DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

PEER-2K24

PROJECTS ON ELECTRICAL ENGINEERING RESEARCH

3rd-Edition

Editors:
Gowtham Patnaik
Ganesh Gokulapati

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EDITORIAL DESK

This book chapter provides an in-depth analysis of recent research projects in electrical engineering. The authors are from 4 th -year B.Tech, who have conducted a comprehensive literature review to identify the most promising projects in the field. Each chapter includes an overview of every project, as well as a detailed analysis of the methodology, results, and conclusions. The authors also discussed about the potential future research directions in electrical engineering and highlight areas that require further exploration.

Readers of this book chapter will gain insights into the latest research projects in electrical engineering, including their objectives, methodology, and findings. They will also learn about the potential impact of these projects on the field and the broader society. This book chapter is suitable for electrical engineering students, researchers, and practitioners who want to stay up-todate with the latest advancements in the field.

Gowtham Patnaik
Ganesh Gokulapati

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Chairman's Message

On behalf of the institution, I extend my heartfelt congratulations to the Electrical Engineering students on their recent achievements. Your dedication and hard work have brought great pride and glory to the institution.

I am particularly impressed with your recent book chapter on "PEER-2K24" (3rd Edition). This book chapter is a testament to your commitment to the field of electrical engineering and your ability to innovate and excel. Your research provides valuable insights into the latest advancements in the field and highlights areas that require further exploration. Your work serves as a shining example of what our students can accomplish with their passion and hard work.

I am proud to see that the institution has been able to provide a conducive environment for your academic and personal growth. The faculty members and staff have played an instrumental role in shaping your academic and research journeys. I take this opportunity to thank them for their tireless efforts.

As you move forward, I am confident that you will continue to make a significant contribution to the field of electrical engineering. You are the future of this field, and I have no doubt that you will excel and make a positive impact on society.

Once again, congratulations on your achievements, and I wish you all the very best for your future endeavours.

SRI DADI RATNAKAR,

Chairman, DIET.

Principal's Message

It is with great pride and joy that I extend my heartfelt congratulations to the Electrical Engineering students on their recent achievements. Your dedication, hard work, and academic excellence have brought great honour to our institution.

I would like to acknowledge the exceptional work that you have done on the book chapter, "PEER-2K24" (3rd - Edition). Your research provides valuable insights into the latest advancements in the field and highlights the potential for future research directions. The thoroughness and quality of your work reflect your passion and dedication for electrical engineering.

I would also like to take this opportunity to express my gratitude to the faculty members and staff who have supported and nurtured you throughout your academic journey. Their tireless efforts have helped you to reach your full potential and achieve great things.

As you embark on your future endeavours, I am confident that your contributions to the field of electrical engineering will make a significant impact on society. Your work serves as an inspiration to future generations of students who will follow in your footsteps.

Once again, congratulations on your achievements. I wish you all the very best for your future endeavours, and I look forward to hearing about your continued successes.

Dr. R. VAIKUNTARAO,

Principal, DIET.

HoD's Message

As the Head of the Electrical Department, it gives me great pleasure to share with you the recent achievements of our B. Tech. students in Electrical Engineering. Our students have demonstrated exceptional academic performance throughout their program, and they have made significant contributions to the field of electrical engineering.

I am particularly proud of their recent book chapter on "PEER-2K24" (3rd -Edition). This book chapter showcases their dedication to research and innovation, and it provides insights into the latest advancements in the field of electrical engineering. The authors conducted a comprehensive literature review to identify the most promising projects in the field, and they analysed these projects in detail to provide a comprehensive overview of each one. They also discussed potential future research directions in electrical engineering and highlighted areas that require further exploration.

This book chapter is a testament to the commitment and passion of our students for electrical engineering. Their contributions to the field are truly inspiring, and we are confident that they will go on to achieve great things in their careers.

As a department, we are committed to providing our students with the knowledge, skills, and resources they need to excel in the field of electrical engineering. We are proud of their achievements and are confident that they will make a meaningful impact on society. Thank you for taking the time to read about our students' achievements. We hope that their work inspires you to pursue your own passion for electrical engineering.

Dr. A S L K GOPALAMMA,
Head of the Electrical Department, DIET.

Message from BoS Member

Our life would be unthinkable without the use of electrical energy. The growing utilisation of the latter is a decisive prerequisite for a rapid development of industry and agriculture. I'm very much pleased to say that the Department of EEE provides various opportunities to hone student skillsets which is required for the industry.

Wherever there is a consumption of electricity, there lies the role of electrical engineer. In industrial countries, the consumption of electrical energy increases by 4 % to 7 % per year. Whole world is looking to tap renewable energy sources these days for producing the required electrical power which attracts electrical engineers to be indulged in research and implementation.

Each day, life will send you little windows of opportunity. Your destiny will ultimately be defined by how you respond to these windows of opportunity. Too many among us are afraid to be ourselves. So, we give up our dreams to follow the crowd. But remember, every great leader was initially laughed at. Now they are admired. We need every single one of you to develop your talents and your skills and your intellect so you can help us to solve our most difficult problems. It's very difficult at accept failure every time at every level which eventually leads us to work smart by taming our skillsets on a greater level to be successful.

"Become part of the world's techno and eco revolution with a degree in Electrical and Electronic Engineering"

With Best Wishes,

Dr. G.V. Nagesh Kumar,

Professor & Head, Dept of EEE, JNTUACE Pulivendula.

Message from BoS member

Life is a journey full of twists, turns, and unexpected detours. Similarly, your career path may not always follow a linear trajectory. Your time as a student is just one thread in this grand tapestry, but it holds immense potential to shape the course of your future. Embrace every moment with curiosity, resilience, and a willingness to learn. Your academic pursuits are undoubtedly crucial, but they are just one aspect of your journey.

Take the time to explore your passions, discover your strengths, and nurture your interests beyond the confines of the classroom. Engage in extracurricular activities, pursue hobbies, and seek out experiences that ignite your curiosity and broaden your horizons. While it's essential to set academic and career goals, remember that the path to success is rarely a straight line. Be open to unexpected opportunities and willing to pivot when necessary.

Your journey may take unexpected turns, but each twist and turn presents an opportunity for growth and self-discovery. When it comes to your career, remember that success is not solely determined by academic achievements or technical skills. Soft skills such as communication, teamwork, adaptability, and emotional intelligence are equally important. Invest time in developing these skills, as they will serve you well in any professional setting.

So, embrace the journey, seize every opportunity, and remember that the path to success is as much about the experiences you have along the way as it is about reaching your destination.

Dr. R. Srinu Naik,
Associate professor, Andhra University.

Message from BoS member

Dear Electrical Engineering Students,

My heartiest appreciations to you for the best projects carried during the course of study.

It is your exemplary work as a student, which will be remembered for ever and also you can share this as your experience during your career.

My sincere compliments to the teaching staff and HOD(EEE) for taking this wonderful initiative of publishing a book on Best practices of the projects carried by engineering students as part of the curriculum.

Mr. K. V. Rao,
GM(Projects) I/c Electrical & Services
Visakhapatnam steel Plant.

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PROJECTS ON ELECTRICAL ENGINEERING RESEARCH

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Chapter-1

Microgrid Energy Management System Using Adaptive Bat Optimization Technique

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Micro grid is a localized energy systems that incorporate renewable sources and improve energy resilience have become increasingly popular as a result of the growing demand for cost-effective and environmentally friendly energy solutions. Microgrids frequently use a variety of energy sources, including batteries, solar power, and wind power. In order to meet the energy needs of the nearby community or institution, optimal use of these sources is ensured via effective energy management. By encouraging the use of renewable energy sources, decreasing dependency on fossil fuels, and cutting greenhouse gas emissions, effective energy management in microgrids helps to maintain a sustainable environment. In this research, a new method for optimizing micro grid performance using an Adaptive Bat Optimization (ABO) strategy is presented. Maximizing the use of renewable energy sources is the goal of the planned Microgrid Energy Management System (MEMS).

A Microgrid is a localized energy system that integrates distributed energy resources (DERs) to generate, store, and distribute electricity within a specific geographic area. Unlike traditional centralized power grids, micro grids operate autonomously or in conjunction with the main grid, offering increased reliability, resilience, and sustainability. The Energy Management System (EMS) is a critical component in a Microgrid, optimizing the generation, storage, and consumption of energy resources. The EMS monitors and analyzes available energy resources, minimizing costs and enhancing system efficiency. It also manages energy consumption patterns, prioritizing critical loads and implementing load shedding strategies. Energy storage systems, such as batteries, are integral components of microgrids, and the EMS controls their charging and discharging cycles based on factors like energy prices, demand forecasts, and state of charge. The EMS also manages the interaction with the external grid and employs advanced monitoring and control mechanisms to gather real-time data. The EMS incorporates robust cybersecurity measures to protect against potential cyber threats and ensure the reliability and resilience of the Microgrid. An optimization problem for a Microgrid Energy Management System (EMS) involves defining the objective function, decision variables, constraints, and additional parameters to achieve optimal energy operation. The objective function aims to minimize overall costs, while decision variables represent control actions for various components. Constraints reflect the physical and

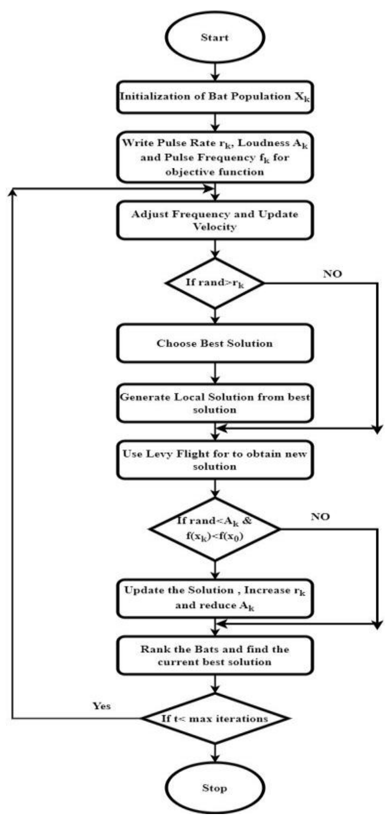

Figure 1 Block Diagram

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operational limitations of the Microgrid, such as power balance equations, energy storage capacity constraints, and ramping limits. The Bat Algorithm (BA) is an optimization technique based on bat echolocation behavior. it mimics bats' foraging behavior to solve optimization problems. Bats emit echolocation pulses to locate prey and adjust their flight paths. The algorithm initializes a population of virtual bats, simulating their movement in the search space, updates their positions, and iteratively optimizes solutions. Bats use their loudness and frequency to adjust their echolocation pulses and attract better solutions. To make the BA adaptive, adaptive learning rates are integrated to dynamically control step sizes in the search space, balancing exploration and exploitation. The pulse rate determines the probability of a bat emitting a pulse, and the frequency affects the rate at which a bat changes its position.

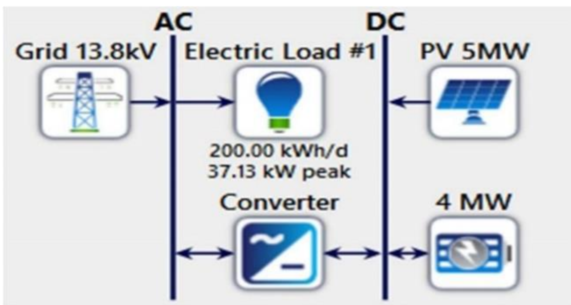

Figure 2 Single Line Diagram of Microgrid

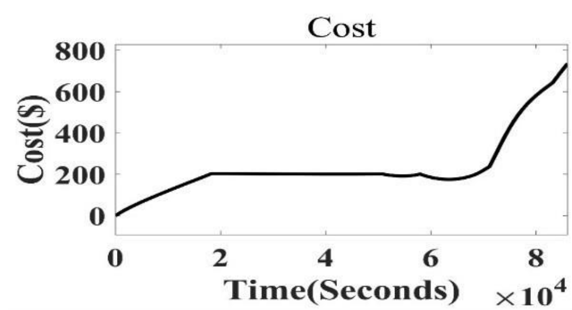

Figure 3 Cost Curve of ESS without EMS

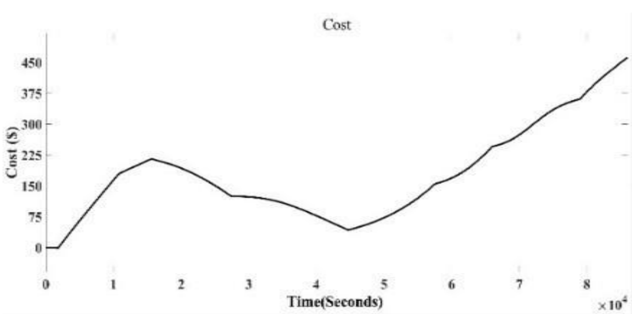

Figure 4 Cost Curve of ESS with proposed EMS

S.NO	METHOD	COST ($)	Average Iterations
1	Proposed Method (Adaptive BAT algorithm)	487.5	75
2	BAT Algorithm	550.65	100
3	Genetic Algorithm	590.98	250
4	PSO	598.13	300
5	ANT algorithm	602	450
6	Linear Programming	616	500

Table 1 Comparative Cost Analysis of Proposed Method with Other Methods in Literature

The Adaptive Bat Algorithm (ABA)-based Microgrid Energy Management System (MEMS) is a promising solution for optimizing complex and dynamic microgrid operations. It allows for fine-tuning of parameters, autonomously adjusting to changing conditions and energy demands. The system's success lies in efficient renewable energy use, cost reduction, and reliable power supply. Further research could focus on refining and expanding adaptive mechanisms for a wider range of scenarios.

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Chapter-2

Load Flow Analysis on various distribution systems to identify weak bus

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The accurate assessment of power distribution networks is imperative for ensuring their reliable and efficient operation. Load Flow Analysis (LFA) plays a crucial role in identifying weak buses within distribution systems by providing insights into the steady-state behavior of the network. LFA calculates voltage magnitudes and phase angles at each bus in the distribution system. Deviations from nominal voltage levels indicate potential weak buses experiencing voltage instability due to factors such as high loading or inadequate reactive power support. In this paper, a Backward Forward Sweep Load Flow Analysis (BFS-LFA) method is proposed as a tool for identifying weak buses within distribution systems. The BFS-LFA method iteratively computes the power flow in both forward and backward directions, enabling the determination of voltage magnitudes and phase angles at each bus. By analyzing the voltage profiles and power losses, weak buses, which are prone to voltage instability or significant power losses, are identified. Various distribution system configurations are investigated to assess the effectiveness of the proposed method under different operating conditions and network topologies. The results demonstrate the capability of BFS-LFA in pinpointing weak buses, thereby facilitating targeted reinforcement or optimization strategies to enhance the overall reliability and performance of distribution systems.

An electrical distribution system is an intricate network of components designed to deliver electrical power from the transmission system to end-users efficiently and reliably. It encompasses a wide range of equipment and infrastructure, including substations, transformers, distribution lines, switches, and meters. Substations serve as intermediate points between the transmission and distribution systems. It is the simplest and most common type of distribution system, suitable for relatively small service areas with low to moderate loads. Weak buses can adversely impact the overall reliability, stability, and efficiency of the distribution system. Weak buses may experience voltage instability, where voltage levels deviate significantly from their nominal values. This instability can lead to voltage sags or swells, affecting the quality of power supplied to connected loads. Buses with high voltage drop indicate significant impedance between the source and the load. Recent studies have explored advanced LFA methods, including Newton-Raphson iterations, and heuristic optimization techniques, for weak bus identification.

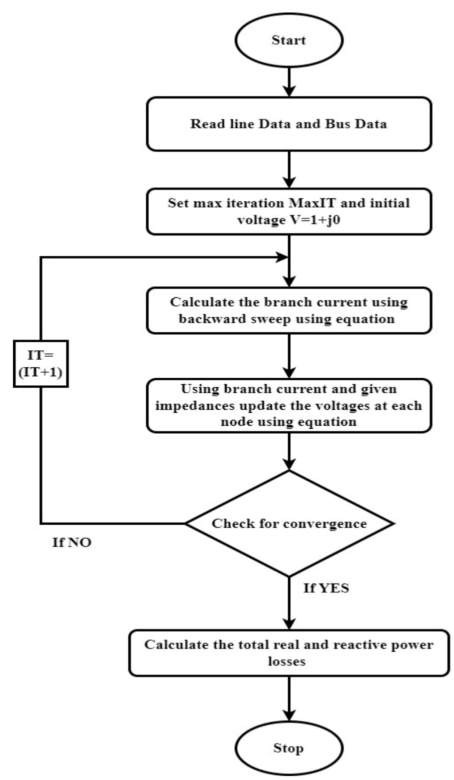

Figure 1 Flowchart of proposed methodology

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These methods offer improved accuracy, computational efficiency, and scalability, enabling comprehensive analysis of system behaviour and identification of critical weak buses. Recent research has focused on multi objective optimization techniques to simultaneously address multiple objectives, such as voltage stability, loss reduction, and load balancing, while identifying weak buses. Identifying weak buses is crucial for ensuring the optimal operation and performance of the distribution system.

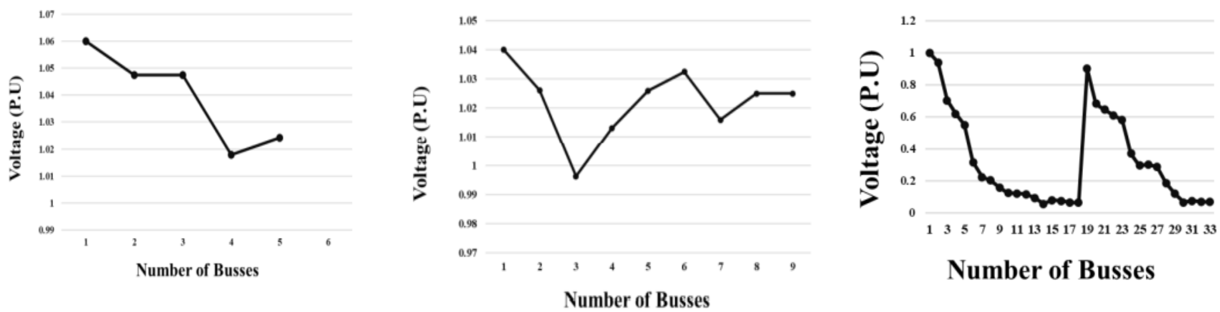

Figure 2 Load flow analysis on IEEE5, IEEE9 and IEEE33 Bus system

Load flow analysis, voltage stability studies, and power quality assessments are among the methods used to identify and address weak buses in electrical distribution systems. Once identified, measures such as capacitor banks, voltage regulators, feeder reconfiguration, or equipment upgrades can be implemented to mitigate the effects of weak buses and enhance system reliability and performance. In this project, backward forward sweep algorithm is used to analyse various distribution systems to identify weak bus. IEEE 5, IEEE 9 and IEEE 33 test bus systems are used to validate the proposed method.

Figure 3 Identification of weak bus using Load flow analysis on IEEE5, IEEE9 and IEEE33 Bus system

in the distribution system. Hence from the results we can conclude that weak bus from IEEE 5 Bus Test System is Bus 4, weak buses from IEEE 9 Bus Test System are Bus 3, 4 and 7. And weak buses from IEEE 33 Bus Test System are Bus 13,14, 16 and 24. In conclusion, the application of load flow analysis to various distribution systems for the identification of weak buses represents a pivotal undertaking in power system engineering.

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Chapter-3

Estimation of SOC For Lithium-Ion Battery Using EKF Method

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State of charge (SOC), a measure of the amount of electricity stored, is calculated, and used by battery management systems (BMS). However, SOC is not easily recognized because it is not directly visible and is challenging to quantify due to the nonlinear properties of batteries under complex working conditions. An increasing number of electric vehicles (EVs) are using Li-ion batteries of the Lithium Ferro-Phosphate (LFP) type. Therefore, it's imperative to guarantee that the vehicle maintains a high level of autonomy while honouring the special qualities of LFP batteries and having accurate state-of-charge (SoC) monitoring. The SOC is obtained by dynamically charging and discharging the cell. Next, the proposed model is used with the Extended Kalman Filter (EKF) to accurately estimate the SoC of the LFP battery. The simulation was performed in Simulink of MATLAB.

Rechargeable battery is an electrochemical device which converts electrical energy to chemical energy during charging and converts chemical energy to electrical energy during discharging. Rechargeable battery plays important role in future technology since it is potentially to be applied as energy storage element in green technology applications, such as electric vehicle (EV) and photovoltaic (PV) system. The renewable energy source can be stored in battery packs and thus help to reduce the reliance on fossil fuels.

In the aspect of technology, the rechargeable battery is improved from lead acid battery to nickel-based battery and from nickel-based battery to lithium-ion (Li-ion) battery. Lithium-ion battery has higher terminal voltage, higher power density and higher energy density compared to the other rechargeable batteries. Nowadays, Li-ion battery is widely adopted in portable electronic devices, such as laptop computers, smart phones and digital cameras.

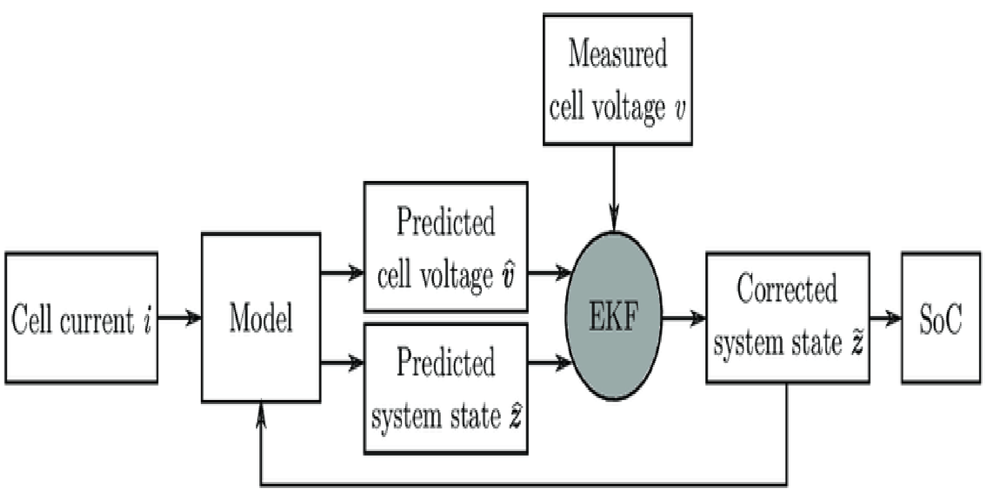

Figure 1 Block Diagram

Extended Kalman filter (EKF):

EKF is a widely used state evaluation method for non-linear dynamical systems. This filter provides an efficient computational recursive method through a linearization process for state estimation.

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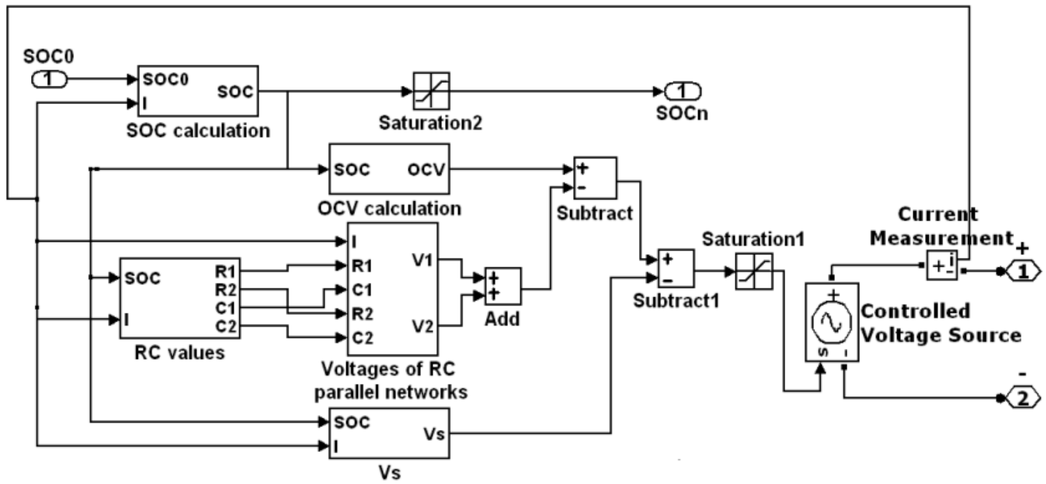

Figure 2 Proposed simulation model in MATLAB/Simulink

SIMULATION RESULTS:

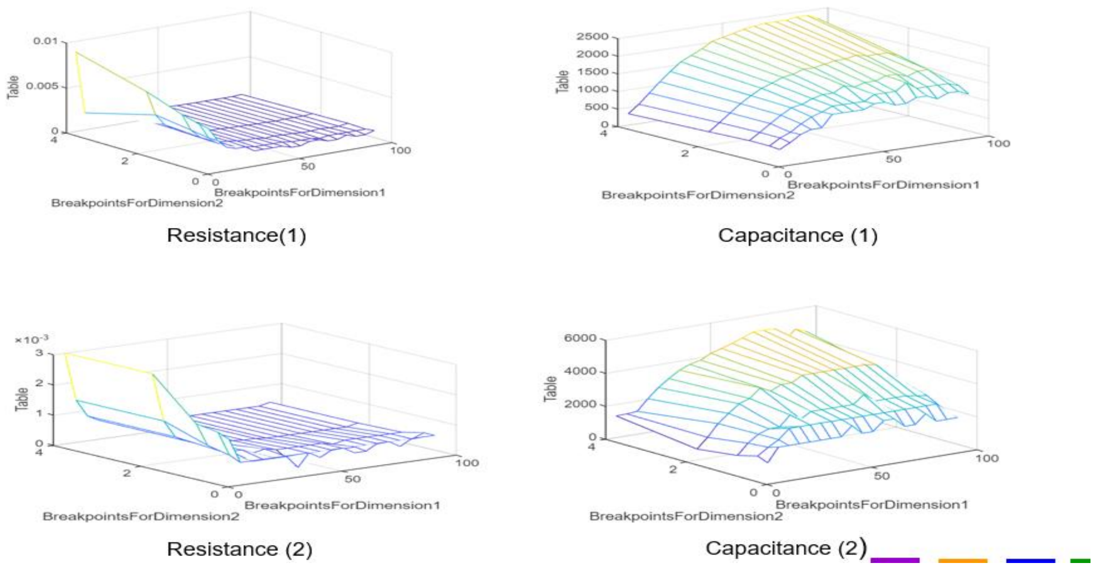

Figure 3 Results of EKF Method

In this paper Because of its excellent safety and charging and discharging capabilities, the equivalent circuit model of a lithium ferro phosphate battery cell is taken into consideration in this research. Diffusion, polarization, and internal resistance make up the analogous cell model. In MATLAB, the battery cell is simulated for the EKF and coulomb counting methods. The cell's parameters are taken into account for different charging and discharging speeds.

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Chapter-4

Power Quality Improvement Using Dynamic Voltage Restorer

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Power quality is one of the major concerns in the present era. It has become important, especially, with the introduction of sophisticated devices, as their performance is very sensitive to the quality of power supply. Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that results in inefficient performance of end use equipment's. The major problems related with power quality are the voltage sags, swells, and harmonics. Dynamic voltage restorer is controlled by using one control strategies, one is control of DVR using UPQC (Unified Power Quality Conditioner) method. In first method controlling is done by analyzing the load side voltage and thus setting parameters of DVR to maintain the load voltage but this strategy could not work for variable load. Whereas, in UPQC control method load voltage can be maintained under variable load conditions also. In this work UPQC Control method are used for DVR control. The analysis is done using MATLAB / SIMULINK and results obtained from both the methods. The main concern of consumers of electricity is the reliability and quality of power.

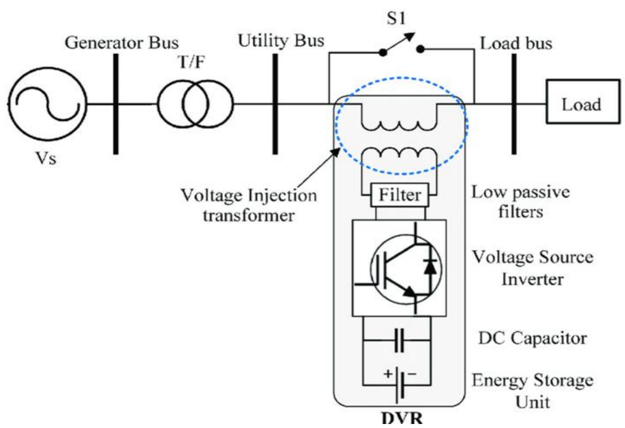

Figure 1 Block Diagram

Just a few decades ago, momentary power outages, sags, swells, surges had relatively little effect on most industrial processes. Today, manufacturing systems, sensitive telemetry, and precision electronic equipment can be disturbed, halted, or even damaged by voltage sag of two or three electrical cycles Short-lived sags may not cause much harm other than cause a slight flickering of lights; temporary sag is bound to have a greater impact on the industrial customers. If the sags exceed two to three cycles, then manufacturing systems making use of sensitive electronic equipment's are likely to be affected leading to major problems. It ultimately leads to wastage of resources (both material and human) as well as financial losses. Power Quality is an essential concern in the modern power system that can affect consumers and utility. The integration of renewable energy sources, smart grid systems and extensive use of power electronics equipment caused myriad problems in the modern electric power system.

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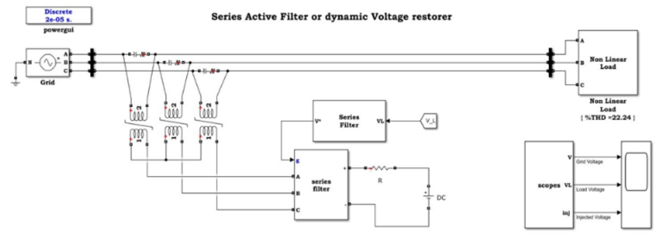

Figure 2 Simulink Diagram

To generate simulation results for a Dynamic Voltage Restorer (DVR) based on an applied input voltage, I would need details such as the circuit configuration, load characteristics, and any specific parameters related to the DVR model. Please provide more information so I can assist you effectively. By the results presented in this thesis it is believed that all objectives of the research

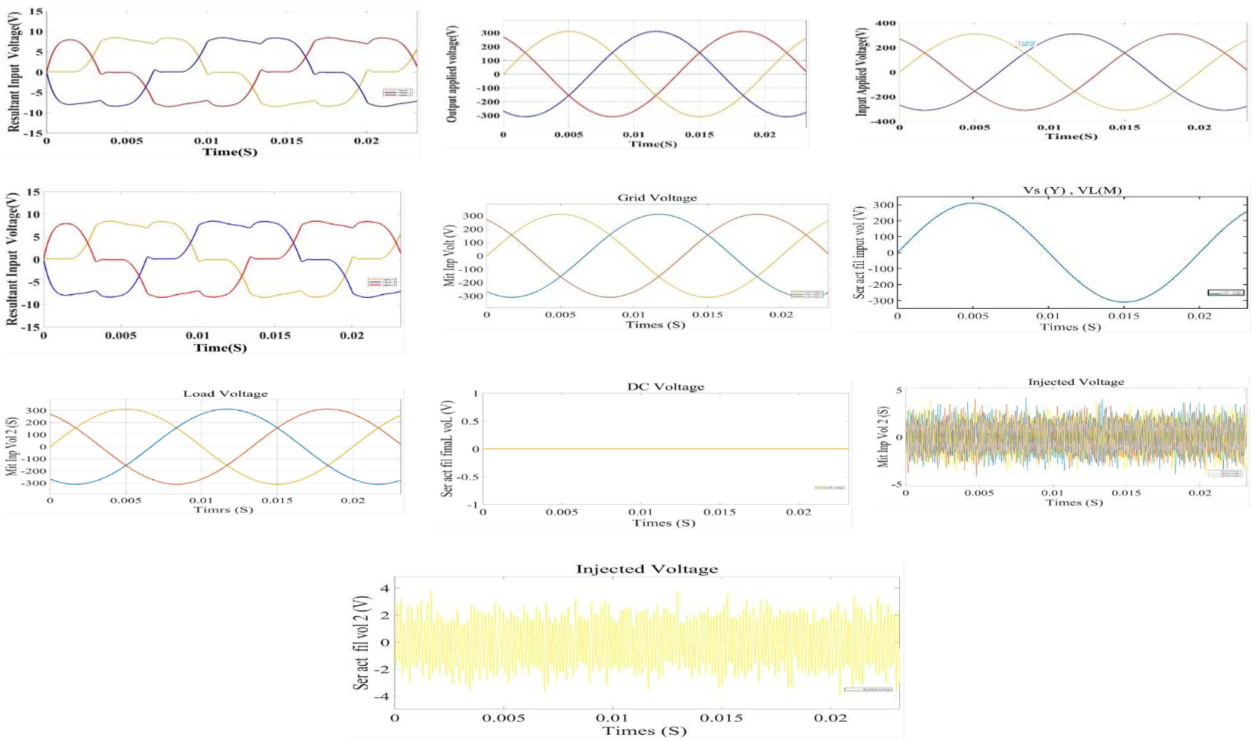

Figure 3 Output Results

project have been fulfilled. The main conclusions are identified as: DVR's different modes and injection methods are discussed and it has been seen that DVR do not exchange real and reactive power in normal state. Regarding the system topology for a DVR four topologies have been studied. It includes two topologies with stored energy and two methods, which uses the remaining supply voltages and increase the supply current to restorer the load voltages. Modelling of DVR has been studied and two schemes are used for voltage control. The closed loop voltage control scheme shows better output voltage and better damping as compared to open loop scheme. Different control strategies have been analyzed and simulated for different load conditions. The DVR restores the load voltages to the pre-voltage levels. The load voltages are not phase shifted that is it is in phase injection scheme. The SRF theory-based control scheme proves to be better than self-generated PWM technique.

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Chapter-5

Vehicle-To-Grid Technology in a Micro-grid Using DC Fast Charging Architecture

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Batteries from electric vehicles (EVs) may be used in microgrids as possible energy storage devices. By storing energy when it is excess (Grid-To-Vehicle, or G2V) and returning it to the grid (Vehicle-To-Grid, or V2G) when needed, they can aid in micro-grid energy management. . This study presents the architecture for establishing a V2G-G2V system in a micro-grid employing level-3 fast charging of EVs. A dc rapid charging station is modeled as part of a micro-grid test system for connecting EVs. This is shown in a simulation view. This demonstrates the modes of operation used for electric vehicles. The harmonic distortions are reduced by this method.

The chargers are housed in an EVSE and are off-board for DC rapid charging. It has two modes of operation
1)Charging mode, or the Buck mode of operation: In this charging process, power is transferred from the grid to the vehicle (G2V). The Buck mode of operation, also known as charging mode: When the upper switch (S buck) is engaged, the converter steps down the input voltage (V dc) to the voltage needed to charge the battery (V batt). This is how a buck converter works.

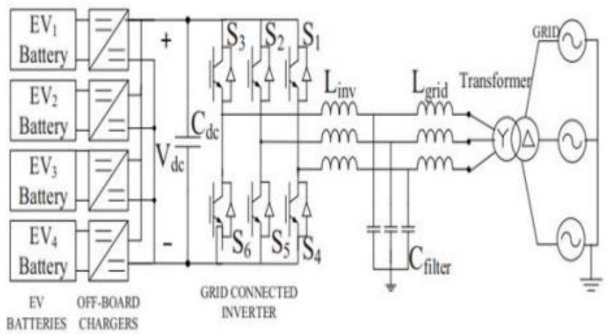

Figure 1 EV charging station for fast DC Charging

2) Boost mode of operation (discharging mode): t. In this instance, the battery is in the discharge state and the net power flow is from the car to the grid (V2G). When the lower switch (S boost) is engaged, the converter acts as a boost converter to increase the battery voltage (V batt) to the dc bus voltage (V dc). The circuit is completed when the switch is in the on position and current flows via the inductor, capacitor, and anti-parallel diode of the top switch

MICRO-GRID TEST SYSTEM CONFIGURATION:

The EV battery storage system consists of four EV batteries that are connected to the 1.5 kV dc bus of the charging station via off-board chargers.
Additionally connected to this DC bus is the solar PV system via a boost converter and MPPT controller. The micro-grid is connected to the wind turbine-powered, doubly-fed induction generator at the point of common connection (PCC).

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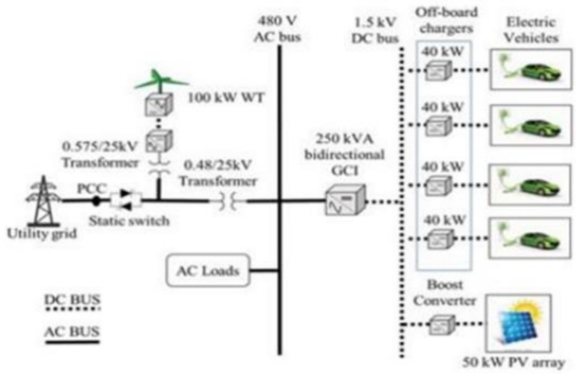

Figure 2 Proposed microgrid test system

Transformers are used to link the corresponding ac systems to the utility grid and step up the voltages. In conclusion, a V2G system on a microgrid using a dc quick charging architecture is modelled and designed. A DC fast charging station with off-board chargers and a grid. Connecting EVs to a microgrid is the aim of a connected inverter. This power electronic interface's control system enables bidirectional power transfer between EVs and the grid. The microgrid's active power regulation features; in addition to other services, reactive power management and frequency regulation are also possible with the proposed V2G system.

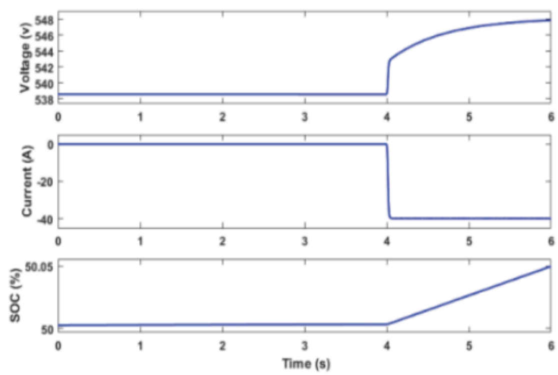

Figure 3 Voltage, current and SOC of EV2 battery during G2V operation

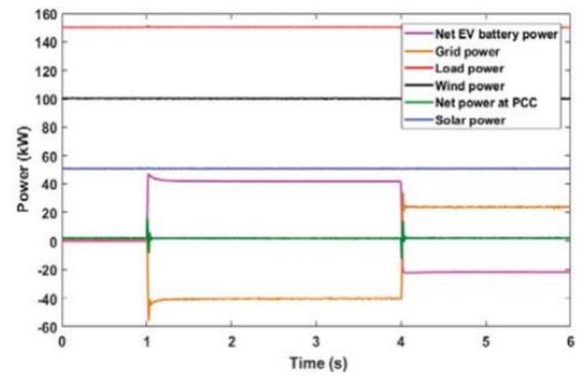

Figure 4 Active power profile of various components in the system

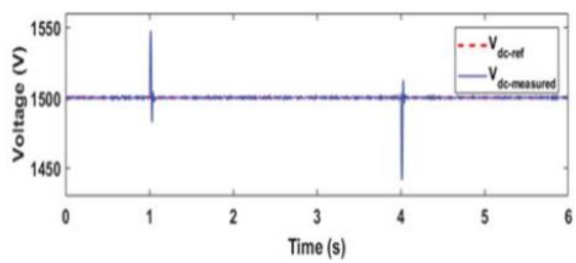

Figure 5 Variation in DC bus voltage

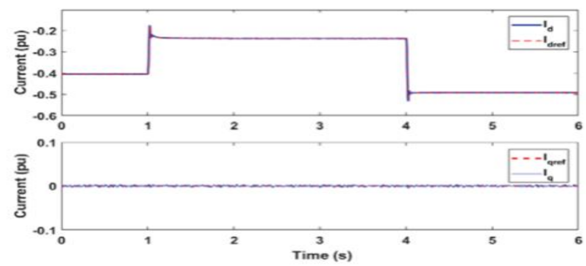

Figure 6 Reference current tracking by inverter controller

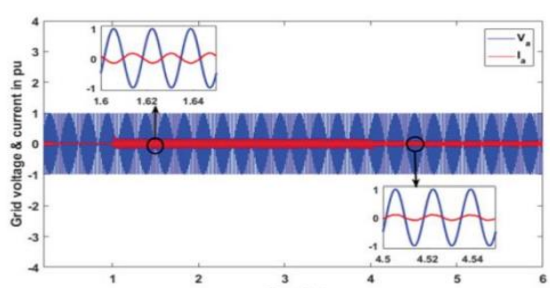

Figure 7 Grid voltage and grid injected current during V2G-G2V operation

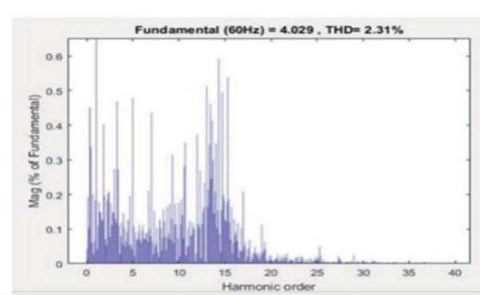

Figure 8 Harmonic spectrum and THD of Grid-injected current

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Chapter-6

Inverter Based Smart Solar Powered Plant Monitoring System

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The rapid expansion of solar power installations has underscored the need for robust operational safety, performance monitoring systems. Traditional monitoring systems often exhibit limitations in detecting and responding promptly to these faults, leading to prolonged downtime's, reduced performance, and safety concerns. This research addresses the major issue of ground faults in solar power plants and presents a novel approach that makes use of Internet of Things (IOT) technology. The suggested method combines Internet of Things (IOT) devices for real-time data gathering and processing, making it possible to quickly locate ground defects. The technology facilitates data-driven decision-making and guarantees ongoing monitoring. It is further distinguished by the application of predictive maintenance procedures, which minimize downtime and maximize plant reliability. Through the use of sophisticated analytic. the system is able to anticipate problems in addition to identifying errors, enabling proactive maintenance. The results show the potential for revolutionary advancements in fault management, establishing the suggested framework as a crucial facilitator for the deployment of robust and sustainable solar energy.

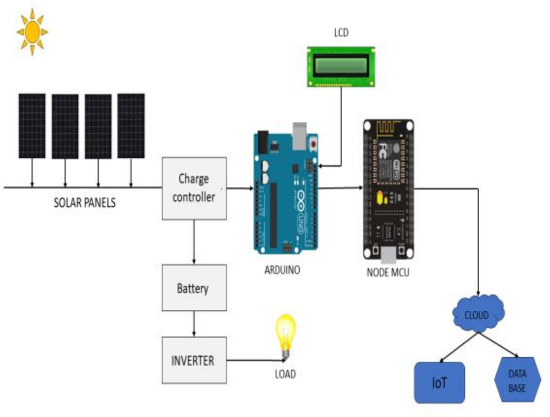

Figure 1 Block Diagram

Solar power plants are innovative leaders in the relentless search for clean and renewable energy solutions. They harness the sun's infinite energy to produce electricity. As the world's population comes to understand the necessity of making the shift to greener energy, designing and maintaining solar power plants has become essential work. Photovoltaic (PV) technology is harnessed by solar power plants to turn sunlight into electrical power. Domestic solar power plants, which serve the energy demands of individual households as opposed to large-scale utility solar farms, represent a decentralized and ecologically friendly method of electricity generation.

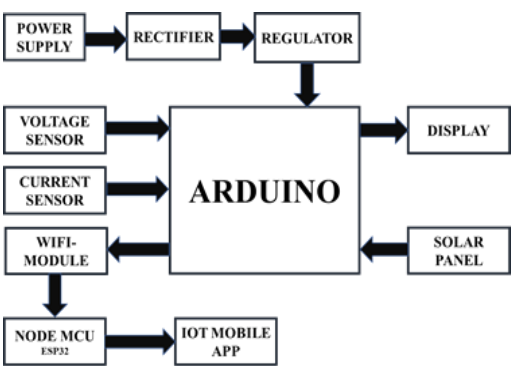

Figure 2 Line Diagram

Case 1: During Initial Case: When the power supply is" ON" Initializing the Solar power plant monitoring the module gets started with indicating "IOT BASED UNDER GROUND FAULT DETECTION" in the LCD as shown in fig 3.1.

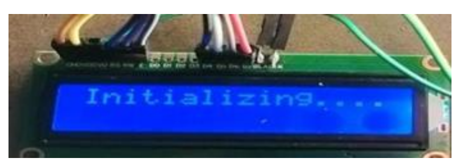

Figure 3.1 Initializing

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Case-2: Open Circuit (When all Switches Open): If a ground fault is not addressed promptly, it may escalate into an open circuit fault where the electrical circuit is interrupted. Open circuit faults can lead to a complete loss of power to the external load source in the affected section of the solar array. These systems may employ ground fault sensors and monitoring devices to continuously check for potential ground faults. Alarms can be visual, audible, or transmitted IOT through communication systems and the display shows the fault in line 1 as shown in fig 3.2.

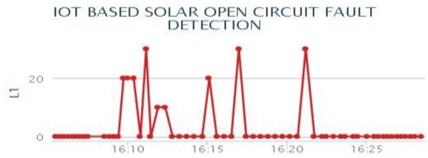

Figure 3.2 Fault Detection in Line

Case-3: Close Circuit: (When all switches are close):

Monitoring in solar power plants during ground faults is crucial for ensuring the safe and efficient operation of the photovoltaic (PV) system. Ground faults occur when an unintended electrical connection is established between the conductive components of the system and the display shows the fault in line 2 as shown in fig 3.3, and decreased overall system performance.

Figure 3.3 Fault Detection in Line 2

ADVANTAGES:

- Monitoring systems can detect ground faults at an early stage, allowing for prompt action before the issue escalates.
- Reduced downtime means higher overall energy production and improved plant performance.
- Monitoring enhances the reliability of the solar power plant by identifying and addressing ground faults USING IOT.
- Sudden drops in insulation resistance can indicate the presence of a ground fault.
- Early detection and rapid response to ground faults contribute to a safer working environment for maintenance personnel and overall plant operations.

Applications of Solar Panels:

Residential Solar Power Systems, Commercial and Industrial solar Installation, Solar Water Heating Systems.

The integration of IOT technology to enhance operational safety and performance monitoring in solar power plants during ground faults represents a significant stride towards a more robust and efficient renewable energy infrastructure. By leveraging real-time data collection, analysis, and communication, this innovative approach empowers solar plant operators to swiftly detect and respond to ground faults, minimizing downtime and optimizing overall system performance.

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Chapter-7

Fortifying Microgrid Resilience by Exploring Wavelet Multiresolution Analysis and Data Mining Approaches

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The protection problems in microgrids affect the reliability of the power system caused due to highly distributed generator penetrations. Therefore, fault protection in microgrids is extremely important and needs to be resolved to enhance the robustness of the power system. This project proposes a combined signal processing and data mining-based approach for microgrid fault protection. In this study, first, the multiresolution decomposition of wavelet transform is employed to pre-process the voltage and current signals to compute the total harmonic distortion of the voltage and current. Then, the statistical indices of standard deviation, mean, and median of the total harmonic distortion and the negative sequence components of active and reactive power are used to collect the input data. After that, all the available data is provided to the random forest-based classifier to evaluate the efficiency of the proposed scheme in terms of the detection, identification, and classification of Faults. This is used in different aspects of data collection by simulating various fault and no-fault cases for both looped and radial configurations under grid-connected and islanded modes of operation. The simulations were performed on a standard medium voltage microgrid using MATLAB/SIMULINK, whereas the analysis for testing and training of the random forest was conducted in Python. Three-phase DC/AC Converter in the model is used to connect the microgrid and the utility, and it is also used to change the modes between grid and islanded. The base values used in this study are 25kV, 47MVA, and 60Hz. The test system is comprised of one IIDG (DER) that is PV Array. The PV array consists of 86 parallel strings. Each string has 7 SunPower SPR-415E modules connected in series. A Grounding transformer that is used to provide a neutral in a three-phase, three-wire system. The transformer consists of three two-winding transformers connected in zig zag. A 120/25kV Dyn transformer is used to interconnect the microgrid and the main grid. Another three-phase transformer is connected to this microgrid. A three-level bridge is connected to the transformer that implements a three-level power converter that consists of one, two, or three arms of power switching devices. An inverter control is connected to the three-level bridge IGBT. Inverter control refers to the method by which an inverter, typically used in electrical systems, is regulated to manage the output frequency and voltage. In three-phase systems, a fault may involve one or more phases and ground, or may occur only between phases. In this project, we performed the detection, identification and analysis of the faults, wavelet multi-resolution

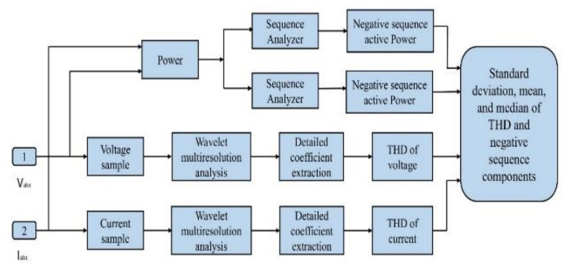

Figure 1 Block Diagram

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analysis and data mining for specific stored data values in the microgrid. The simulation was performed in MATLAB/SIMULINK and data analysis is done in Python.

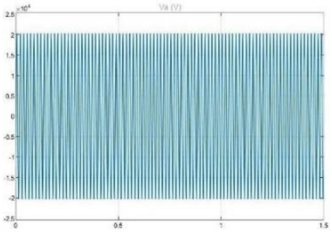


Figure 2 Voltage without Fault

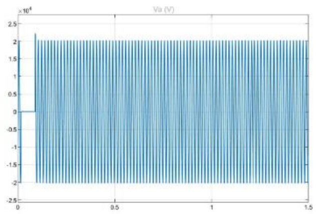


Figure 3 Current Without Fault

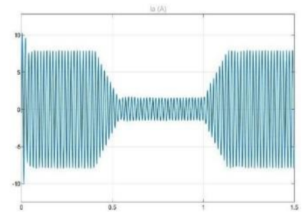


Figure 4 Voltage with Fault

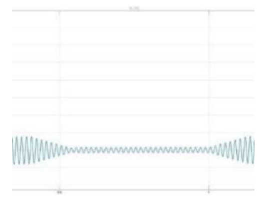


Figure 5 Current with Fault

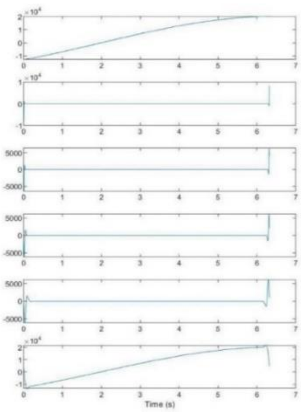


Figure 6 Multiresolution Voltage without fault

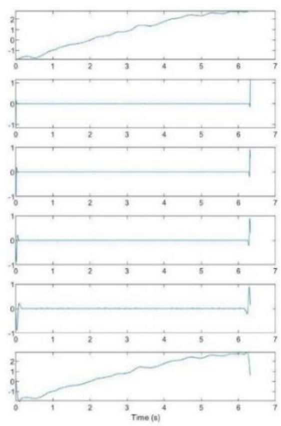


Figure 7 Multiresolution Current without fault

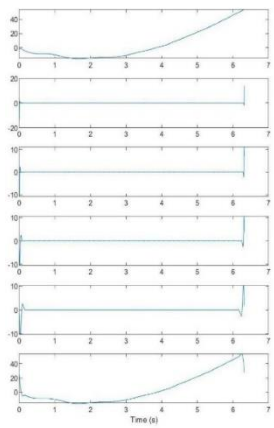


Figure 8 Multiresolution Voltage with fault

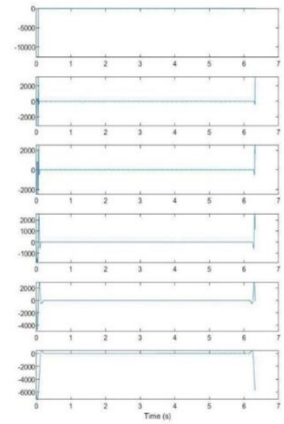
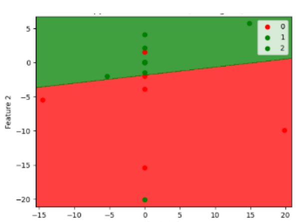
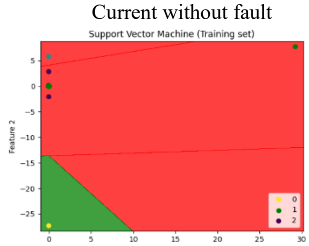
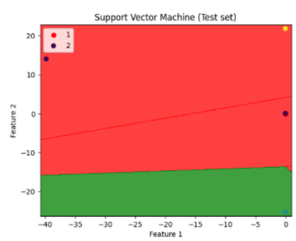
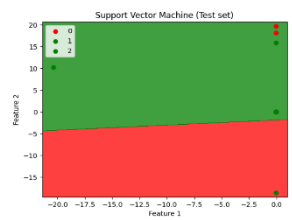


Figure 9 Multiresolution Current with fault









	Total Cases (2038)	No-fault	Fault	Accuracy
DECISION TREE	No-fault (1019)	849	170	78.45%
	Fault (1019)	269	750	
ADA – BOOST	No-fault (1019)	1010	9	49.90%
	Fault (1019)	1008	11	
SUPPORT VECTOR MACHINE (SVM)	No-fault (1019)	197	822	78.36%
	Fault (1019)	775	244	
K–NEAREST NEIGHBOUR	No-fault (1019)	93	926	76.74%
	Fault (1019)	638	381	
ARTIFICIAL NEURAL NETWORK	No-fault (1019)	183	836	69.18%
	Fault (1019)	574	445	

In this study, the total dataset consists of 2038 cases, where 1019 are fault events and 1019 are no-fault cases. To build the data mining model for fault detection for the proposed scheme, the current dataset is divided into five parts with a proportion of 75% for training and 25% for testing. In this study, the total dataset consists of 2038 cases, where 1019 are fault events and 1019 are no-fault cases, which are obtained as discussed above table. This will be regarded as a data mining and signal processing based microgrid fault protection system.

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Chapter-8

Wavelet Entropy Measurement Based Power Quality Disturbances Diagnosis

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Electric power quality is the degree to which the voltage, frequency, and waveform of a power supply system conform to established specifications. Good power quality can be defined as a steady supply voltage that stays within the prescribed range, a steady AC frequency close to the rated value, and a smooth voltage curve waveform (which resembles a sine wave). In general, it is useful to consider power quality as the compatibility between what comes out of an electric outlet and the load that is plugged into it. The term is used to describe electric power that drives an electrical load and the load's ability to function properly. Without the proper power, an electrical device (or load) may malfunction, fail prematurely or not operate at all. There are many ways in which electric power can be of poor quality and many more causes of such poor-quality power.
The quality of electrical power may be described as a set of values of parameters, such as:

- Continuity of service (whether the electrical power is subject to voltage drops or overages below or above a threshold level thereby causing blackouts or brownouts)
- Variation in voltage magnitude
- Transient voltages and currents
- Harmonic content in the waveforms for AC power

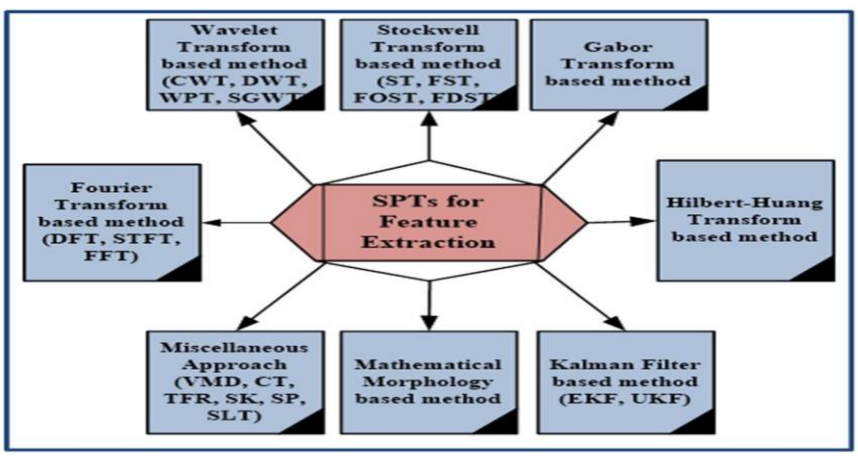

Figure 1 Block Diagram

Power quality may represent an important factor in the competitiveness of several activities. This competitiveness is affected by the costs associated with the power quality problems and the growing number of customers with high requirements regarding power quality. Power quality problem costs are associated with production interruption, defective products, large restarting process, indirect costs, etc.

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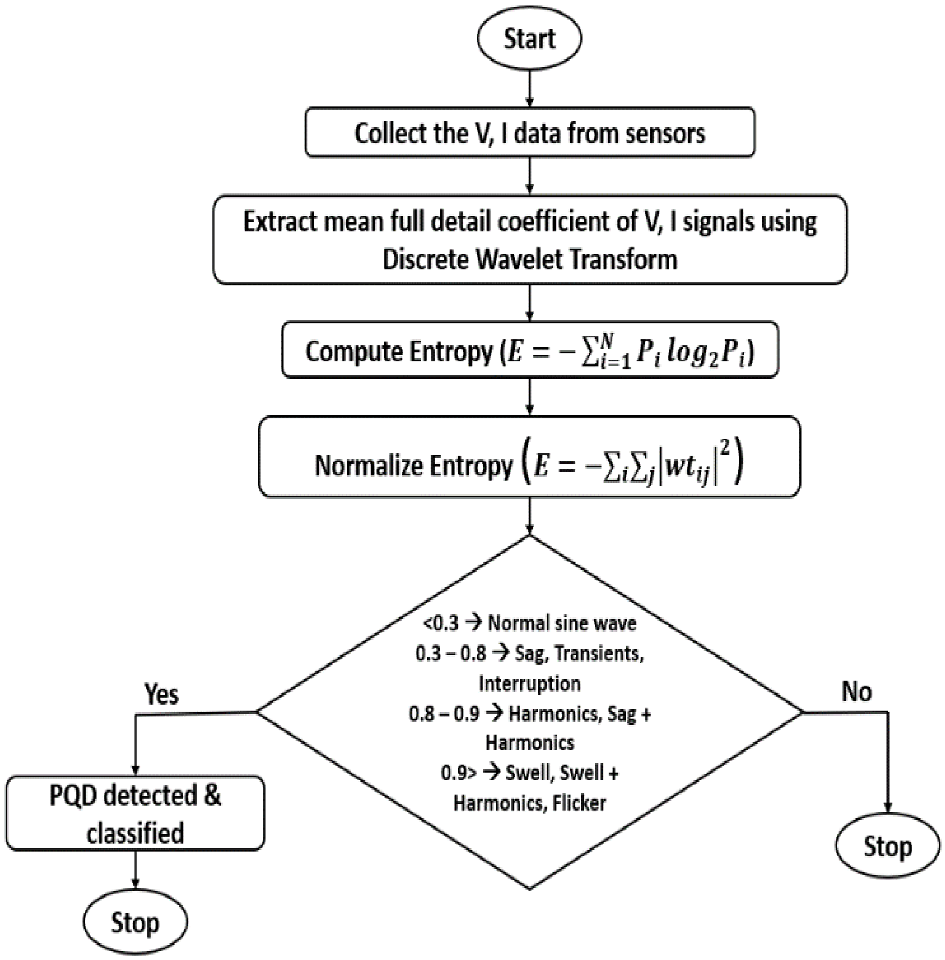

Figure 2 Flow Chart of Proposed Method

when the signal exists as short-term transient disturbances. The DFT method is a frequency domain technique that estimates the individual harmonic components, and does not provide time domain information for non-stationary PQ disturbances signals. The FFT is a method used to obtain harmonic information about the monitored signals. However, this method is not suitable for detecting short or transient spikes. The STFT is an improvement of FT to overcome the DFT disadvantages. However, its disadvantage is that the size of the window is fixed for all frequencies, so there is a low resolution for high frequencies and unsuitability is found for the analysis of the non-stationary and transient PQ the basic idea of PQD's detection and classification. Initially, gather data from sensors regarding voltage and current. Then use the Discrete Wavelet Transform to get the mean full detail coefficient values of the V and I signals. Next, use mathematical formulas to compute and normalize entropy. Stop the process if the entropy values are rated; if not, carry on with the detection and classification of power quality disruptions.

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Chapter-9

Enhancing Power Quality in the distribution system using DSTATCOM with Hybrid Power Filters

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Modern electrical and electronic equipment, such as computers, servers, medical devices, and industrial machinery, are highly sensitive to variations in voltage, frequency, and waveform. Even minor disturbances can lead to equipment malfunction, downtime, and potential damage. Power quality is crucial for the reliable and efficient operation of electrical systems and equipment. By combining Distribution Static Synchronous Compensator (DSTATCOM) with Hybrid Power Filters (HPFs) to enhance power quality within distribution systems. The integration of DSTATCOM and HPFs offers a comprehensive solution by mitigating these issues concurrently. DSTATCOM provides rapid reactive power compensation and voltage support, while HPFs effectively suppress harmonics and filter out undesirable disturbances, thereby contributing to the overall reliability and performance of modern power grids.

The primary goal of this project is to reduce the Total Harmonic Distortion (THD%) at the PCC (Point of Common Coupling) in the distribution system. The Block Diagram Indicates the entire out view of this Project by using a Shunt Active Filter (DSTATCOM) and Series Passive Filter (LCL filter). By combining both the filter we can reduce the harmonics generated by the Non-linear load at the PCC.

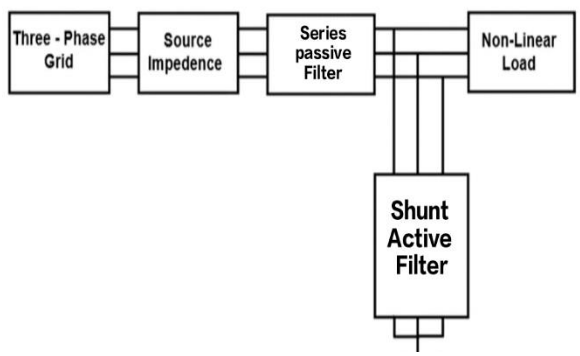

Figure 1 Three-phase AC Grid System with Hybrid Power Filter Bagram

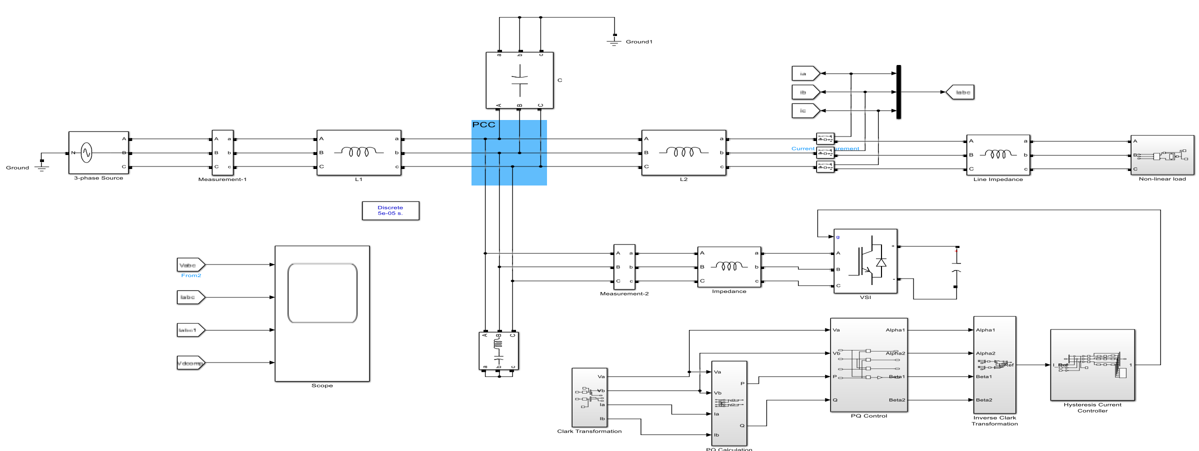

Figure 2 Simulink Diagram

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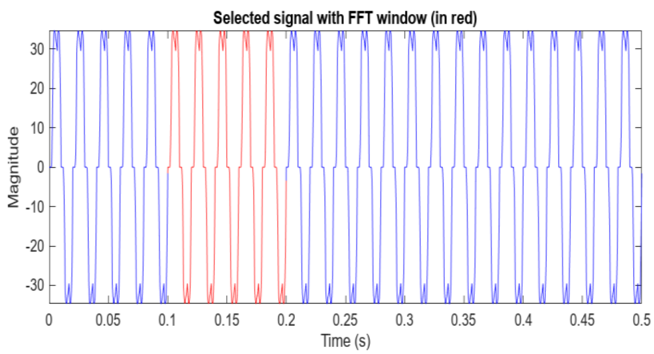
Here the Hybrid Power Filter and Distribution Static Synchronous Compensator (DSTATCOM) are combined to enhance power quality in nonlinear loads. These filters, consisting of passive and active filters, effectively mitigate harmonics and reactive power. When combined with DSTATCOM, the hybrid filters provide a comprehensive solution, ensuring a more adaptable response to nonlinear load challenges. Testing shows the system effectively suppresses harmonics, enhances power factor, and maintains a stable electrical supply. In the system design, we performed two types of tests, and the output current and voltage ratings for them are obtained as follows concerning the time.



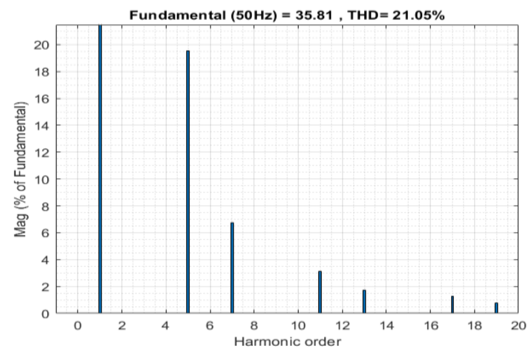
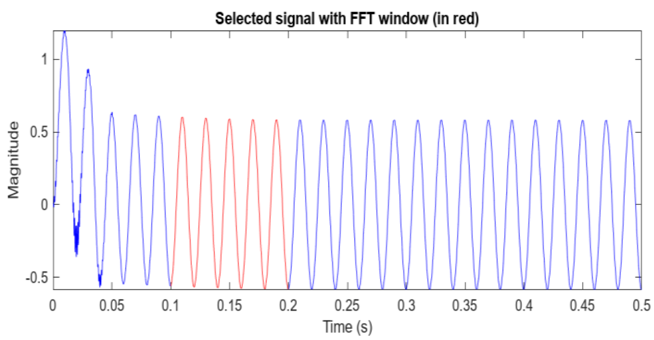


Figure 3 THD Analysis at PCC without compensation



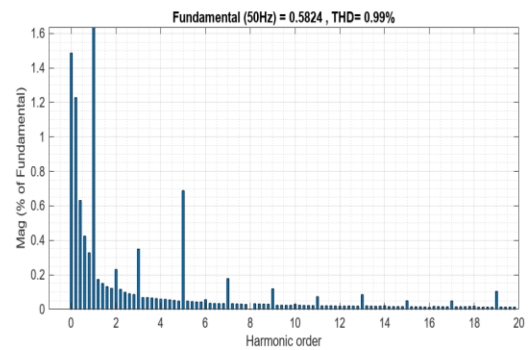


Figure 4 THD Analysis at PCC with compensation

The Total Harmonic Distortion (THD) analysis at the Point of Common Coupling (PCC) shows a significant improvement in power quality, with a recorded THD of 0.99%. This reduction is attributed to the effective mitigation of harmonics and improved reactive power compensation, enhancing the overall system's power quality. The THD value of 0.99% at the PCC demonstrates compliance with IEEE 519 standards, indicating high quality and reliability in the electrical system. The Hybrid Power Filter and DSTATCOM have proven to be a robust solution, addressing harmonics and reactive power challenges, contributing to a system that meets industry standards for power quality.

THD Analysis	Using only DSTATCOM (THD%)	Using Combined DSTATCOM and Hybrid Power Filter (THD%)
At the Non-Linear load	21.05%	12.50%
At the PCC	4.22%	0.99%

Table-1 THD Analysis

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Chapter-10

Design and Impact analysis of low water head hydro power generation using waste water systems

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A creative and sustainable method of exploiting renewable energy is the design and study of low water head hydro power generating using wastewater systems. In order to generate power, we repurpose the flow of waste water by utilizing its potential energy. Even in low-gradient situations, we may collect the kinetic energy of the running water by carefully incorporating turbines and generators into the wastewater. We adjust the system to guarantee maximum energy extraction and lowest impact on the environment. The work presents the dynamic flow rate dependency on the portable hydro power generation. The case study carried out at the remote area dedicated to farming. The most advanced renewable energy sources now in use are hydrogen, wind, sun, and hydropower. Hydro energy is the most researched, safe, effective, and dependable renewable energy source since it is the most developed energy technology. Renewable energy has immense potential to alleviate global warming and climate change while also meeting the world's energy needs. Hydro energy is a naturally occurring resource that is available everywhere and doesn't emit any hazardous or greenhouse gases. It has been reported that hydro has a about 90% conversion efficiency from water to wire operation. Hydro systems have a somewhat greater initial cost, but they are more dependable and efficient because they need very little maintenance. Small hydroelectric plants can be installed at various water distribution network locations to provide an intriguing amount of electricity that may be advantageous to the local community. Depending on the amount of power the plant produces, small hydro power plants are divided into three categories: Mini, Micro, and Pico hydro systems. An installation is categorized as a mini hydro system if its power production is less than 2 MW, and as a micro hydro system if its power production is less than 100 MW. Hydro power plant. Small Power generation that is less than 5MW, the installation is classified as Micro hydro power plant. The block diagram is used for the design of the prototype for the working model. We tested this on a agriculture site which is used for the agriculture farms. We find that the pressure of water is having fluctuations so we to have make the pressure equal all times by the storage tanks we make it the constant when the water from the field pump is getting out then we place some storage tank of flowing than it enters to the device with a constant flow of water and we use gate system to the device to make the gate opening and closing. We

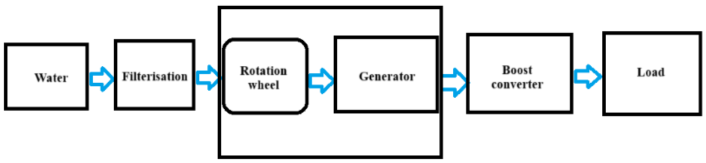

Figure 1 Block Diagram

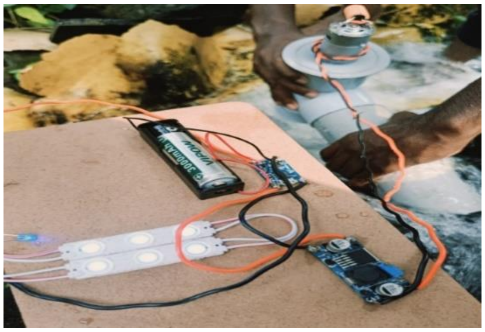

Figure 2 Prototype of proposed system

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design the prototype for the small hydro systems and done the simulation for large hydro systems. In the simulation we kept the synchronous block and excitation block. We give the values to the input of simulation. We also design for the large-scale hydro power systems in MATLAB.

For large scale power systems, we done in the MATLAB and we get the outputs.
In this parameter of turbine gate terminals are sets a limit 0.1 to 2 as min to max of gate opening time. By changing the Hydraulic turbine beta () & Tw(sec) output of pm is changed along with the parameters of the hydraulic turbine by changes of beta and time it changes the total machine output by a constant initial mechanical power(pu) 100. By taking a Tw(sec) constant and varying of beta

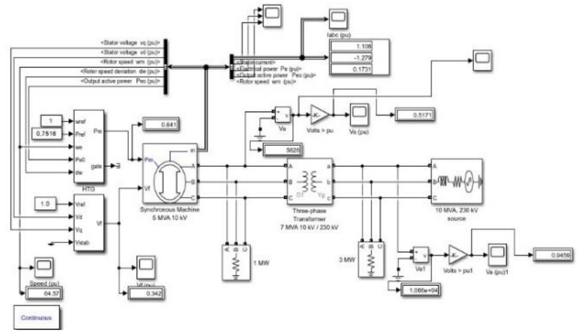

Figure 1 Simulation of Proposed system

Beta	Tw(sec)	Rotor Speed Nr	pm	Excitation	Gain voltage	Stator Currents		
						A	B	C
0.75	0.75	34.24	2.348	0.5021	-0.5295	0.59	-0.974	0.3817
1.5		34.23	2.959	0.4473	0.5362	1.233	-1.314	0.08106

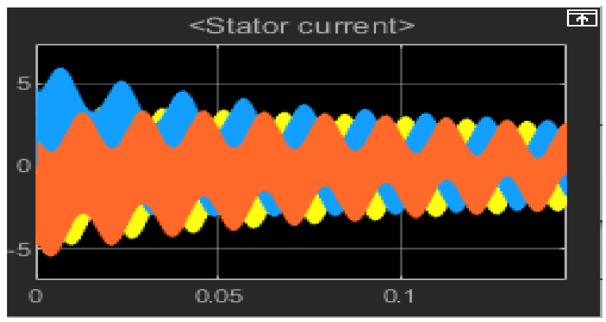

Figure 4 Output Waveform of Rotor Speed and Active output Power

Parameters	Units	Values
average inflow	m^3/s	2.435
average outflow	m^3/s	1.205
Voltage	V	29
Current	A	5.5
Power	W	159.5
Efficiency	%	0.31162
Length	m	0.2
cross sectional area of pipe	m	0.143
Radius of the pipe	m	4.75
Water head	m	2.65

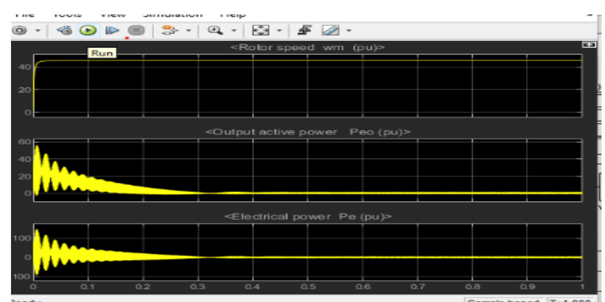

Figure 5 Output Waveform of Stator Current

(0.75, 1.35) we can observe changes in rotor speed, excita3tion, gain voltage and stator currents (a, b, c). Pico hydro turbines have great potential to electrify the rural and hilly areas. This paper was aimed to design a Pico hydro turbine which was installed on sewage pipelines to produce electricity for local population. The project was divided into three phases. In first phase sewage pipeline water quality was be tested in lab in term of pH, dissolved solids and suspended particle. As suspended particle and acidity of water could result in failure and corrosion of turbine. The theoretical power and energy available in sewage pipeline was be calculated. The turbine model then was manufactured and installed on sewage water pipeline. Pico hydro promising technology of the current scenario and future in terms of power generation and overcoming climate change issues. This technology without loss of mass flow rate in pipeline generates electricity. This technology only uses the kinetic energy of water.

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Chapter-11

Time frequency analysis based on fault detection in distribution system

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In electrical power networks, fault identification and classification are essential to preserving the dependability and effectiveness of distribution systems. Power supplies to consumers may be disrupted by a variety of defects that can affect distribution systems, including short circuits, line breaks, and equipment malfunctions. It is critical to promptly and precisely identify these issues in order to save downtime, maximize maintenance efforts, and guarantee continuous service delivery. methods for classifying and detecting faults that are especially suited for distribution networks. It examines both established techniques and recently developed technology, with an emphasis on the use of sophisticated signal processing and machine learning algorithms. These methods examine voltage and current waveforms using real-time data from sensors dispersed throughout the network, allowing for quick fault discovery and categorization.

In today's rapidly evolving energy landscape, ensuring the reliability and efficiency of distribution systems is paramount. Distribution systems form the backbone of electrical supply networks, facilitating the transfer of electricity from transmission grids to end-users. However, these systems are susceptible to various disturbances, such as faults, which can disrupt service and compromise reliability. Fault detection in distribution systems is a critical aspect of maintenance and operation. Traditional fault detection methods often rely on time-domain analysis, which may not adequately capture the complex transient behaviours associated with faults. As distribution systems become increasingly interconnected and dynamic, there is a growing need for more sophisticated techniques capable of accurately identifying and characterizing faults in real-time. Time-frequency analysis presents a promising approach to address this challenge. Unlike traditional methods, time-frequency analysis offers a comprehensive framework for analyzing signals in both the time and frequency domains simultaneously. By capturing the time-varying spectral characteristics of signals, it provides valuable insights into the transient phenomena associated with faults. A radial distribution system is a common electrical power distribution network configuration where power flows from a single source, such as a substation or a power plant, outward to various loads or consumers. A single diagram of a radial distribution system typically illustrates elements commonly included in a single diagram of a radial distribution system.

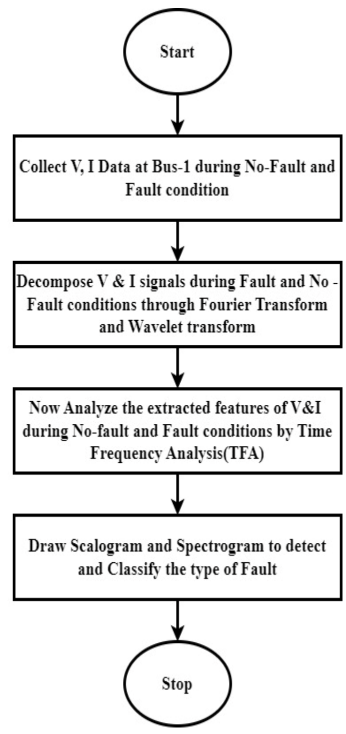

Figure 1 Flow chart of proposed system

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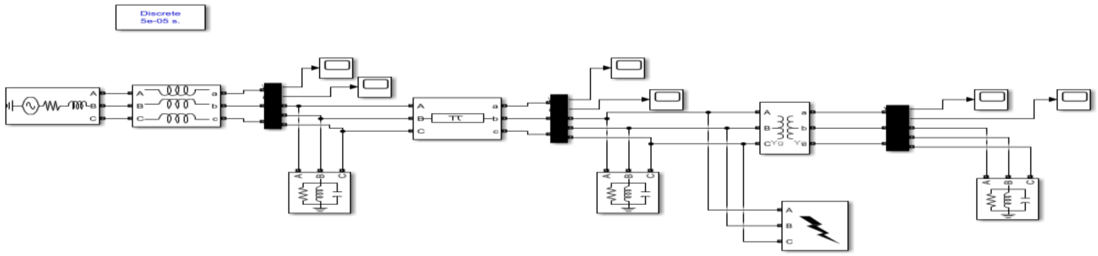


Figure 2 Simulation diagram

In this project, we performed the detection, identification and analysis of the faults in distribution system based on time frequency analysis. The simulation was performed in MATLAB/SIMULINK and data analysis is done in Python.

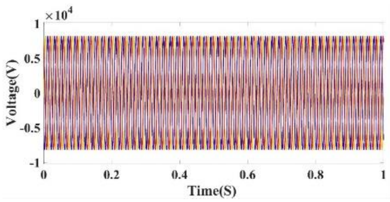


Figure 3 Voltage at Bus-2 During No Fault condition

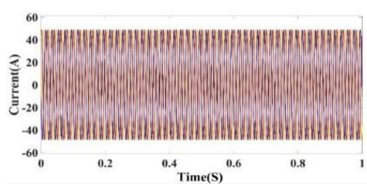


Figure 4 Current at Bus-2 During No Fault

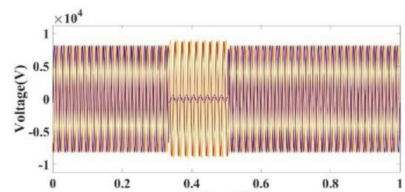


Figure 5 Voltage at bus-2 during Fault

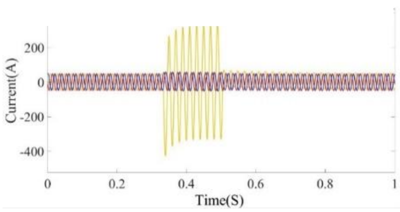
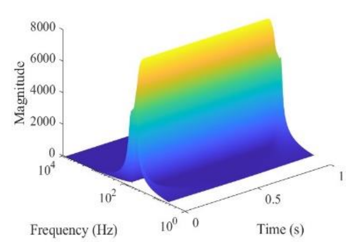
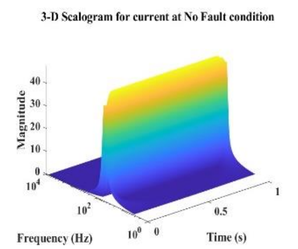
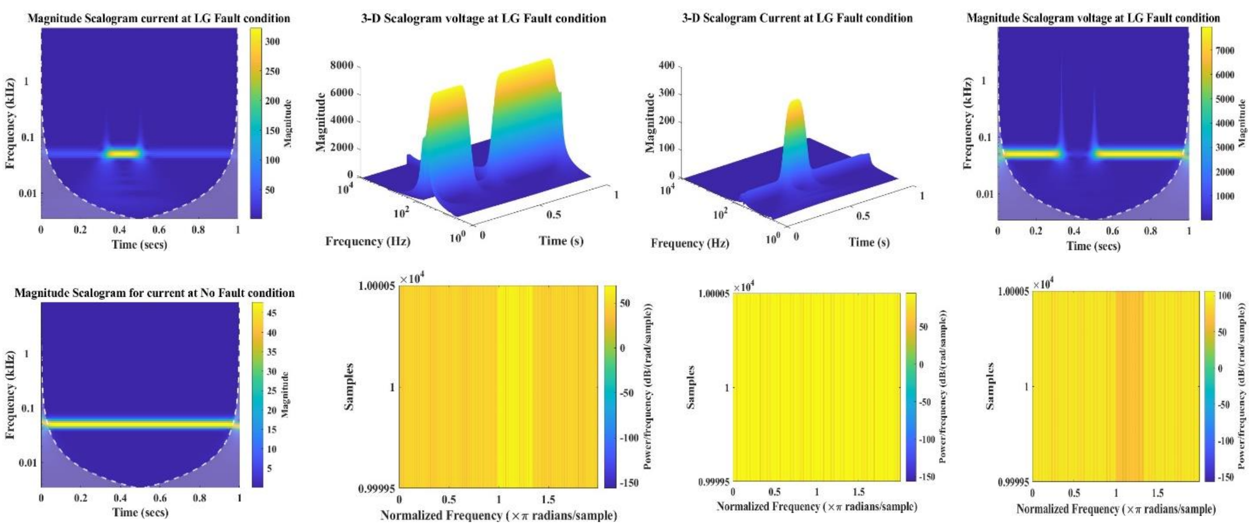


Figure 6 Current at bus-2 during Fault







Time-frequency analysis has a lot of potential to improve distribution system failure detection. When compared to conventional methods, time-frequency analysis provides a more thorough and precise means of defect detection because of its capacity to capture the time-varying spectrum features of signals.

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Chapter-12

Smart Shoe & Bracelet System for Enhanced Obstacle Detection

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Introduces an easy-to-use system to help visually impaired people move around safely. We've created special shoes and a bracelet to detect obstacles in their path. The shoes have sensors that feel for things like curbs or low objects, making the shoe vibrate if it finds one. The bracelet has sensors to spot higher obstacles like tree branches or doorframes. When it finds one, it vibrates to warn the person.

We've designed everything to be user-friendly, so it's easy for anyone to use. And we're working on making it even smarter over time, so it learns to recognize obstacles better.

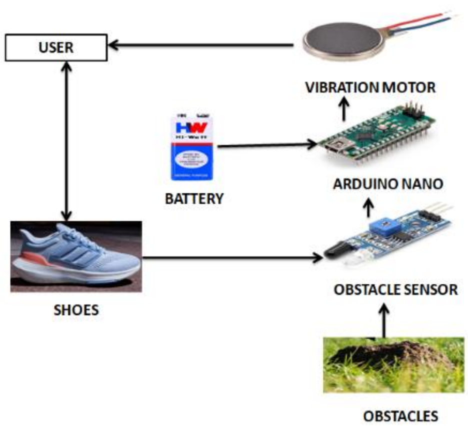

Figure 1 Block Diagram

Our goal is simple: to give visually impaired people more independence and keep them safe as they go about their day. In the future, we hope to make it even better and more helpful.

Our challenge ambitions to assist visually impaired people navigate their environment greater thoroughly and independently. We`ve evolved a gadget that consists of unique footwear and a bracelet to locate barriers. The footwear can experience low barriers like curbs, at the same time as the bracelet detects better ones like branches. When an impediment is detected, the gadget signals the wearer thru vibrations, supplying well timed warnings to keep away from accidents. Our purpose is to beautify the regular lives of visually impaired people through supplying them with a dependable and user-pleasant device for impediment detection and navigation assistance. With our challenge, we are hoping to deliver an experience of self-assurance and empowerment to people with visible impairments, allowing them to navigate the sector with more ease and peace of mind.

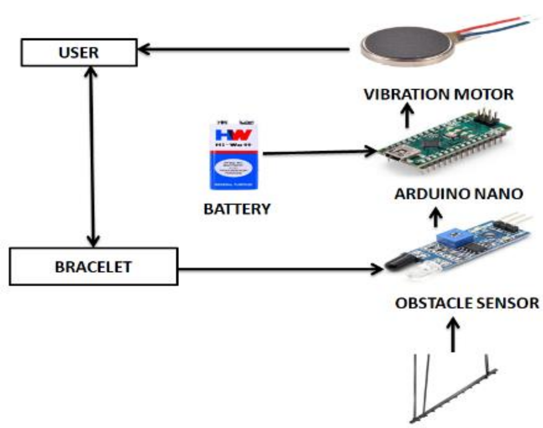

Figure 2 Components Used

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Objectives:

1. Develop a smart shoe and bracelet system equipped with obstacle sensors capable of detecting both lower height obstacles (e.g., curbs, stairs) and higher height obstacles (e.g., tree branches, doorframes).
2. Implement an intuitive feedback mechanism utilizing vibrations to alert the wearer of detected obstacles, with vibrations directed to the appropriate shoe or hand based on the obstacle height.
3. Integrate ultrasonic sensors or a camera into the bracelet component to detect higher height obstacles, ensuring comprehensive obstacle detection coverage for the wearer.
4. Design the system to be user-friendly and easy to operate, considering the needs and abilities of visually impaired individuals.
5. Employ advanced algorithms for obstacle detection and localization, optimizing the accuracy and reliability of the system in real-world environments

Explanation of algorithms for detecting lower and higher height obstacles:

Lower Height Obstacles Detection Algorithm:

- The algorithm in the smart shoes is designed to detect obstacles at lower heights, such as curbs, stairs, or low-lying objects.
- It utilizes sensors placed strategically within the shoes to measure distances to nearby objects.
- When the wearer approaches an obstacle, the sensors detect the object's presence based on changes in distance measurements.
- The algorithm analyzes these sensor readings and compares them to predefined thresholds to determine if an obstacle is present.
- If an obstacle is detected, the algorithm triggers vibrations in the corresponding shoe to alert the wearer and facilitate obstacle avoidance.

In conclusion, the smart shoe with obstacle sensors and the bracelet with ultrasonic sensors or a camera has the potential to significantly improve the daily lives of visually impaired individuals. By addressing key challenges in navigation and promoting autonomy, safety, and confidence, this assistive technology contributes positively to the well-being and inclusivity of the visually impaired community.

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Chapter-13

Smart Home Automation using IoT

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The rapid advancements in Internet of Things (IoT) technology have paved the way for innovative solutions in home automation, enhancing the convenience and efficiency of daily life. This project explores the integration of IoT with traditional manual switch control to manage home appliances seamlessly. The Blynk platform is employed as a user-friendly interface to facilitate remote monitoring and control.

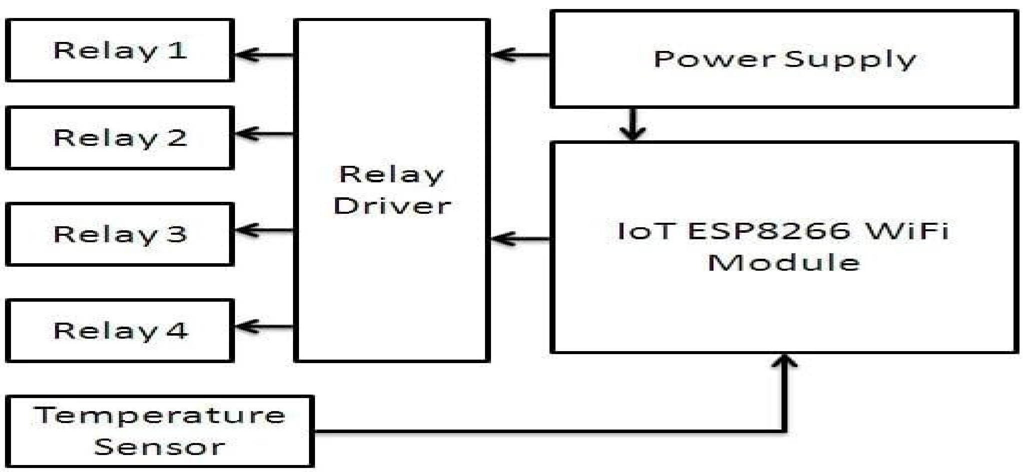

Figure 1 Block Diagram

IOT-based smart home automation with manual control entails the integration of several components to facilitate both remote and local operation of home appliances. At the core of the system lies a microcontroller or single-board computer (SBC) such as Arduino, Raspberry Pi, ESP8266, or ESP32, serving as the central processing unit. This microcontroller coordinates the communication between various sensors, actuators, and the internet. Sensors play a crucial role in detecting environmental parameters or conditions like temperature, humidity, light intensity, or motion, providing input data to the microcontroller. Actuators, on the other hand, execute physical actions based on commands from the microcontroller, controlling appliances such as lights, fans, motors, or locks. These actuators, which may include relays, servo motors, or motor drivers, are connected to output pins of the microcontroller. Additionally, a Wi-Fi module like ESP8266 or ESP32 facilitates internet connectivity, allowing for remote monitoring and control via a web interface or mobile application. Incorporated into the

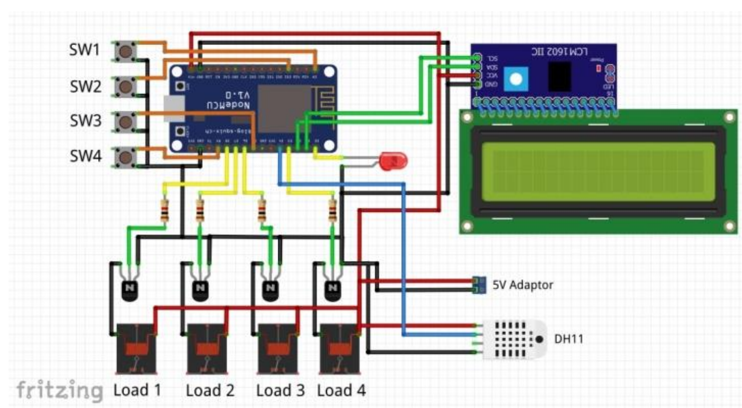

Figure 2 Circuit Diagram

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circuit are manual control switches or interfaces, which enable local operation of appliances regardless of internet connectivity or remote control.

These physical switches, which could be push buttons, toggle switches, or touch-sensitive interfaces, are connected to digital input pins of the microcontroller to detect user inputs for manual control. Lastly, a stable power supply, whether from a battery, DC adapter, or power bank, is crucial to power the entire circuit. The connections within the circuit are essential for its functionality. Sensors are typically connected to analog or digital input pins of the microcontroller to provide input data.

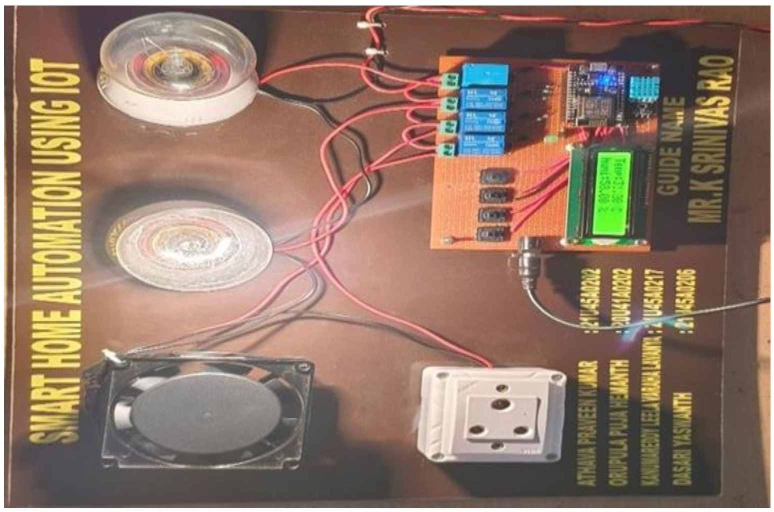

Figure 3 Hardware

For instance, a relay may be connected to a digital output pin to switch on/off a light bulb. The microcontroller communicates with the Wi-Fi module through serial communication (UART, SPI, or I2C) to send and receive data over the internet. Manual control switches or interfaces are connected to digital input pins of the microcontroller to detect user inputs for manual control. Manual control switches or interfaces are incorporated into the circuit to allow for local operation independent of internet connectivity. These physical interfaces, connected to digital input pins of the microcontroller, provide users with a tactile means of interacting with their home devices. A stable power supply ensures the reliable operation of the entire system, whether from batteries, DC adapters, or power banks. The connections between components are carefully established to ensure seamless communication and functionality. Overall, this circuit diagram combines IOT-based smart home automation with manual control, providing users with the flexibility and convenience of controlling their home appliances both remotely and locally.

The following are the features of our system:

- Easy to use.
- Saves unnecessary power consumption.
- Low cost compared to other automation systems.
- Easy to implement.
- Has good processing power.
- Uses reliable wireless connection.

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Chapter-14

Design And Implementation of an Electric Bicycle with GPS

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Electric bicycles, commonly known as e-bikes, have emerged as an environmentally friendly solution to urban transportation. This abstract delves into the incorporation of regenerative braking, pedal-power energy capture, and solar power technology in e-bikes, with a primary focus on augmenting sustainability and energy efficiency. Regenerative braking is a technology that captures and stores energy when the e-bike's brakes are engaged, transforming kinetic energy into electricity. While the energy generated from pedaling is less substantial, researchers are diligently working on optimizing its potential. In the present scenario, the number of vehicles on the road has been increasing at a Rapid pace which results in a tremendous increase in air pollution which ultimately leads to global warming. To reduce the air pollution in urban areas electric vehicle usage is increasing day by day. E-bikes are classified according to the power that their electric motor can deliver and the control system, i.e., when and how the power from the motor is applied. Also, the classification of e-bikes is complicated as much of the definition is due to legal reasons of what constitutes a bicycle and what constitutes a bicycle and what constitutes a moped or motorcycle such as the classification of these e-bikes varies greatly across countries and local jurisdiction. The

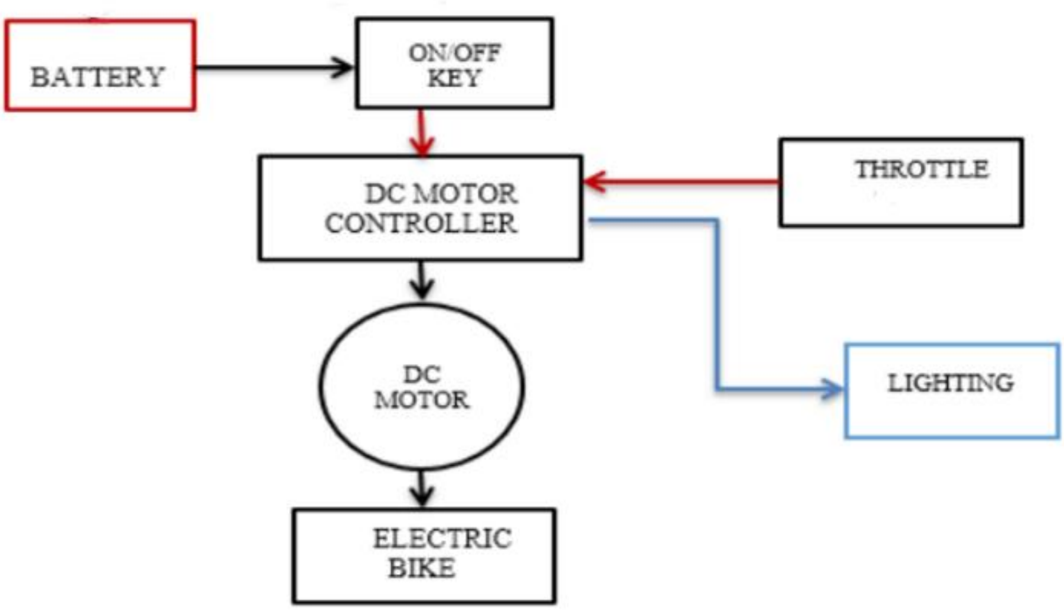

Figure 1 Block diagram of converting Electric Bicycle

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objective is to design and implement an electric bicycle with a GPS tracking system. Here the current from battery moves to controller where all the connections are made. When the power is given to the motor, it rotates the wheel using chain and sprocket. Electric Motor Bicycles are in high demand in India because they produce less pollution, have fewer maintenance costs, and produce less noise. The basic configuration of an electric bicycle drive consists of a controller that controls the power flow from the battery to the electric motor.

Mode-1

Regular Mode:

This mode relies only on the rider's pedaling power, providing a manual cycling experience. The results indicate that in Regular Mode, the bicycle retains the lightweight and straightforward nature of a conventional bike, allowing riders to navigate effortlessly through various terrains. The absence of electric assistance in this mode promotes a classic cycling feel, ideal for users seeking exercise or when the battery is conservatively used.

Figure 2 Bicycle

Mode-2

Thumb Throttle Mode:

Thumb Throttle offers a distinctive feature where the rider can control the electric motor directly using a throttle. The thumb throttle mechanism enhances user accessibility and provides an effortless riding experience, particularly in scenarios where immediate power delivery is crucial, such as navigating through traffic or tackling sudden inclines.

Mode-3

Pedal Assist Mode:

Pedal Assist Mode introduces a harmonious collaboration between human pedaling and electric motor assistance. In Pedal Assist Mode, riders experience a natural and intuitive boost, making it an ideal choice for longer rides, hilly terrains, or situations where maintaining a consistent speed is essential. The integration of sensors ensures that the motor assistance aligns seamlessly with the rider's pedaling cadence, providing a more dynamic.

From this project we have done the conversion of cycle to a good condition E-cycle which has almost every feature compared to every cycle in market. It is cost efficient and follows all the of the eco system. We got a good Lithium-ion battery which gives the range 40km (or even more, depends on the driving conditions.) and a top speed of 25km/h.

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Chapter-15

Solar powered outdoor Air Purifier

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In the present context, it is imperative to devise an air filtration system capable of assessing air quality in any location. This system employs a high-powered energy source to gauge its effectiveness, thereby mitigating pollution both indoors and outdoors. Air pollution arises from the introduction of harmful substances, encompassing gases, particles, and biological elements, into the atmosphere, leading to health issues such as diseases, allergies, and even fatalities in humans. Furthermore, it adversely affects animals, crops, and the natural or man-made environment. Human activities and natural phenomena contribute to air pollution. The main aim of this paper is to design a solar-driven air purification setup incorporating an Arduino Nano and a PM 2.5 air filter. This system aims to improve outdoor air quality by harnessing renewable energy, thus offering an eco-friendly solution to combat air pollution. The high level of air pollution in urban areas is undeniable. Most of this pollution originates from vehicles and construction activities, manifesting as particulate matter such as methane, carbon dioxide, and dust. These pollutants contribute to various health issues, including the development of asthma, diminished lung function, and respiratory illnesses. Among these, larger dust particles are particularly prevalent. Improved air quality, characterized by minimal particulate matter, is essential for the well-being of all living organisms. The block diagram in Fig-1 illustrates the air purifier system, featuring a solar panel that charges a battery. This battery then powers a motor driving a heavy-duty suction fan, which draws air from the purifier's base through multiple filters to eliminate PM 10 and PM 2.5 particulates along with gases. The Circuit diagram Offers a functional perspective of a system and demonstrates the interconnectedness of its various components. Figure 2 displays the circuit diagram of the solar-powered outdoor air purifier described in this paper.

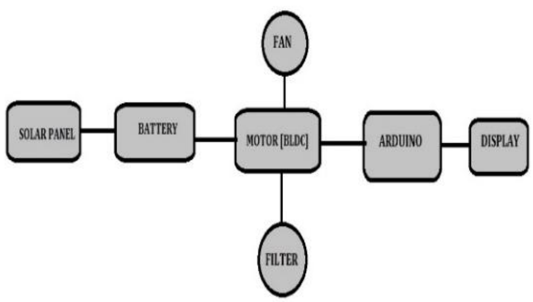

Figure 1 Block Diagram

The solar powered outdoor air purifier mainly consists of, PM2.5 Air purifier, BLDC Motor, Suction fan, PV array, battery, inverter, ESC, Arduino nano, Buck converter, LCD Display, Potentiometer as shown in the fig-3. The Solar Powered air purifier system has the following advantages –

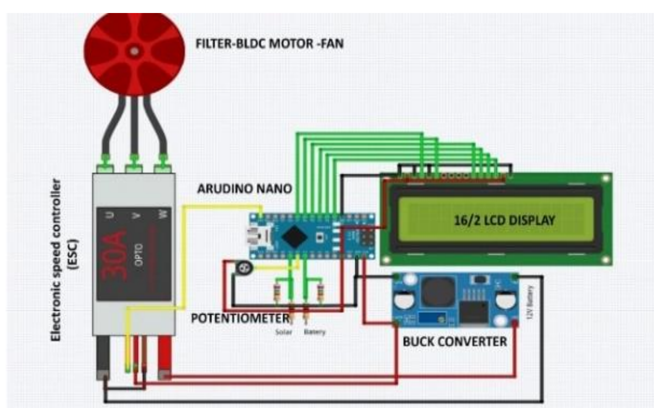

Figure 2 Circuit Diagram

1.It is designed for portability, allowing for easy transportation to school play areas, parks, residential neighborhoods, and public spaces.

2. It is an efficient system.

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3. Instant pollution control system.

When the power supply is switched on to the air purifier the module gets started with a beep sound indicating "WELCOME-DIET-ENGG-COL" in the LCD and also The LCD displays "WELCOME-EEE-DEPARTMENT" indicating the department environment. Then initial states of the Solar array & the Battery are displayed in the LCD indicating that the module is ready for the operating in the desired conditions. Once the Air Purifier module is activated it sucks the polluted air and gives out the purified air which indicated in the LCD in litres as shown in fig-4. Clean air stands as a paramount necessity for all, emphasizing its pivotal importance. Indoor air pollution emerges as one of the top five threats to public health. To address this, air purifiers are engineered with particulate matter filtering mechanisms, targeting pollutants such as dust, pollen, and gaseous compounds like hydrocarbons. This paper presents the design of a novel portable air purifier furnished with a sequence of filters designed to improve air quality in both residential and office environments. T Specifically designed for application in hospitals, offices, senior living facilities, and similar settings, the Smart Air Purifier efficiently eliminates dust, fungus, and harmful gases from the atmosphere. Its versatility is enhanced by its portability and the ability to operate directly through AC power, achieved by connecting an adapter to an Arduino device powered by DC. The technology utilized in this Air Purifier demonstrates promising potential, particularly in scenarios where dust density is elevated, thereby conserving energy. Therefore, it can be concluded that the combination of filters (pre-filter, dust filter, and fine filter) demonstrated effectiveness in purifying the ambient air.

Figure 3 Solar Powered Outdoor Air Purifier Prototype

Figure 4 Analysis of proposed method during Operating State

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Chapter - 16

Implementation of a Grid-Integrated PV- Battery System for Residential Applications & EV's

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The rapid advancement of renewable energy technologies and the growing adoption of electric vehicles (EVs) necessitate innovative energy management solutions. In this study, we present the design and Smart Grid Integration of Photovoltaics and battery storage, specifically tailored for residential use. Our proposed system harnesses solar energy to power homes and facilitate EV charging, thereby optimizing energy consumption and contributing to a greener household. Renewable energy sources, particularly solar photovoltaics (PV), have gained prominence as viable alternatives to conventional fossil fuels. Simultaneously, the surge in electric vehicle also increasing in numbers. The need for sustainable energy solutions our research focuses on the seamless integration of PV systems with battery energy storage, aiming to enhance grid resilience, reduce dependency on non-renewable sources, and promote environmental stewardship by empowering Homes by Grid-Integrated PV-Battery Systems.

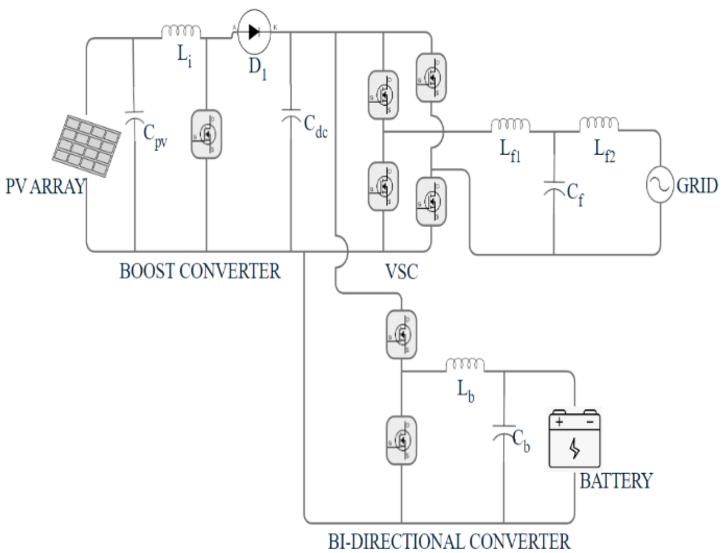

Figure 1 Proposed Circuit diagram

The power leveling are achieved by charging and discharging the battery, which also improves system reliability. In addition to reactive power correction and harmonics suppression, the voltage-source converter serves as an active power filter. The proposed system configuration is shown in Fig.1. The solar panel is connected to a boost converter. The required output voltage of the PV system is determined by modifying the parallel strings and series modules within the PV array block. Additionally, the grid is receiving power from the PV block through its connection to the boost converter, whose output is coupled to an inverter that converts DC to AC voltage. To charge and discharge the battery as needed, we connected a bidirectional buck-boost converter in parallel to the VSC converter. The boost converter cleverly manipulates components like inductors, capacitors, and switches to achieve voltage boosting without the need for AC conversion on varies its output power. The Voltage source converter input is boosted output of the boost converter where it remains at a 400volts. The voltage source converter converts the DC into AC and supply to the grid. The VSC converter takes DC input from the boost converter after that it convert the DC into AC by using switching devices (MOSFET's). VSC generates AC voltages without relying on an AC system. It achieves this by sequentially switching devices to present unidirectional DC voltage from a DC capacitor as AC voltage on the AC side. The Grid voltage and current waveforms are shown in the above figure. The grid voltage is 230 volts which is

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determined in Simulink model. There the current and voltages are in-phase witch each other & there are some fluctuations in grid current due to unstable conditions. To reduce these fluctuations, we are using LCL filters at the grid input based on their configurations. These fluctuations are due to power demand variation and sudden changes.

To protect from these, we need to use protections relays and proper grounding is required. The proposed scheme used for a PV array and a BESS to a single-phase grid with multifunctional properties. The system exhibits unique features of adaptable control under various practically occurring situations. The system is best suited for residential applications especially for charging/discharging of EVs due to the reliability of uninterruptable power to the grid and the load. The proposed system integrates solar photovoltaic (PV) panels with battery storage. It connects to a single-phase grid, serving both residential loads and EVs. It contributes to grid stability and efficient energy utilization. Further research and real-world deployment are essential for widespread adoption.

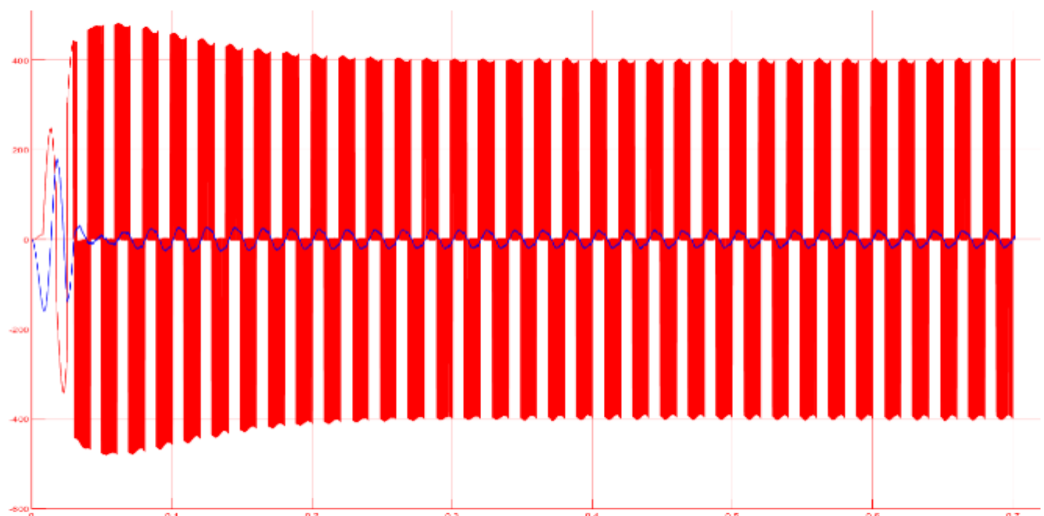

Figure 2 Output waveforms of VSC converter and grid

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Chapter-17

Mutual Induction Based Resonant Power Charging for Electric Vehicle Batteries

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Wireless power transfer systems are gaining popularity in modern times due to their diverse range of applications, including charging devices such as cell phones, laptops, electric vehicles, underwater vehicles, and implants. Inductive power transfer (IPT) is a wireless power transfer technology that is widely used in these systems. This work aims to design an electric vehicle wireless power transfer charger using the IPT method. To achieve this goal, a series-series (SS) compensated IPT system was developed. The designing formulas for this system were derived, and values were calculated to create a 2 KW wireless power charger. The implementation was carried out using Simulink/MATLAB.

WPT technology has garnered considerable interest among EV owners, as it eliminates the inconvenience typically associated with charging. When energy is transmitted wirelessly to the EV, charging becomes a seamless and effortless process. In the case of stationary WPT systems, EV drivers simply park their cars at the charging station. Conversely, in the case of dynamic WPT systems, the EV can be powered while in motion, allowing for uninterrupted travel. Moreover, compared to EVs that rely on conductive charging, those equipped with wireless charging technology may exhibit a reduction in battery capacity of 20% or less. The Figure represents the Block Diagram of the Wireless Power Transfer (WPT) system for electric vehicle (EV) charging. This system is initiated by a Direct Current (DC) supply, which acts as the primary power source and can be sourced from diverse resources, such as batteries, solar panel arrays, or any other DC power origin. MATLAB/Simulink was utilized to design and simulate the wireless power transfer (WPT) system shown in Figure with the parameters specified in Table I. Primarily, a 100 Ω load across capacitor Co was inserted to examine the output current. The purpose of the simulation was to determine whether a 240 V DC input supply could be used to send electricity wirelessly. A high-frequency DC-AC inverter is used to first invert this input voltage before feeding it to the primary/transmitting coil. Mutual induction is used to create a resonance between the primary and secondary coils, enabling the secondary side to receive high-frequency AC power. Before being applied to the load, which consists of a 100 Ω resistor, the AC received from the secondary coil is rectified.

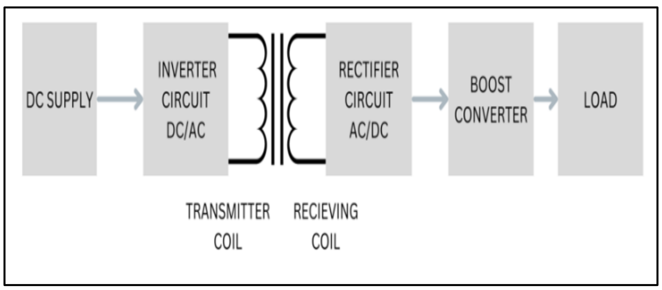

Figure 1 Block Diagram

DC power origin. As the central component of the system, the inverter plays a crucial role by converting the DC input power into high-frequency Alternating Current (AC). This conversion is essential for establishing an efficient means of power transfer through magnetic fields. The transmitter coil, shaped as a loop of wire, is energized by the AC produced by the inverter. This energization generates a magnetic field, facilitating the wireless transmission of power. On the EV side, the receiving coil, another loop of wire, captures the magnetic field from the transmitter coil, inducing an AC current within itself. The next stage

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entails a rectifier, which transforms this induced AC back into DC current. Following this, a boost converter increases the DC voltage to a level suitable for charging the EV's battery. The primary goal of this integrated system is the flawless and efficient wireless transmission of power from the initial DC supply to the EV's battery. Figure illustrates the key components and their interconnected functions, providing a comprehensive visual representation of the Wireless Power Transfer system for electric vehicle charging.

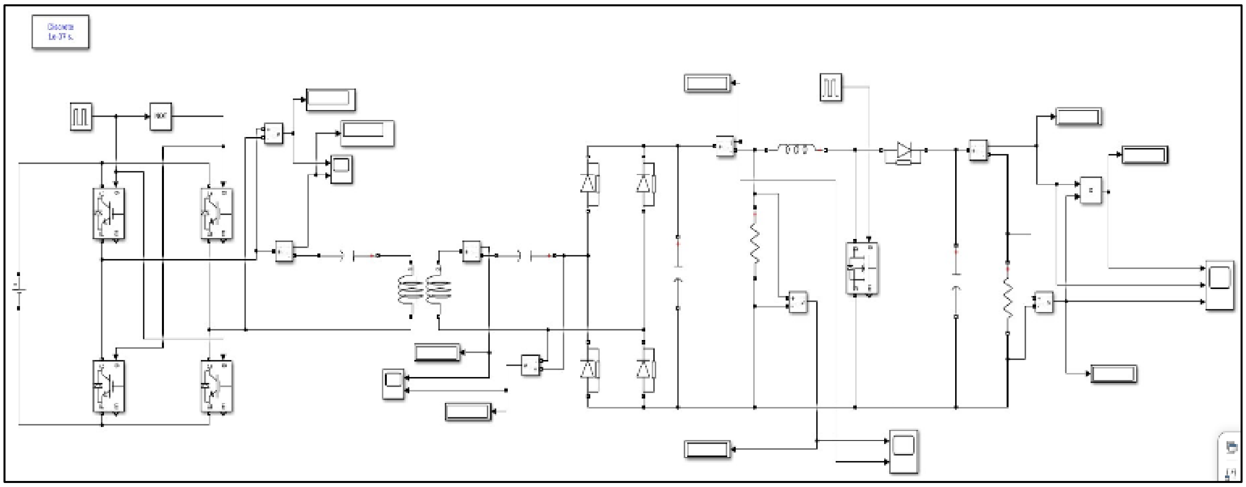

Figure 2 MATLAB/Simulink Model

voltage, and power without using a boost converter on the load side. After adding a boost converter to the load side, the output voltage, current, and power were examined using a 100 Ω load. Variations in output voltage can be achieved by controlling the boost converter's duty cycle, which in turn controls the planned WPT system's output. The purpose of the simulation was to determine whether a 240 V DC input supply could be used to send electricity wirelessly. A high-frequency DC-AC inverter is used to first invert this input voltage before feeding it to the primary/transmitting coil. Mutual induction is used to create a resonance between the primary and secondary coils, enabling the secondary side to receive high-frequency AC power. Before being applied to the load, which consists of a 100 Ω resistor, the AC received from the secondary coil is rectified. Similar to this, adding a boost converter to the load side results in an output voltage of 450 volts DC and an ampere of current, as shown in Fig. 8. It is conspicuous that the output voltage and current waveforms are both planar, indicating that a accurate output power of two kilowatts can be achieved from the system. In this study the design, operation, and simulation of a wireless power supply (WPS) system grounded on inductive coupling, employing MATLAB/Simulink software. This paper's core objective is to deliver an all-inclusive analysis of wireless charging for EVs. Both with and without a boost converter added to the load side, the same results were observed. The boost converter produced smoother output waveforms, which is important for battery charging applications. The output power was measured at 2 KW with a 100 Ω load. This system for wirelessly charging EV batteries could become a reality as technology develops, but more study is required to fully understand its possibilities.

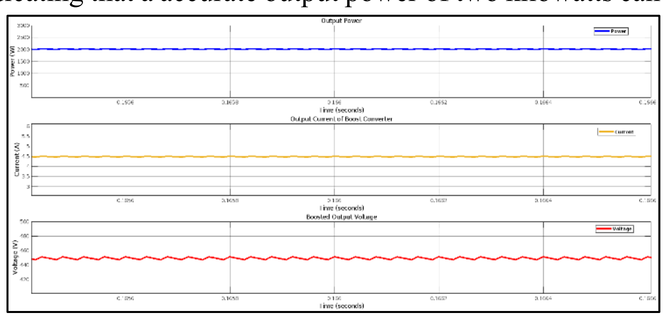

Figure 3 Output power and current and voltage

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Chapter-18

Battery and Supercapacitor Fed BLDC Motor for EV Applications

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This research uses simulation to investigate the viability and capacity of a hybrid energy storage system (HESS), which consists of battery and super-capacitor units. Over the past 20 years, there has been a significant increase in the price of petrol due to the extensive usage of internal combustion engine (ICE)-based cars, which has had a detrimental impact on the environment and accelerated the depletion of fossil fuel supplies.

Due to these difficulties as well as the poor efficiency of traditional drivetrains, the automative industry is now seriously considering and pursuing drivetrain electrification in automotive systems. In Electric motors that are fueled by onboard energy storage systems provide all or some of the propulsion in electrified vehicles. To address the shortcomings of current energy storage devices and further the drive towards vehicle electrification, the HESS topology was selected with consideration for cost, performance, and the ease of use of power and control circuits. The necessary power, converter losses, energy storage device constraints, and battery cell current quality are all taken into account in the design.

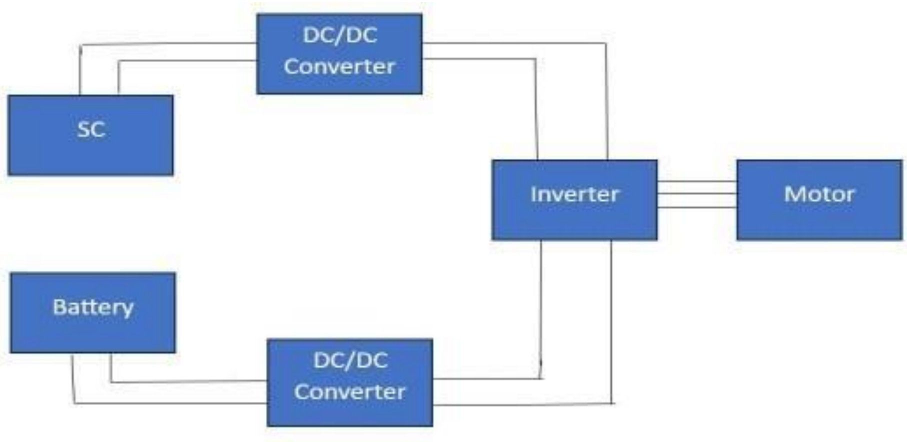

Figure 1 Block diagram

Since most of these densely populated cities are walkable or bikeable from both the workplace and residential regions, electric vehicles (EVs) have become a mainstay of transportation. Over time, this dependable but underappreciated mode of transportation has changed from basic utility bikes to strong geared mountain bikes to electric aided bicycles. Concerns about pollutants and running out of fuel have brought the electric vehicle market and research community back to life. Right now, batteries are the weak point in any electrically powered vehicle, including bicycles.

The primary obstacle to the acceptance of electric propulsion as the primary mode of both private and public transportation has been the unavailability of a single, reasonably cost energy storage device that can simultaneously provide high power density and high energy density. Combining a high-energy storage device, like an electrochemical battery or fuel cell, with a high-power device, like an electric double layer capacitor (EDLC), ultra-capacitor, or super capacitor, is currently the only practical way to solve this issue.

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Typically, the battery bank and supercapacitor array are interfaced to the load bus via a power converter that uses an energy management control approach.

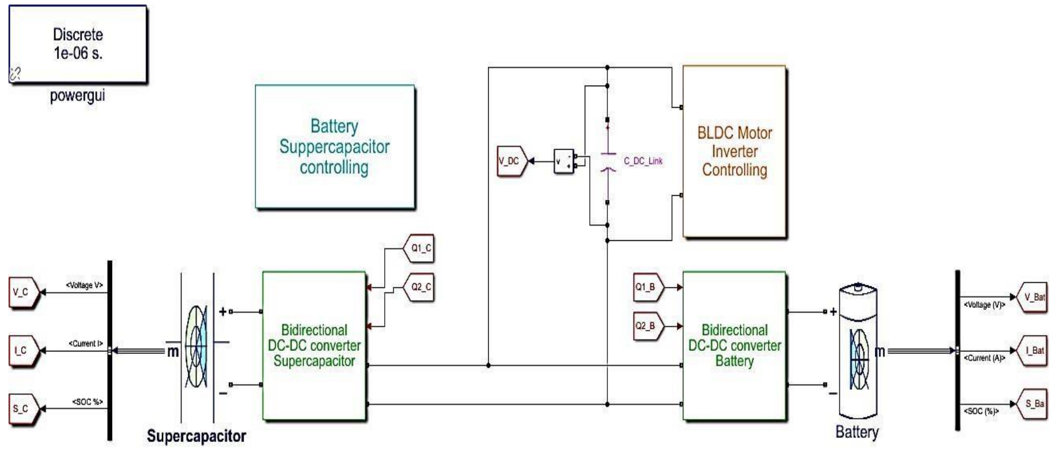

Figure 2 simulation diagram showing a BLDC motor fed by a battery and super capacitor

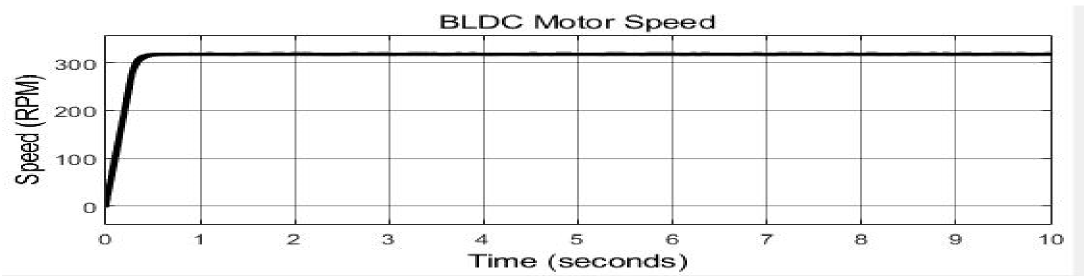

Figure 3 BLDC motor Speed

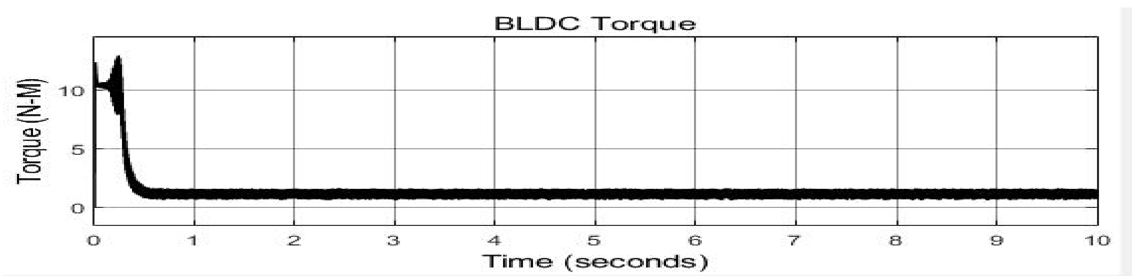

Figure 4 Torque Characteristics

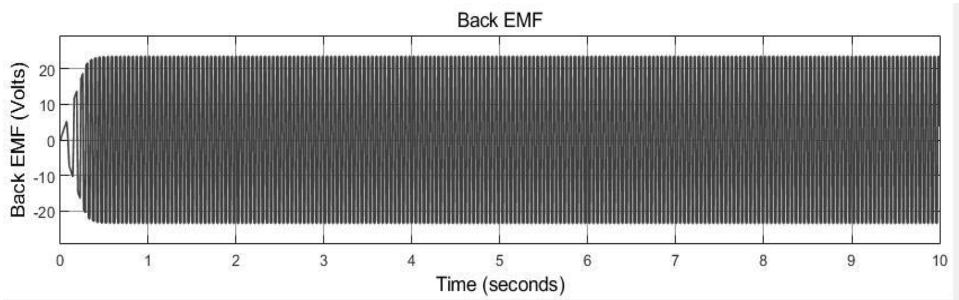

Figure 5 BLDC Back EMF

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Chapter-19

Fault detection and classification in PV systems using MRA DWT and AdaBoost classifier

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The increasing integration of photovoltaic (PV) systems into the global energy grid emphasizes the need for robust fault detection and classification methodologies to ensure optimal performance and reliability. This research presents a novel approach for fault identification in PV arrays by combining the Multiresolution Analysis (MRA), Discrete Wavelet Transform (DWT), and AdaBoost classifier. The proposed methodology involves capturing the unique frequency and time-domain characteristics associated with various fault types within PV arrays. MRA is employed to extract relevant features from the acquired data, followed by DWT to enhance the discriminative power of the features.

The processed data is then fed into an AdaBoost classifier, leveraging its ensemble learning capabilities to improve fault classification accuracy. Simulation and Experimental validation are conducted using real-world 3X3 PV array data under different fault scenarios, including shading, module failures, and electrical anomalies. The results demonstrate the effectiveness of the proposed approach in accurately detecting and classifying faults, even in the presence of noise and changing environmental conditions. Comparative analyses with existing fault detection methods highlight the superiority of the proposed MRA-DWT-AdaBoost framework in terms of accuracy, robustness, and computational efficiency. In recent years the power demand through the renewable energy sources is increasing from day to day. Among all, solar photovoltaic (PV) system is more reliable, efficient and economical in nature.

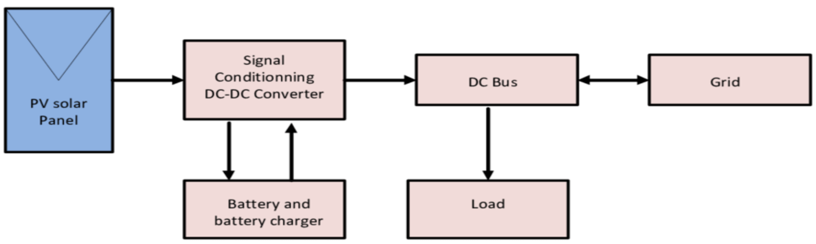

Figure 1 Block diagram of PV System

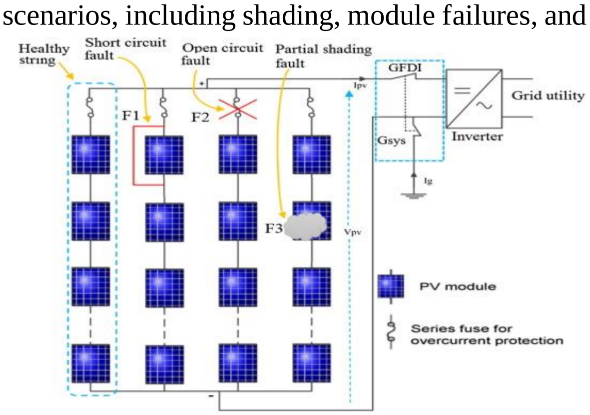

Figure 2 Types of Faults in PV Array

However, PV system may suffer from the intermittency of environmental conditions. With these, PV system may come across different faults conditions like Open Circuit faults, Short Circuit faults and Partial Shading Condition.

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MRA enables signal analysis at different detail levels. DWT, a specific MRA implementation using wavelets, decomposes signals into approximation and detail coefficients at various resolutions, providing a multi-scale representation.

1. Data Collection: Collect representative data including voltage, current, and temperature under normal and fault conditions.

2. Preprocessing: Remove noise, handle missing values, and normalize features.

3. Feature Extraction: Apply MRA and DWT to extract relevant features from preprocessed data.

4. Classification: Utilize AdaBoost classifier for fault detection and classification, training it on selected features and fault labels.

Figure 3 Flow chart of Methodology

The proposed method is validated on the 3X3 PV array by simulation and experiment. 3X3 PV array with various faults is shown in Figure 4. The circuit is a configuration model of a 3x3 solar PV array. It is a circuit model of a solar photovoltaic (PV) array that is connected in a series-parallel configuration.

The model considers the effects of irradiance and temperature on the PV array's output.

The circuit consists of the following components:

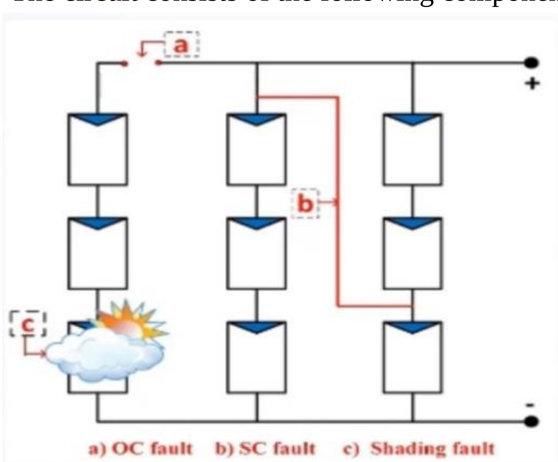

Figure 4 3X3 PV Array system with various fault Condition

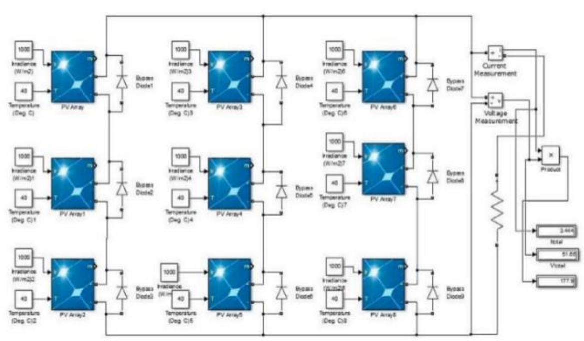

Figure 5 Simulation Model

A solar PV array, which is represented by a black box with the label "PV Array". The PV array is made up of 3x3 solar cells, which are connected in a series-parallel configuration. A current meter, which is represented by the symbol "A". The current meter measures the current that is flowing through the PV array. A voltage meter, which is represented by the symbol "V". The voltage meter measures the voltage that is across the PV array.

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Chapter-20

Smart power management: Wi-Fi-controlled electrical equipment's

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In this project "Wi-Fi controlled electrical appliances by using Alexa and google assistant" we can operate our home electrical appliances like fans, bulbs etc. easily in the less time consuming and less effort. Home automation is becoming more and more common place and popular all around the world. By employing technology to regulate and carry out tasks that we would typically carry out manually, home automation makes everything in the house automatically controlled. In this case, the user will interact directly with the system via a web-based interface, whereas household appliances like lights, fans, etc. are controlled remotely by the ESP Rainmaker app, remote, Alexa, Google assistant, normal operating, and scheduling. Relay hardware circuits that manage the home's running appliances will be interfaced with the server.

Home automation is the automatic

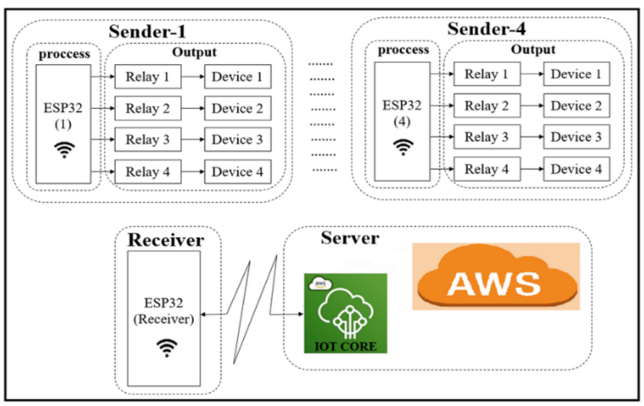

Figure 1 Block Diagram

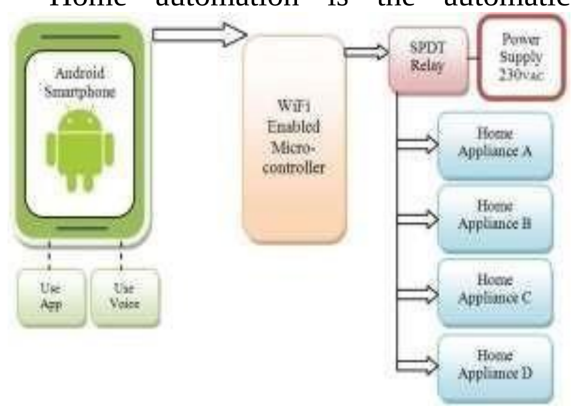

Figure 2 Home Automation

control of electronic devices in your home. These devices are connected to the Internet, which allows them to be controlled remotely. With home automation, devices can trigger one another so you don't have to control them manually via an app or voice assistant. For example, you can put your lights on schedules so that they turn off when you normally go to sleep, or you can have your thermostat turn the A/C up about an hour before you return to work so you don't have to return to a stuffy house. Home automation makes life more convenient and can even save you money on heating, cooling and electricity bills. Home automation can also lead to greater safety with Internet of Things devices like security cameras and systems.

Home automation works via a network of devices that are connected to the Internet through different communication protocols, i.e Wi-Fi, Bluetooth, ZigBee, and others. Through electronic interfaces, the devices can be managed remotely through controllers, either a voice assistant like Alexa or Google Assistant or an app. Many of these IoT devices have sensors that monitor changes in motion, temperature, and light so the user can gain information about the device's surroundings. To make physical changes to the device, the user triggers actuators, the physical mechanisms like smart light switches, motorized valves or motors that allows devices to be controlled remotely.

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Home automation works on three levels:

Monitoring: Monitoring means that users can check in on their devices remotely through an app.

Control: Control means that the user can control these devices remotely.

Automation: Finally, automation means setting up devices to trigger one another.

The experimental model was made according to the circuit diagram and the results were as expected. The loads are switched ON when the ESP32 gets the signal correctly from Esp Raimaker application and it drives the particular load relay correctly. The loads are switched OFF only when the Esp32 gets the OFF signal from Esp Raimaker application i.e., from the user. The kit is connected to AC Supply and this 230V 50HZ will converted into 5V by means of DC Adapter. This 5V is regulated by voltage regulator here ESP32 needs 3V to activate similarly relay requires 5v for working. Whenever the user presses an icon in the application the information will be send to ESP32 MC via Wi-Fi the ESP32 MC analyses the received commands and turns ON/OFF of the respective device via relay. We can operate our home automation by Alexa device, Google Assistant through our voice commands and also with help of Remote and mannual operating.

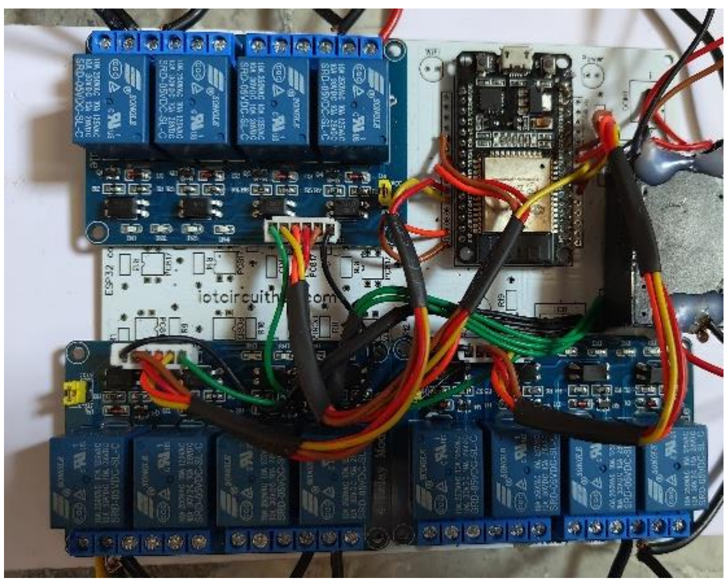

Figure 3 Prototype

In this IoT project, we did how to make an ESP RainMaker home automation system. With this ESP32 project, you can control 8 home appliances with ESP Rainmaker, Google Assistant, Alexa**,** IR remote**,** and manual switches.

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Chapter-21

Analysis of SOC estimation and emission reduction of various hybrid electric vehicles

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A comprehensive analysis of state-of-charge (SOC) estimation and its impact on emission reduction in various types of hybrid electric vehicles. With the increasing adoption of electric and hybrid vehicles, accurate SOC estimation plays a crucial role in optimizing battery management systems and enhancing vehicle performance. Furthermore, reducing emissions from hybrid electric vehicles remains a significant challenge, necessitating advanced control strategies and emission reduction technologies. This chapter reveals about IM&PMSM-based series and parallel hybrid electric vehicles with FWD powertrain configurations and NiMH and Li-ion-based battery packs. All the designs were tested in a MATLAB/Simulink software environment, and the proposed series hybrid model with a Li-ion battery driven by a PMSM motor gave optimum results with better SOC, and NiMH-based series hybrid electric vehicles emitted less contamination to the environment**.** The transportation sector is a major contributor to greenhouse gas emissions and air pollution, driving the need for more sustainable and environmentally friendly vehicle technologies. According to the International Energy Agency (IEA), the transportation sector accounted for approximately 24% of global CO2 emissions in 2019, with road vehicles being the largest contributor. Compared to traditional vehicles driven by internal combustion engines (ICEs), electric vehicles (EVs) have a number of advantages. First off, electric vehicles (EVs) have zero tailpipe emissions, which lowers air pollution and enhances local air quality. This is especially crucial in urban areas where conventional vehicles are a major source of smog and respiratory problems. Moreover, EVs require less maintenance and have fewer moving parts than ICE cars, which lowers maintenance and repair costs over the course of ownership. In comparison to conventional vehicles, hybrid electric vehicles (HEVs) use two power sources: an internal combustion engine and an electric motor. This results in lower fuel consumption and pollution. This decrease in greenhouse gas emissions helps fight climate change and enhances the quality of the air in cities, where vehicle pollution is a major issue. Furthermore, HEVs are essential for advancing technological innovation in the automotive industry. HEVs also have regenerative braking systems, which recover energy lost during braking and use it to increase overall efficiency and lessen brake component wear.

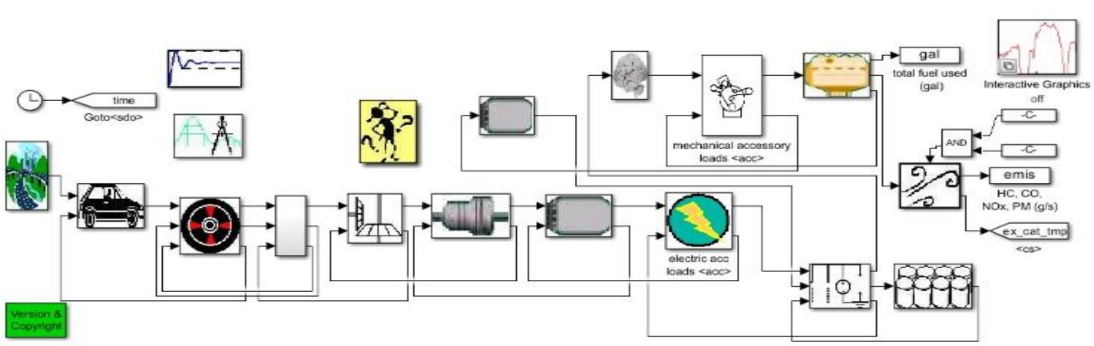

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Figure 1 Block diagram

Here we have used series hybrid vehicle with lithium- ion battery with a nominal voltage of 267v which is approximately 25 modules and here we have used AC induction motor with a rating of 75kw(continuous).

we have used series hybrid vehicle with lithium- ion battery with a nominal voltage of 267v which is approximately 25 modules and here we have used Permanent magnet motor with a rating of 58kw(continuous).

we have used series hybrid vehicle with Nickel metal hydride battery with a nominal voltage of 436v which is approximately 65modules and here we have used AC induction motor with a rating of 75kw(continuous).

we have used series hybrid vehicle with Nickel metal hydride battery with a nominal voltage of 436v which is approximately 65modules and here we have used Permanent magnet motor with a rating of 58kw(continuous).

we have used parallel hybrid vehicle with lithium-ion battery with a nominal voltage of 267v which is approximately 25 modules and here we have used AC induction motor with a ratingof 75kw(continuous).

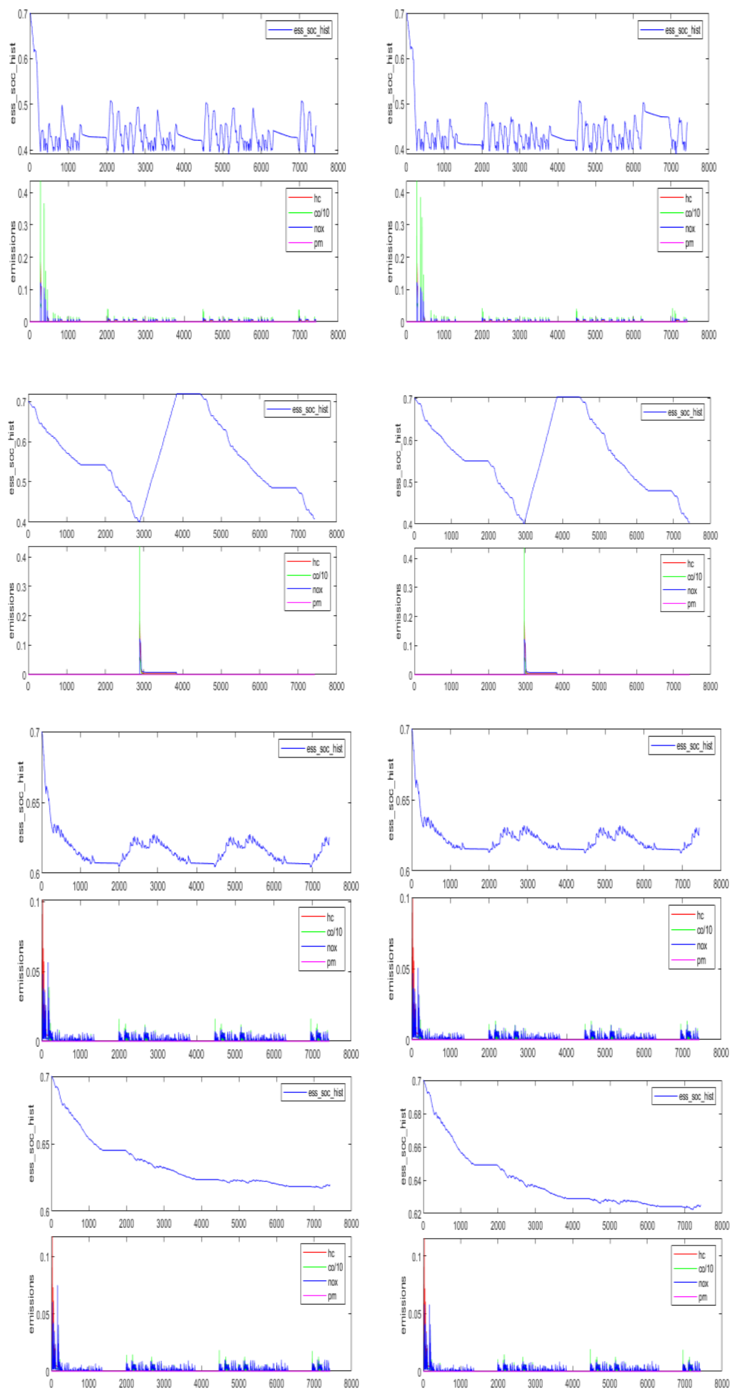

Figure 2 Output waveforms of proposed method

we have used parallel hybrid vehicle with lithium-ion battery with a nominal voltage of 267v which is approximately 25 modules and here we have used Permanent magnet motor with arating of 58kw(continuous). we have used parallel hybrid vehicle with Nickel metal hydride battery with a nominal voltage of 436v which is approximately 65modules and here we have used AC induction motor with a rating of 75kw (continuous). This chapter provides a comprehensive analysis of SOC estimation and emission reduction for a series of hybrid vehicles.

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Chapter-22

Battery Monitoring & Protection System

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The automotive sector is rapidly transitioning to electric vehicles, offering opportunities to profit from data generated and enhance efficiency and security. This project aims to integrate location tracking, theft prevention, battery condition monitoring, and control systems using Arduino technology. Additional components include a theft detector, Arduino CPU, and real time tracking position sensor. Advanced protection techniques, such as disconnecting the battery, adjusting charging and discharging currents, and initiating cooling operations, are crucial for a sustainable and electrified future.

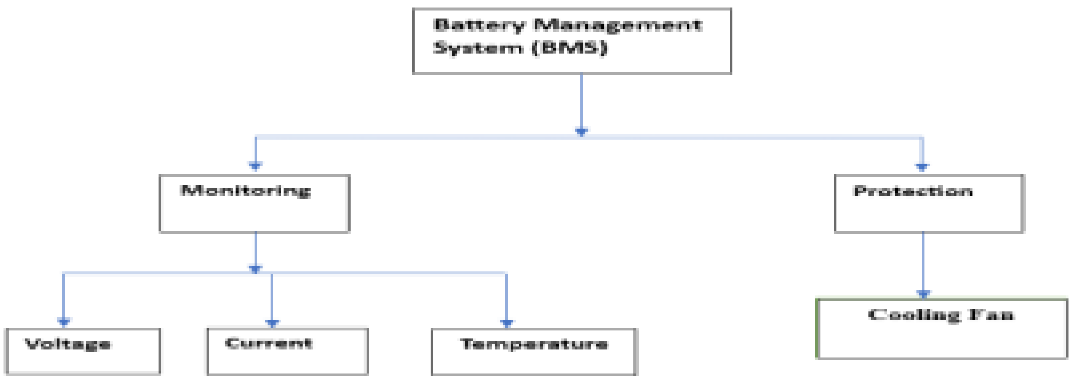

Figure 1 Block diagram of Battery Monitoring System

The Battery Monitoring System (BMS) is crucial in battery-powered applications like electric cars and renewable energy storage systems to safeguard and continuously monitor battery

Figure 2 Display of Voltage, Current and Temperature

performance. The Battery Monitoring and Protection System is a complex system designed to ensure the safe operation of batteries. It uses sensors to track temperature, voltage, and current, and sends this data to a central control unit. The data is analyzed by sophisticated algorithms to detect anomalies and set off safety features like cooling fans in case of overheating. A load

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management component disconnects light loads automatically at the anode, releasing negatively charged electrons or ions into the external circuit. This system is particularly useful in lithium-ion batteries where electrons are left behind as lithium ions migrate from the anode to the electrolyte. Figure 2: Battery Monitoring System. The Battery Monitoring and Protection System monitors voltage, current, and temperature to ensure efficient battery operation. It uses complex algorithms to detect abnormalities and initiate safety measures like load separation and cooling fans. The system uses a user interface for real-time information and manual participation, and rigorous safety protocols ensure reliability. The system can activate fans or heat sinks to evacuate excess heat and prevent overheating if battery temperature rises.

Voltage Monitoring: Voltage monitoring is crucial for assessing battery health and charge state. Sensors continuously measure voltage levels, which can indicate imbalanced cells or overcharging or undercharging. Algorithms analyze data to detect anomalies and implement preventative measures. Real-time voltage information helps users make informed decisions about battery care and usage.

Current monitoring:

Current monitoring monitors the flow of electrical charge in and out of a battery, allowing for analysis of load behavior and power consumption. It detects potential overload or short circuits, and algorithms continuously scan data for irregularities, enhancing battery efficiency and preventing damage.

Battery	**Voltage measurement results**		**Accuracy Percentage (%)**
	Voltage sensor	**Multimeter**	
1	12.90	12.85	99.61
2	12.75	12.63	99.05
3	12.10	12	99.17

Table 1 Voltage Measurement Result

Temperature Monitoring

Temperature monitoring is crucial for controlling battery thermal properties and preventing overheating. Temperature sensors provide heat stress data, which algorithms use to maintain optimal conditions and initiate cooling devices. Real-time temperature monitoring enables proactive action to prevent overheating and increase battery lifespan. In summary, the study focused on temperature, voltage, and current properties to develop a comprehensive management and monitoring method for battery systems. Safety measures like fans and quick cooling were implemented. By integrating sensors with a microcontroller and developing control logic, a robust system was built for real-time state monitoring and dynamic adaptation. Preventative measures like voltage, current, and temperature thresholds were added to ensure consistent operation and reduced system failure probability.

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Chapter-23

Electric Vehicle to Grid Reactive Power Control using CPIC Technique

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Electricity plays a major role in our day to day lives. One such emerging application is the use of an electric vehicle in place of combustion vehicles. As these vehicles consume energy from the power grid along with alternate energy sources like solar charging stations, the need for improving the power quality also increases. This is mainly due to the ever-growing technology which brought a rapid need of power which is varied drastically compared to past life cycle. This in turn will increase the load on the generation and transmission which causes the voltage sags and a drop in the power factor affecting the quality of power. This can be partially addressed with the help of electric vehicles through proper control of the converters used for vehicle to grid connection. This project aims to understand the V2G operation through the classical PI control [CPIC] strategy along with reactive power support where the simulation and analysis of the work is done through PSCAD software.

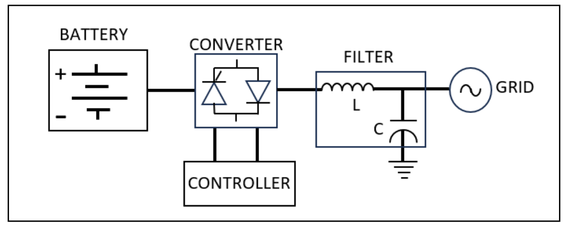

Figure 1 Single line diagram of converter

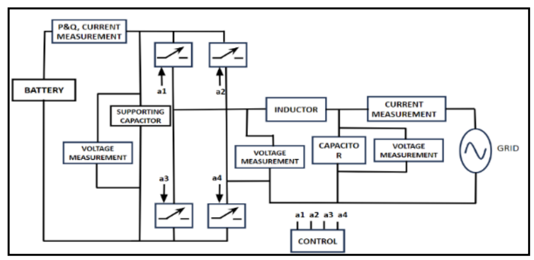

Figure 2 Block diagram of EV to grid

Electrical Vehicle plays a vital role in our day-to-day life as it consumes electric energy rather than fossil fuels it has several advantages like low emissions, economical and efficient. Although our conventional vehicles having high torque, people prefer to use EV's as compared to conventional vehicles. EV contains battery as storage device and we can charge these batteries with the help of electric energy which is supplied by the grid. We can store the excess energy generated by the grid in the EV batteries by charging it (G2V). It also has the advantage of supplying electrical energy to grid whenever needed (V2G). This process of supplying electric energy back to grid (V2G) makes better change in electrical utilization system. As these vehicles consume energy from the power grid along with alternate energy sources like solar charging stations, the need for improving the power quality also increases. This is mainly due to the ever-growing technology which brought a rapid need of power which is varied drastically compared to past life cycle. This in turn will increase the load on the generation and transmission which causes the voltage sags and a drop in the power factor affecting the quality of power. This can be partially addressed with the help of electric vehicles through proper control of the converters used for vehicle to grid connection. This project aims to understand the V2G operation through a converter control strategy along with reactive power support where the simulation and analysis of the work is done through PSCAD software and also a hardware model will be constructed to analyze and estimate the outcomes of V2G model.

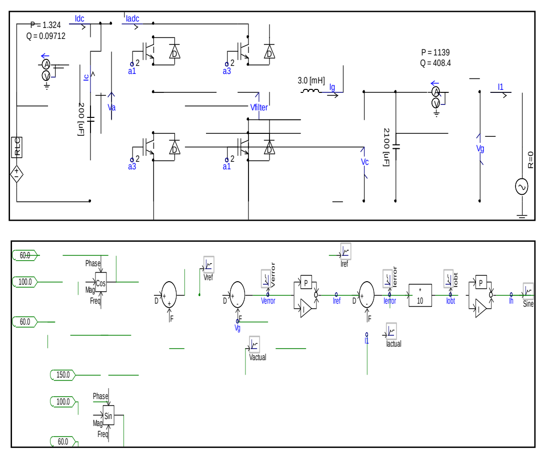

Figure 3 Simulation diagram of EV to Grid.

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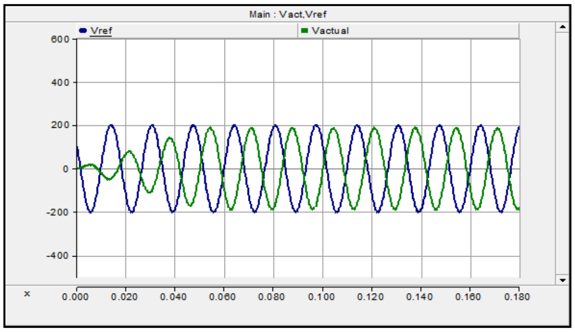

Figure 4 Comparison of actual and reference voltage waveforms

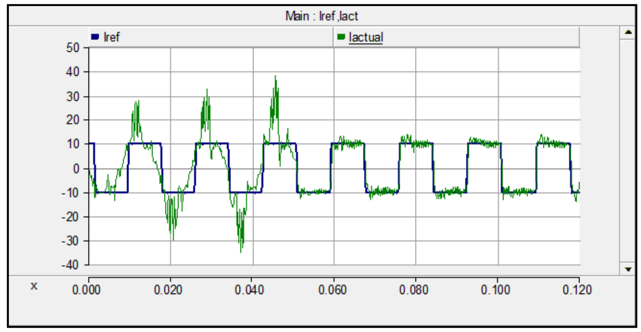

Figure 5 comparison of actual and reference current waveforms

As depletion in fossil fuels enhanced the development of electric vehicles for our transportation sector. As we know these electric vehicles uses electrical energy as a source for charging the battery inside the electric vehicle. These electric vehicles will have a huge demand in future due to rapid increasing in pollution and depletion of fossil fuels. This paper proposes a charging station having an AC/DC converter inside it, used for electric vehicles for charging the vehicles and also as well as the capability to support the reactive power for the grid. This converter implementation inside the charging station will vary this from others, as these converters having the controlling capability, we can control the output by varying the control parameters like grid current, ref voltage, gain etc.,

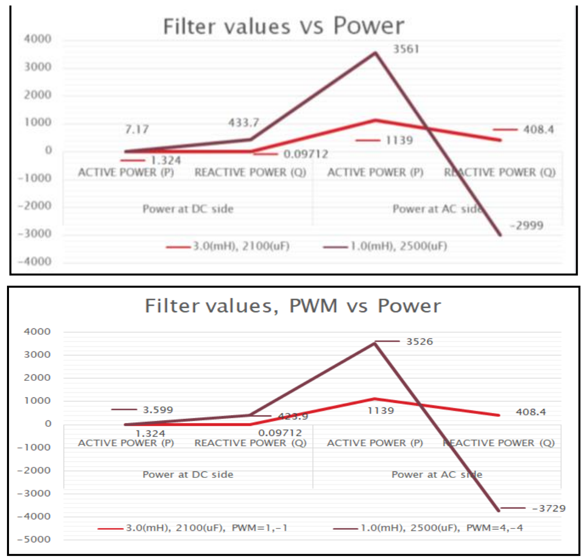

Figure 6 Filter, PWM Vs Power Characteristics

S.L. N.O.	Filter		Power at DC side		Power at AC side	
	INDUCTOR (L)	CAPACITOR (C)	ACTIVE POWER (P)	REACTIVE POWER (Q)	ACTIVE POWER (P)	REACTIVE POWER (Q)
1	3.0(mH)	2100(uF)	1.324	0.09712	1139	408.4
2	1.0(mH)	2500(uF)	7.17	433.7	3561	-2999

Table 1 Filter Vs Power comparison

SL. No.	Filter		PWM Upper, Lower limits	Power at DC side		Power at AC side	
	INDUCTOR (L)	CAPACITOR (C)		ACTIVE POWER (P)	REACTIVE POWER (Q)	ACTIVE POWER (P)	REACTIVE POWER (Q)
1	3.0(mH)	2100(uF)	1, -1	1.324	0.09712	1139	408.4
2	1.0(mH)	2500(uF)	4, -4	3.599	423.9	3526	-3729

Table 2 Filter, PWM Vs Power comparison

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Chapter - 24

IIoT for Energy Management Systems using Green Energy

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This project pioneers a sustainable energy management system by integrating renewable energy sources, thermal generation, and load-dependent switching. Dynamic allocation of power based on individual load activation optimizes resource usage. Extensive simulation in the Proteus environment validates robust performance across varied load scenarios. The Arduino Uno platform facilitates seamless integration of power sources, enhancing efficiency. Results indicate reduced fuel consumption, cost savings, and lowered carbon emissions, promoting environmental sustainability. This scalable solution offers a holistic approach to energy management, addressing the urgent need for sustainable energy solutions.

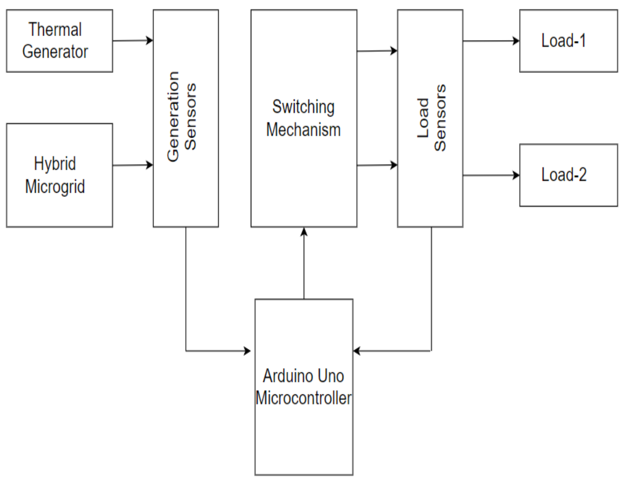

Figure 1: Block Diagram of the Proposed

The methodology of the study involves a comprehensive approach to designing, simulating, and evaluating a smart energy management system. The design framework is conceptualized around the integration of renewable energy sources, thermal generation, load-dependent switching mechanisms, and Arduino Uno control. Firstly, the materials and equipment required for the study are identified and procured, including solar panels, wind turbines, thermal generators, an Arduino Uno Microcontroller, 5V Relays, loads, and Proteus Simulation Software. The design process begins with the development of circuit diagrams and control logic using Proteus Simulation Software. This software provides a virtual environment to simulate the behavior of the proposed system under various conditions, allowing for the refinement of the design before implementation. Simulation tests are conducted using Proteus to assess the performance of the system under different load scenarios. Parameters such as power generation, energy consumption, and system reliability are analyzed to evaluate the effectiveness of the proposed design. Sensor input plays a crucial role in the operation of the system, providing real-time data on energy demand, renewable energy availability, battery levels, and overall system status. Sensors including solar irradiance sensors, wind speed sensors, battery level sensors, and system status sensors are strategically deployed throughout the energy infrastructure to collect this data. The Arduino Uno microcontroller serves as the central control unit of the system, receiving input from the various sensors and executing programmed algorithms to dynamically adjust power allocation, switch between power sources,

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and activate/deactivate loads as needed. Through iterative testing and refinement, the methodology aims to optimize energy distribution, minimize fuel consumption, and maximize the use of renewable energy sources and energy storage systems.

The proposed smart energy management system operates within a basic grid framework comprising generators and loads. Under normal load conditions, where the power demand matches the output of the thermal generator, the hybrid microgrid remains inactive. However, when the load surpasses the capacity of the thermal generator, the hybrid microgrid is triggered into action. This results in a scenario where both the thermal generator and hybrid microgrid supply power to meet the increased demand. The allocation of power is then governed by load requirements, ensuring stable power supply and grid stability while minimizing reliance on non-renewable energy sources. Overall, the system demonstrates efficiency in optimizing resource allocation for renewable energy utilization, contributing to grid resilience, reduced environmental impact, and significant fuel savings.

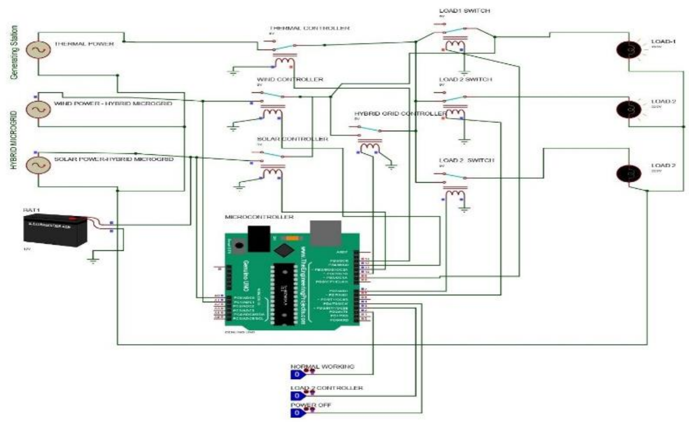

Figure 2: Simulation of the Proposed System

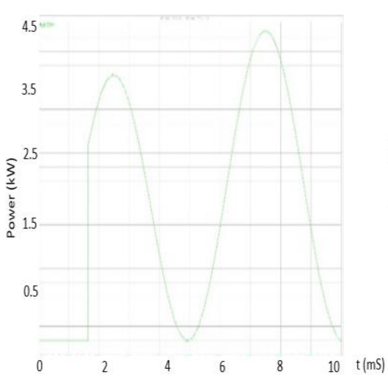

Figure 3 Load under Normal

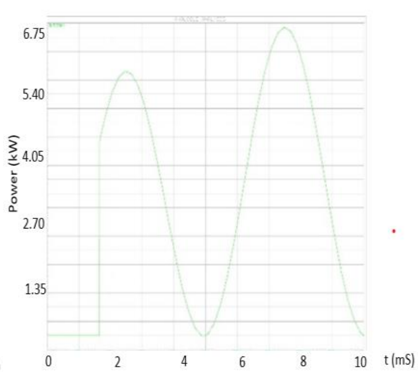

Figure 4 Load under Overload

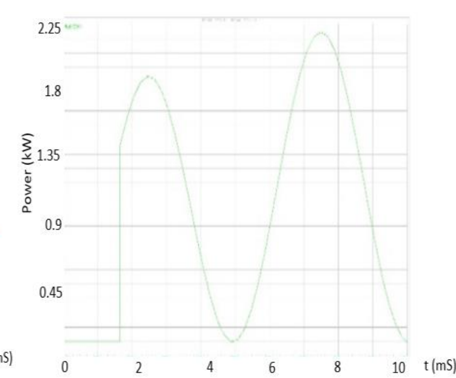

Figure 5 Generation by Hybrid

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"Success is not final; failure is not fatal:
It is the courage to continue that counts."

—Winston Churchill