque speed (T_s)	8.0 mili second(msec)
8	Torque Current (T_c)	4.5 msec
9	Resistance	0.5 ohms

3.4. Data Analysis:

A tachogenerator is used to measure the real speed. Its response is compared with the reference source, and the microprocessor corrects the mistake before sending the rectified control signal toward the preamplifier through its output. The power amplifier (PA) with output saturating at U, the DC motor, as well as the digital-to-analog conversion (DAC) make up the system's continuous part. An independently activated DC motor's transfer function can be roughly represented as:

$$G_m(S) = \frac{K_m}{T_m s+1}\text{(Rad/s*velocity)}$$

Where the mechanical time constant, Tm, as well as the transfer gain Km are typically provided beforehand.

4. RESULTS AND DISCUSSION

The goal of the study work is to provide a straightforward, highly effective speed controller for just an indirect field-oriented, microprocessor-based motor control system. Devices for controlling the speed of DC motors are widely used in daily life. It works well with a variety

of home appliances, robotic motion control technologies, and industrial automated systems. Without a doubt, its applicability in small-scale manufacturing environments will support our country's efforts to develop. This study's newly created microcontroller-based control system for changing a DC motor's speed would undoubtedly increase the demand for automated processes in small- and medium-scale industrial workplaces.This circuit's components have been located, and the finished circuit has been examined. The speed of such an electric fan was managed by this circuit. In addition, it would be used to facilitate the direction of small toys, the brightness of a lamp, and a variety of other functions. However. A de motor's conversion efficiency is rarely greater than 85%. A typical AC motor has 90% efficiency. Even taking significant losses within the control system into account. Finally, employing ac improves the overall efficiency of both the propulsion system-control. The DC motor is the ideal option while operating at low frequencies since energy recovery is easiest for it.

4.1. Application of DC Motors in Different Fields:

Since DC motors offer a higher starting torque than induction motors, they are employed in a wide range of applications. DC motors with abrasives offer excellent efficiency and superb rotational control, in addition to being simple to miniaturize. Thanks to the shortage of brush wear, brushless DC motors have a long lifespan, are simple to maintain, and are silent. Since they are used in numerous procedures and applications found all around us, DC motors are simple to locate. For more than 130 years, DC motors have served as a mechanical source of power. They may be used for everything from powering a bedroom ceiling fan to generating mechanical energy for a huge printing machine.

4.1.1. Diesel Electric Locomotives:

In diesel electrical locomotives, the combustion produced by the diesel car is paired with a generator, which transforms it from rotational energy into electrical power. The engine's wheels are connected to DC motors which receive the transformed electrical energy.

4.1.2. Electric Vehicles:

Electric car windows that are powered by electricity are retracted and adjusted using brushed DC motors. Due to their extended lifespan and lack of noise, automated tools are used in many applications for electric vehicles where brushed motors are more commonly used. Windshield wipers as well as CD players both employ brushless DC motors. Current hybrid electric cars are all powered by brushless DC motors.

4.1.3. Cranes:

The motor must be able to sustain a full load at zero velocity in situations with overhauling loads as mechanical brakes might not have been necessary. DC motors provide the most economical and secure choice in certain scenarios. The advantages of their height and weight are significant.

4.1.4. Conveyor Systems:

DC motors are a perfect choice for conveyor systems since they have consistent speed and high power requirements. DC motors have been discovered to provide strong torque during start-up and even steady speed in other operations. The most popular type of DC motor utilized in conveyor applications is brushless. A key need for conveying equipment is that they are silent and simple to manage.

4.1.5. Ceiling Fans:

DC-powered ceiling fans have grown quite popular. They have a quick start-up torque and consume less electricity. A transformer may quickly convert current alternating current in some kind of a house or office to direct current, which reduces the power needed by the fan. Brushless DC motors have been most frequently utilized in ceiling fans, much like in other DC vehicle applications.

4.1.6. Pump Drives:

Due to their easy control, strong starting horsepower, variable speed regulation, and good transient performance, DC motors have always been the primary power source for pumps for many years. Pumping systems depends on brushed DC motors being their main source of power for a long time. For the performance of pump systems, permanent magnet DC motors including brushless DC motors have emerged as more advantageous options.

4.1.7. Elevators:

Due to their difficulties in correctly leveling with both the floor and decelerating, AC motors are not practicable in high-speed escalators. These issues are solved by DC motors since they offer limitless speed control by adjusting the current sent to the armature. Similar to ceiling fans, a transformer is used to convert incoming AC electricity to DC so that the DC motor for something like an elevator may operate.

5. CONCLUSION

For the synthesizing of control parameters inside a direct digital system for motor speed control, many analytical techniques have been suggested. The digital control rule that is used and the method of monitoring the controlled variable are the key determinants of the system structure that is chosen (motor speed). The intermediate electrical engineering participants without an experience in control theory were able to comprehend the microcomputer-based dc motor speed-controlling system. To regulate the motor's speed, the system combines a microprocessor, another slow-processing data-gathering device, and a microcomputer.Students can learn the motor's no-load and load characteristics by bypassing the controller. In comparison to the conventional way of data collecting utilizing analog equipment, computerized data collection is more efficient. The reaction speed is one of the general characteristics determined by the position controller and determined by the control system, where the complimentary controller controls the susceptibility to parameter fluctuations traits that dampen. Include steady-state inaccuracy since there is no interference between both the two controllers, such design style has the advantage that any type of controller may be used as a position controller.

REFERENCES

[1] D. S. B. Utomo, A. Rizal, and A. F. O. Gaffar, “Model reference neural adaptive control based BLDC motor speed control,” 2018. doi: 10.1109/ICEEIE.2017.8328761.

[2] B. Liu, “Speed control for permanent magnet synchronous motor based on an improved extended state observer,” *Adv. Mech. Eng.*, 2018, doi: 10.1177/1687814017747663.

[3] A. T. Nguyen, M. S. Rafaq, H. H. Choi, and J. W. Jung, “A model reference adaptive control based speed controller for a surface-mounted permanent magnet synchronous motor drive,” *IEEE Trans. Ind. Electron.*, 2018, doi: 10.1109/TIE.2018.2826480.

[4] V. P. Nicholson, J. W. L. Keogh, and N. L. L. Choy, “Can a single session of motor imagery promote motor learning of locomotion in older adults? A randomized controlled trial,” *Clin. Interv. Aging*, 2018, doi: 10.2147/CIA.S164401.

[5] A. Sabir and S. Ibrir, "Induction motor speed control using reduced-order model," *Automatika*, 2018, doi: 10.1080/00051144.2018.1531963.

[6] A. N. Abd, "Adaptive Inverse Neural Network Based DC Motor Speed and Position Control Using FPGA," *DJES*, 2018, doi: 10.24237/djes.2018.11311.

[7] A. Idir, M. Kidouche, Y. Bensafia, K. Khettab, and S. A. Tadjer, "Speed control of DC motor using PID and FOPID controllers based on differential evolution and PSO," *Int. J. Intell. Eng. Syst.*, 2018, doi: 10.22266/ijies2018.0831.24.

[8] D. Bao, H. Wang, X. Wang, H. Wang, and C. Zhang, "Sensorless speed control based on the improved Q-MRAS Method for induction motor drives," *Energies*, 2018, doi: 10.3390/en11010235.

[9] N. Pimkumwong and M. S. Wang, "Online speed estimation using artificial neural network for speed sensorless direct torque control of induction motor based on constant V/F control technique," *Energies*, 2018, doi: 10.3390/en11082176.

[10] S. Kesler, "Performance Analysis of Different PWM Techniques on V/f-based Speed Control with Boost Voltage Application for Induction Motors," *Pamukkale Univ. J. Eng. Sci.*, 2018, doi: 10.5505/pajes.2018.13845.

[11] J. J. Wang, "Parameter optimization and speed control of switched reluctance motor based on evolutionary computation methods," *Swarm Evol. Comput.*, 2018, doi: 10.1016/j.swevo.2017.09.004.

[12] M. S. Wang, S. C. Chen, and C. H. Shih, "Speed control of brushless DC motor by adaptive network-based fuzzy inference," *Microsyst. Technol.*, 2018, doi: 10.1007/s00542-016-3148-0.

[13] I. K. and A. I., "Fractional Order PID Controller Design for Speed Control DC Motor based on Artificial Bee Colony Optimization," *Int. J. Comput. Appl.*, 2018, doi: 10.5120/ijca2018916525.

[14] A. M. Zaki, M. El-Bardini, F. A. S. Soliman, and M. M. Sharaf, "Embedded two level direct adaptive fuzzy controller for DC motor speed control," *Ain Shams Eng. J.*, 2018, doi: 10.1016/j.asej.2015.10.003.

[15] S. K. Sahu, "Microcontroller Based Dc Motor Control," *Internatonal J. Eng. Reserach Technol.*, vol. 1, no. 3, pp. 1–4, 2012.

[16] V. R., "Design and Analysis of Motor Control System for Wireless Automation," *J. Electron. Informatics*, vol. 2, no. 3, pp. 162–167, 2020, doi: 10.36548/jei.2020.3.002.

[17] S. Buriakovskyi, A. Maslii, O. Pasko, and I. Denys, "Research and development of an electric traction drive based on a switched reluctance motor," *Transp. Probl.*, vol. 13, no. 2, pp. 69–79, 2018, doi: 10.20858/tp.2018.13.2.7.

[18] R. Szczepanski, M. Kaminski, and T. Tarczewski, "Auto-tuning process of state feedback speed controller applied for two-mass system," *Energies*, vol. 13, no. 12, pp. 1–16, 2020, doi: 10.3390/en13123067.

[19] M. Divandari, B. Rezaie, and A. Ranjbar Noei, "Speed control of switched reluctance motor via fuzzy fast terminal sliding-mode control," *Comput. Electr. Eng.*, vol. 80, p. 106472, 2019, doi: 10.1016/j.compeleceng.2019.106472.

CHAPTER 20

ARDUINO-BASED SMART HOME SECURITY SYSTEM

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ABSTRACT: ***Home security is a major requirement of the household to protect the home safer from intruders getting robbed. Automated security systems are a useful addition to today's home where safety is an important issue. Now technology has spread in every field of our lives. In the present era, everybody has some kind of connectivity with technology whether in front of a mobile, laptop, or other. Here we discuss the use of technology in the field of home security. In this, we used an Arduino UNO microcontroller board. This system is based on door lock security, fire sensing unit, LPG leakage alert system, and laser light LDR wall protection system. here, a security system has been developed that uses the sensor to detect any security violation and sends out the alert signal to a high-intensity buzzer. in this paper, it has been ensured a four-level security system. there are many benefits to having a smart home security system, in addition to having a traditional system. Some of the top benefits include; integration, convenience, accessibility, 24/7 protection, and intelligent security professional assistance. The future scope of this system is to provide automated security in the home, offices, and any institution.***

KEYWORDS: Arduino- based security, Door security, Fire detection, LPG leakage, Smart home security system.

1. INTRODUCTION

For the last few years home security is an essential requirement of the household to keep the home safer from intruders getting robbed. So researchers and companies try to implement an algorithm and make some gadgets that keep your home safe from intruders[1]–[3]. This leads to advance technology that makes your home intelligent or modern this is called a home automation & security system also. With this technology, house owners can control other appliances as well like lighting systems, electrical appliances, and many mores. Nowadays wireless technology is used to control home appliances instead of wired topological connection[4], [5]. The home security system offers many benefits. After so much research I gave mainly focused on Arduino-based home security systems. It is very easy to install and has a very less cost. Security has been a major concern in every field like colleges, institutes, corporate companies, societies, etc.

. Automated security systems are a useful addition to today's world where safety is an important issue. Incidents like thefts, fire, and LPG gas leakage are very common these days[3]. What is uncommon, is people's awareness of different systems like smoke detectors, gas leakage detectors, etc. installing all these different detectors to keep the house secure is also something difficult to maintain[6]. Here, we have designed an integrated home security system that would help people secure their houses from such incidents. The Arduino-based home security system is designed to help an individual secure his/her house from theft, fire, and LPG leakage[7]. . It is installed over the entry that the front door where an ultrasonic sensor is installed which is connected to the Arduino board and coding is done in a such a manner that detects the human it is turned on the buzzer.This Research uses four different sensors, from which data is sent over a website through the Internet of Things(IoT). The IoT is basically, the network of things by which physical things can exchange data with the help of sensors, electronics, software, and connectivity. These systems do not require any human interaction.

The main objective of a smart home security system is to provide flexible access to the home appliances through an internet connection and the functions are, using sensors to detect the motion of a person entering or leaving the home, using fire sensors to detect fire and lpg leakage and to provide theft protection by LDR sensors, etc.,[8]. There has been much research done on various type of home security systems like sensor-based home security system, fingerprint, and keypad activation for authentication and so much. all type of security system uses only a technique of GSM (lobal System for Mobile Communication). Normally this project aims to keep the secure home from intruders. to increase the performance of a smart automated house, lots of research is going on[9].

The components that are used in the Arduino-based[10] home security system are;

1. Arduino
2. Flame sensor(fire sensor)
3. MQ-6 sensor(LPG leakage detect sensor)
4. Ultrasonic sensor
5. LDR sensor
6. DC servomotor
7. Laser light
8. Buzzer

2. LITERATURE REVIEW

According to Suresh S. et al.,' the system is designed for the home observance and security system consists of sensors that are meant to collect the information that may be employed by the owner to create sensible choices. A passive infrared sensor (PIR) is employed to find out the motion and therefore temperature sensing element is employed to sense the temperature of the house. Various modules especially the PIR module, temperature module, and therefore the GSM module communicate with one another to coordinate and increase the safety of the system. in this, the PIR sensing element and therefore the temperature sensing element are connected to the Arduino board. The digital signal is distributed to the board.

Designing and implementing a smart home security system was discussed by Govinda[11] which provides a couple of methods for providing home security on the concepts of IoT. One of these proposed methods was of using cameras as a sensor. The idea was to set up multiple cameras at different locations such that whenever detects a motion, an alarm will be turned on and an alert will be sent to the owner's phone via sms. The idea is excellent but the cost of the method is high because of use of high-quality cameras and hardware of the system are very expensive.

Another smart security system was introduced by karri and Daniel[11] which proposes the use of the method of Internet of Things (IoT) which sends a notification or alert message to the owners over the medium of the internet instead of using the conventional method of sms. another system was implemented by Jayashri and Arvind[12] which was implemented was a fingerprint-based door accessed sys to unlock a door. The system is good and is added with a few more security features like fire and LPG leakage detection. though the designated system was good the use of fingerprints along with the IoT is very reasonable.in addition to this, it is advised to use another security level in the form of a pin, passcode, etc.

Lee and shen[13] proposed an amazing way to design an electronic locking morse code along with IoT technology they claimed to be an original idea which was never been tried before.

The system uses LEDs as an encrypting medium to send signals. LED in the smartphone was used to make it more accessible to the general public. Microcontroller and a photosensitive resistor which can decrypt the code and unlock the door after checking for the authentication they claimed it to be an easy and user-friendly interface.

3. Methodology

The Arduino-based home security system uses four sensors a flame sensor to detect fire, an MQ-6 sensor to detect LPG leakage, and an ultrasonic sensor to detect human motion and open the gate automatically by operating a DC servomotor. A laser light-sensitive LDR sensor detects any human centered on the wall to elaborate on theft detection (Figure 1).

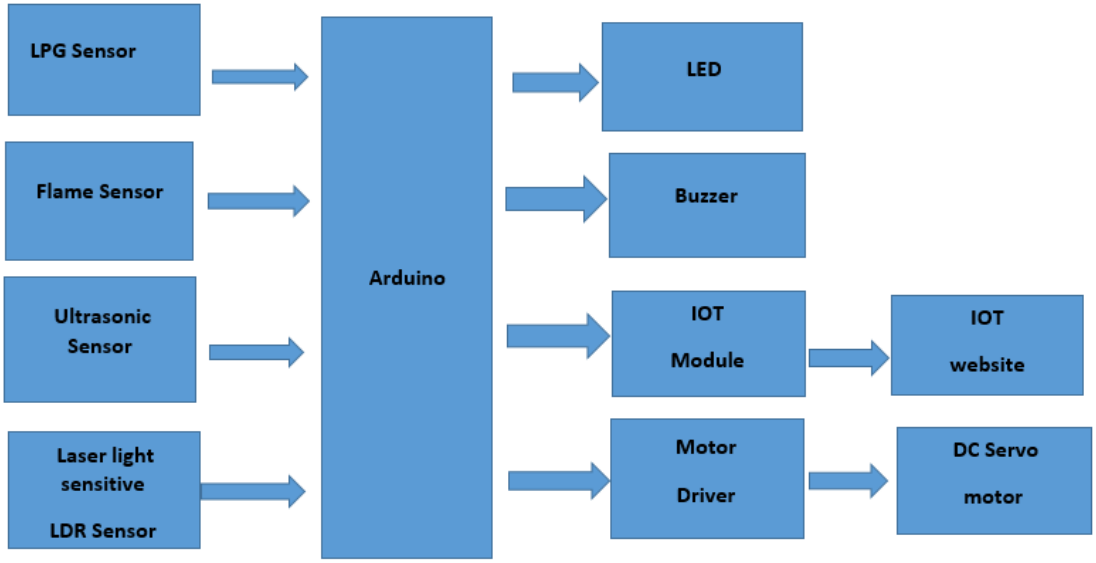

Figure-1 block diagram of Arduino-based home security system[14]**.**

3.1 Arduino:

The Arduino is a small, complete, and breadboard-friendly board based on the atmega328p released in 2008. It offers the same connectivity and specs as the Arduino UNO board in a smaller form factor.The Arduino is equipped with 30 male i/o headers, in a dip-30-like configuration, which can be programmed using the Arduino software integrated development environment (ide), which is common to all Arduino boards and runs both online and offline. The board can be powered through a type-b mini – USB cable or from a 9v battery.The Arduino was released in 2008. In 2019, Arduino released Arduino nano every, a pin equivalent evolution of the nano. It features a more powerful atmega4809 processor and twice in the ram.Arduino is programmed in c++ language to operate on given conditions such as theft, fire detection, LPG leakage detection, etc.

3.2 Ultrasonic sensor:

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect from boundaries to produce distinct echo patterns.Ultrasonic sensors work by sending out a sound wave at a high frequency above the range of human hearing. The transducer of the sensor act as a microphone to receive and send the ultrasonic sound. Our ultrasonic sensors, like many others, use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by measuring time lapses between sending and receiving of the

ultrasonic pulse. It sends an ultrasonic pulse out at 40kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor.

To detect transparent and other items where optical technology may fail, ultrasonic sensors are a reliable choice.

3.3 Servomotor:

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servomotor to rotate with great precision.Ultrasonic sensors detect human motion and the transducer sends the signal to Arduino, then Arduino sends the signal to the servomotor to open/ close the gate. And turned on the alarm buzzer.

3.4 Flame sensor:

The flame sensor is a short, thin metallic rod that creates a small current of electricity to confirm the presence of a flame burning within the furnaces. As the gas valve opens to kickstart the combustion process, the current moves from the sensor to detect the heat from a flame. Working of the flame sensor can detect the heat from the fire using a receiver like electromagnetic radiation and send the signal alarm buzzer through Arduino. This sensor uses the infrared flame flash method, which allows the sensor to work through the coating of oil, dust, water vapor, otherwise ice.

3.5 MQ-6 SENSOR:

MQ-6 Sensor is a metal oxide semiconductor type gas sensor mainly used to detect the LPG and butane gas concentration in the air either at home or in industry. The sensor contains a sensing element, mainly aluminum-oxide-based ceramic, coated with tin dioxide, enclosed in a stainless-steel mesh.Working of MQ-6 sensor to sense the LPG leakage and send the operating signal to the alarm buzzer through the Arduino.

3.6 laser light-sensitive LDR sensor:

photoresistors also known as light-dependent resistors (LDR), are light-sensitive devices most often used to indicate the presence or absence of light or to measure the light intensity. At night the resistance of the LDR sensor is very high.The LDR sensor is mounted on the wall around the home. On one side of the wall laser light is mounted and on another side of the wall is LDR sensor is placed. The laser radiated on the LDR sensor. When a person entered between the laser light and the LDR sensor, the contact between the laser light and LDR is broken, and the LDR sensor is operated to send the signal to the buzzer turned on through Arduino, and the household's peoples are alert (Table 1).

Table 1: Technical specification data of Arduino:

Microcontroller	Microchip ATmega32P
Operating voltage	5 volts
Input voltage	5 to 20 volts
Digital I/O pins	14 (6 optional PWM outputs)
Analog input pins	8
DC per I/O pin	40 mA

DC for 3.3V PIN	50mA
Flash memory	32 KB, of which 2 KB is used by the bootloader
SRAM	2KB
EPROM	1KB
Clock speed	16MHz
Length	45mm
Width	18mm
Mass	7g
USB	Mini-USB type B
ICSP Header	Yes
DC Power jack	No

4. RESULT AND DISCUSSION

In this section, we discuss the implementation of the Arduino security monitoring system evaluation result. Firstly, we integrate the designed system the connection between Arduino with the sensors, and the connection between the buzzer and Arduino. The ultrasonic sensor located at the main gate and servomotor is used for opening & closing gate operation. The flame sensor and LPG leakage sensor are operated in the home to detect fire and LPG leakage along with the buzzer. and the LDR sensor placed on the wall around the home. the scenario of the evaluation is described as follows:

1. Firstly, we activate the system and the intruder will open the gate and enter the home.
2. The system will take detect the movement of the intruder and give a signal to the Arduino.
3. The Arduino will analyze the existence of the intruder and activate the buzzer.
4. The flame sensor detects the fire and activates the buzzer through the analysis of Arduino.
5. MQ-6 sensor senses the LPG leakage and activates the buzzer.
6. The LDR sensor detects the entrance of a thief from the wall and activates the buzzer by analyzing through the Arduino.

4.1 Smart home security benefits:

the are many benefits to having a home security system, in addition to having a traditional system. Some of the top benefits include;

Integration: smart home security system components can communicate to maximize efficiency, and performance and protect from any kind of danger such as theft, fire, LPG leakage, etc.

Convenience: normal processes can be automated and streamlined for convenience. Whether the smart home system ensures light turn on when a tag sensor enters the home or

that the alarm system is automatically operated when the main gate is locked, there are many ways a smart home helps improve the efficiency of protection from dangerous activities.

Accessibility: if you have an internet connection, you can control and monitor your home security anywhere in the world by providing GSM technology and web cameras in addition to this. This may be particularly attractive to pet owners and families who wish to monitor when they are not in the home.

24/7 protection: using a smart home security system and intelligent programming, and cloud storage your home is protected at all times. If security is breached, the feedback is quick and you are informed in a straight way.

Simple set-up: smart home devices are wireless and therefore simply moved from one place, these devices just need to be connected to supply and communicate with others to get started.

Intelligent security: smart home gives you added peace of mind, intelligent programming to detect when something is abnormal, and alert you to unusual activity, ensuring nothing is missed.

Professional assistance: as with any security system, the smart home security system can be installed simply and advised on by experts. Security specialists, like A.P.E., can provide advice, installation, and maintenance to ensure your security system is providing maximum protection.

4.2 Application of Arduino-based home security system:

Security is the main intent of the research, the most important application of this system is to provide security to the home, societies, shopping malls, institutions, etc. this system a person will be intimidated by incidents likely to be caused by fire, theft, or LPG. This system also can be used in banks, restaurants, manufacturing units, etc.

4.3 Advantage and future scope:

The main advantage of this system is that it is fully automated. Once installed, it does not require any kind of human interaction. Also, it is very cost-effective. Arduino-based home security systems can be enhanced to identify fingerprints as opposed to password authentication using a keypad. Additionally, we can have a voice announcement system. It would send out vocal instructions regarding any kind of the four hazardous conditions to detect smoke, temperature, and LPG sensors.

4.4 Discussion:

As we discuss above the PIR module, GSM module, fingerprint-based door lock, and password authentication-based door locks use cameras and L.E.D. for protection. the real problem is each system have a different area of work and perform a different task which means, there is a system that is used to measure the temperature or fire in the building and systems which used cameras and GSM module. The hardware and software cost of these modules is very high and everybody can't afford such systems because of their installation cost. We made such a system that is afforded by every people such as middle-class people for their home security. Such system cost is low budget and the performance, and efficiency of this security system is high.

4.5 Future modification:

As we have discussed in the problems, the first thing is to combine all the related systems to make an overall system that could work with high efficiency and might perform multi tasks such as prevention of unauthorized persons in the house, detection of fire, and to let

housekeeping about any abnormal condition going on in the home in the unavailability of the owner. We could use the GSM module to let the housekeeping stay connected with the house and to control the system from any location outside of the town. The further system should also be capable enough to recognize the danger and must be connected to the various government department for any kind of emergency case.

5. CONCLUSION

As we have seen in the literature section that lots of work have done in the research for a home security system but yet there is something which is not been touched. In any of the security systems, there might be coordination among all the system's proper functioning. security is an issue that is needed in times of emergency; hence the system must be connected to the department that could help in the time of emergency. A lot of work has been done in this field and much more is required to make a security system that gives maximum performance and high efficiency.

REFERENCES

[1] Q. I. Sarhan, "Systematic Survey on Smart Home Safety and Security Systems Using the Arduino Platform," *IEEE Access*. 2020. doi: 10.1109/ACCESS.2020.3008610.

[2] M. Farid, M. Ramlan, and L. Bakar, "Fingerprint Doorlock and Home Security System by Using Arduino and IOT," *Prog. Eng. Appl. Technol.*, 2021.

[3] M. Andriansyah, M. Subali, I. Purwanto, S. A. Irianto, and R. A. Pramono, "E-KTP as the basis of home security system using arduino UNO," in *Proceedings of the 2017 4th International Conference on Computer Applications and Information Processing Technology, CAIPT 2017*, 2018. doi: 10.1109/CAIPT.2017.8320693.

[4] A. A. Roslan and R. Baharom, "Advanced gas leakage, fire and power supply failure monitoring system," *Indones. J. Electr. Eng. Comput. Sci.*, 2019, doi: 10.11591/ijeecs.v17.i1.pp222-227.

[5] J. A. J. Alsayaydeh *et al.*, "Development of Programmable Home Security using GSM System for Early Prevention," *ARPN J. Eng. Appl. Sci.*, 2021.

[6] M. Çavaş and M. B. Ahmad, "Design and Simulation of Four Walls Crossed Security System against Intrusion Using Pic Microcontroller," *Am. J. Eng. Res.*, 2018.

[7] L. Tanutama and W. Atmadja, "Home Security System with IOT Based Sensors Running on House Infra Structure Platform," in *IOP Conference Series: Earth and Environmental Science*, 2020. doi: 10.1088/1755-1315/426/1/012151.

[8] P. Sravani, "High Security Door Lock System by Using Android Mobile with Bluetooth," *Ijitr) Int. J. Innov. Technol. Res.*, 2017.

[9] S. Debnath, S. Ahmed, S. Das, A. Al Nahid, and A. K. Bairagi, "IoT based low-cost gas leakage, fire, and temperature detection system with call facilities," in *2020 2nd International Conference on Advanced Information and Communication Technology, ICAICT 2020*, 2020. doi: 10.1109/ICAICT51780.2020.9333530.

[10] O. Kholmatov and F. Mutalipov, "REAL-TIME HOME SECURITY SYSTEM BASED ON ARDUINO UNO AND GSM WITH SELF-GENERATING PASSWORD PROTECTION," *UniversumTechnical Sci.*, 2021, doi: 10.32743/unitech.2021.86.5.11738.

[11] A. Anitha, "Home security system using internet of things," in *IOP Conference Series: Materials Science and Engineering*, 2017. doi: 10.1088/1757-899X/263/4/042026.

[12] M. Sarma, A. Gogoi, R. Saikia, and D. J. Bora, "Fingerprint Based Door Access System using Arduino," *Int. J. Sci. Res. Eng. Manag.*, 2020.

[13] K. Likhitha, S. Malineni, N. Jampani, and N. L. Prasanna, "Home Security System Using PIR Sensor-IoT," *Int. J. Sci. Res. Comput. Sci. Eng. Inf. Technol.*, 2019, doi: 10.32628/cseit195272.

[14] H. I. M. Shamlan, Y. Wahab, and M. Z. M. Zin, "Automated home security system based on Arduino," *Int. J. Innov. Technol. Explor. Eng.*, 2019.

CHAPTER 21

AUTOMATION VEHICLE ACCIDENT DETECTION AND MESSAGING SYSTEM

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Abstract: ***The technology development has increased traffic hazard and road accident due to the lack of facilities. the dangerous driving can be detected using the accelerometer in car alarm application. It is used as crash or roll over detector vehicle during accident or after the accident. An accelerometer receives the signal which is used to reorganized the several accidents. In this pepper, when vehicle met with an accident or roll over vibration sensor. In this car have 3 sensor one has fire detector sensor, second have smoke detector sensor, third is token switch and IR sensor are used in this project all the sensor working are different. when a vehicle met with an accident or roll over the vibration sensor will detect the signal and sed it to ATMEGA 8A controller. GSM send alert message to police can trace the location to the GPS after receiving the information. When they are coming on this location police are coming on this location and ambulance and send msg to the relatives. During the accident, if the person did not get injured or if there is no serious threat to anyone life, then the alert massage can be stopped by driver of the rescuer team. This is used to detect accidently by mean of vibration sensor.***

KEYWORDS: Accident dictator, Accelerometer, Fire sensor, GSM, IR Sensor, Smoke Sensor.

1. INTODUCTION

An automation vehicle accident detection and messaging system is a technological solution that utilizes sensors, algorithms, and communication technologies to detect accidents involving vehicles and automatically send out distress messages for prompt assistance[1]–[6]. This system aims to enhance road safety, minimize response time, and improve emergency services in the event of a vehicle accident.The core components of an automation vehicle accident detection and messaging system typically include:

Vehicle Sensors: These sensors are installed in vehicles and are responsible for detecting abnormal events or movements that indicate a potential accident. Common sensors used in such systems include accelerometers, gyroscopes, GPS modules, and impact sensors. These sensors continuously monitor various parameters such as sudden changes in speed, acceleration, deceleration, and vehicle orientation.

Accident Detection Algorithms: The system employs sophisticated algorithms to process the data from the vehicle sensors and determine if an accident has occurred. These algorithms analyze the sensor data patterns and compare them against predefined criteria or thresholds that indicate an accident. For example, a significant impact or sudden deceleration beyond a certain threshold may trigger the accident detection algorithm.

Communication System: Once an accident is detected, the system initiates communication to alert emergency services or designated contacts about the accident. This is typically done using wireless communication technologies such as cellular networks, Wi-Fi, or satellite communication. The system can send automated distress messages that include information such as the location of the accident, vehicle identification details, and relevant sensor data.

Emergency Response Integration: The automation vehicle accident detection and messaging system interfaces with emergency response services, such as local authorities, hospitals, or roadside assistance providers. The system can transmit the accident information directly to these services, enabling them to dispatch help quickly and efficiently. Integration with emergency response systems ensures that appropriate assistance is dispatched to the accident location promptly.

User Interface and Alerts: The system may include a user interface or dashboard where users, such as vehicle owners or fleet managers, can monitor the status of their vehicles and receive real-time alerts in case of an accident. The alerts can be in the form of SMS messages, push notifications, or emails, notifying the users about the accident and providing relevant details.

The benefits of an automation vehicle accident detection and messaging system are manifold. Firstly, it enables rapid detection of accidents, allowing for timely intervention and assistance. This can potentially save lives and reduce the severity of injuries. Secondly, by automatically sending distress messages with accurate accident information, emergency response services can mobilize quickly and efficiently. Thirdly, the system provides an added layer of security and peace of mind for vehicle owners, as they know that help will be promptly notified in the event of an accident.

Overall, an automation vehicle accident detection and messaging system leverages advanced technologies to improve road safety, minimize response time, and enhance emergency services in the case of vehicle accidents. By integrating sensor data, algorithms, and communication systems, this system plays a vital role in protecting lives and providing timely assistance on the road[7],[8],[9],[10],[11].

2. DISCUSSION

The automation vehicle accident detection and messaging system is an advanced technology that aims to enhance road safety and emergency response in the transportation industry. This system is designed to automatically detect accidents or abnormal vehicle behavior and promptly notify relevant parties, such as emergency contacts or authorities.

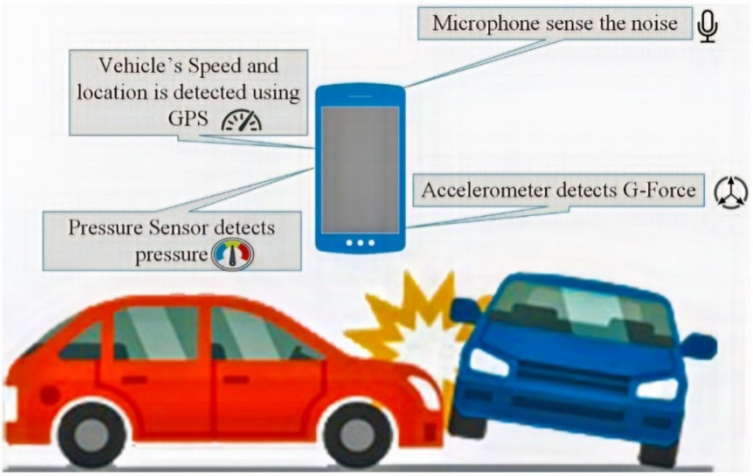

Figure 1: Automation vehicle accident detection and messaging system

By implementing this system in personal vehicles, fleet management operations, public transportation, and emergency services, several benefits can be achieved. It enables quick response and assistance during accidents, minimizes downtime, and ensures passenger safety. Insurance companies can also leverage the system's data for risk assessment and personalized policies. Moreover, integrating the system with smart city initiatives contributes to creating safer and more efficient transportation networks.Overall, the automation vehicle accident detection and messaging system plays a vital role in improving road safety, optimizing emergency response, and facilitating a proactive approach to accident management in the transportation industry (Figure 1).

The application of an automation vehicle accident detection and messaging system is widespread and can be implemented in various scenarios related to road safety and transportation. Some key applications of this system include:

Personal Vehicles: The system can be installed in personal vehicles, such as cars, motorcycles, or bicycles, to provide an extra layer of safety for individual drivers and passengers. In the event of an accident, the system automatically detects the impact or abnormal vehicle behavior and sends distress messages to emergency contacts, allowing for quick response and assistance.

Fleet Management: For organizations that manage a fleet of vehicles, such as transportation companies, logistics providers, or delivery services, implementing an automation vehicle accident detection and messaging system is crucial. It helps monitor the safety of the fleet and ensures prompt response in case of accidents, minimizing downtime and potential risks for drivers and cargo.

Public Transportation: Public transportation systems, including buses, trains, and trams, can benefit from this system to enhance passenger safety. By equipping vehicles with accident detection sensors and messaging capabilities, authorities can quickly respond to accidents and provide necessary assistance to passengers and drivers.

Emergency Services: Integration of the automation vehicle accident detection and messaging system with emergency response services, such as police, fire departments, and ambulance services, is vital. When an accident occurs, the system can directly transmit accident details, including location, to the relevant emergency services. This enables faster response times and ensures that the appropriate assistance is dispatched promptly.

Insurance and Telematics: Insurance companies can leverage the data collected by the system to assess accident risk and determine insurance premiums more accurately. The system's real-time accident detection and reporting capabilities provide valuable insights into driving behavior, enabling insurers to offer personalized policies and incentivize safe driving practices. Telematics solutions can also benefit from the accident detection system by integrating the collected data for analyzing driver patterns and providing feedback on safe driving habits.

Smart City Initiatives: The implementation of automation vehicle accident detection and messaging systems aligns with the goals of smart city initiatives. By utilizing advanced technologies to enhance road safety and emergency response, cities can create safer and more efficient transportation networks. This system contributes to reducing accident-related congestion, improving overall traffic flow, and optimizing emergency services.

The automation vehicle accident detection and messaging system offers several benefits to the transportation industry and society as a whole. Here are some key advantages:

Enhanced Safety: The system significantly improves road safety by detecting accidents or abnormal vehicle behavior in real-time. It allows for immediate communication of the incident, enabling faster emergency response and reducing the risk of further harm.

Prompt Emergency Assistance: By automatically notifying relevant parties, such as emergency contacts or authorities, the system ensures that help arrives quickly at the accident site. This leads to faster medical assistance for injured individuals, potentially saving lives.

Reduced Response Time: Traditional methods of reporting accidents often rely on individuals making emergency calls. The automation system eliminates the need for manual intervention, enabling faster and more efficient incident reporting, which leads to reduced response times.

Efficient Resource Allocation: The system helps emergency services and authorities allocate their resources more effectively. By receiving real-time accident notifications with precise location details, they can dispatch the appropriate personnel and equipment to the scene promptly, optimizing emergency response efforts.

Improved Accident Investigation: The system collects valuable data about accidents, such as time, location, and vehicle behavior before and during the incident. This data can be analyzed to gain insights into accident causes, contributing factors, and patterns. It helps authorities and insurance companies better understand accidents and take proactive measures to prevent future incidents.

Insurance and Legal Benefits: The system's data can be used by insurance companies to assess risks accurately. It enables insurers to offer personalized policies based on individual driving behavior, leading to fairer premiums. Additionally, the recorded data can serve as valuable evidence in legal proceedings related to accidents, ensuring a more accurate and just resolution.

Proactive Maintenance and Vehicle Monitoring: The system can monitor vehicle health parameters and detect potential issues or malfunctions before they lead to accidents. This proactive maintenance approach improves overall vehicle safety and reduces the risk of accidents caused by mechanical failures.

Safer Public Transportation: Public transportation systems can benefit from the system by enhancing passenger safety. Real-time accident detection and immediate communication allow for swift response and evacuation protocols, ensuring the well-being of passengers during emergencies.

Overall, the automation vehicle accident detection and messaging system brings significant advantages, including improved safety, faster emergency response, efficient resource allocation, and data-driven insights for accident prevention. It plays a crucial role in creating safer transportation networks and protecting lives on the roads.

3. CONCLUSION

In conclusion, the automation vehicle accident detection and messaging system is a groundbreaking technology that revolutionizes road safety and emergency response in the transportation industry. By utilizing advanced sensors, real-time data analysis, and instant communication capabilities, the system can detect accidents or abnormal vehicle behavior and promptly notify relevant parties, such as emergency contacts and authorities.The system offers numerous benefits, including enhanced safety, prompt emergency assistance, reduced response times, efficient resource allocation, improved accident investigation, insurance and legal advantages, proactive maintenance, and safer public transportation. These benefits collectively contribute to a safer and more secure transportation ecosystem, minimizing the risk of accidents, mitigating injuries, and potentially saving lives.

With its ability to quickly detect and communicate accidents, the system empowers emergency services to respond swiftly and efficiently, ensuring that help reaches the accident site in the shortest possible time. The data collected by the system also plays a vital role in accident investigation and prevention, allowing authorities to gain insights into accident causes and patterns, implement preventive measures, and create safer road environments.

REFERENCES

[1] A. Vangala, B. Bera, S. Saha, A. K. Das, N. Kumar, and Y. Park, "Blockchain-Enabled Certificate-Based Authentication for Vehicle Accident Detection and Notification in Intelligent Transportation Systems," *IEEE Sens. J.*, 2021, doi: 10.1109/JSEN.2020.3009382.

[2] W. J. Chang, L. B. Chen, and K. Y. Su, "DeepCrash: A deep learning-based internet of vehicles system for head-on and single-vehicle accident detection with emergency notification," *IEEE Access*, 2019, doi: 10.1109/ACCESS.2019.2946468.

[3] N. Kumar, D. Acharya, and D. Lohani, "An IoT-Based Vehicle Accident Detection and Classification System Using Sensor Fusion," *IEEE Internet Things J.*, 2021, doi: 10.1109/JIOT.2020.3008896.

[4] R. Thrivikraman, J. Rajeshkumar, and C. Mageshkumar, "User alerting system for vehicle accident detection system," *Int. J. Adv. Res.*, 2018.

[5] R. A. Jangle, S. S. Girpunje, and G. M. Thorat, "An IOT Based Vehicle Accident Detection and Alert System," *Turkish J. Comput. Math. Educ.*, 2021.

[6] S. Bhavthankar and G. Sayyed, "Wireless System for Vehicle Accident Detection and Reporting using Accelerometer and GPS," *Int. J. Sci. Eng. Res.*, 2015.

[7] A. Maneesha, "Road Safety at Ghats using IoT," *Int. J. Res. Appl. Sci. Eng. Technol.*, 2021, doi: 10.22214/ijraset.2021.36270.

[8] A. S. Kumar, C. Venkatesh, and K. V. D. P. | S. Balaji, "Digital Tachometer using Aurdino," *Int. J. Trend Sci. Res. Dev.*, 2019, doi: 10.31142/ijtsrd23223.

[9] L. Li, N. Nasrabadi, and T. Carr, "Completion design improvement using a deep convolutional network," in *Proceedings - SPE Annual Technical Conference and Exhibition*, 2020. doi: 10.2118/201545-ms.

[10] H. Becker *et al.*, "Impact of vehicle automation and electric propulsion on production costs for mobility services worldwide," *Transp. Res. Part A Policy Pract.*, 2020, doi: 10.1016/j.tra.2020.04.021.

[11] J. Lach, K. Wróbel, J. Wróbel, P. Podsadni, and A. Czerwiński, "Applications of carbon in lead-acid batteries: a review," *Journal of Solid State Electrochemistry*. 2019. doi: 10.1007/s10008-018-04174-5.