



PARVATHAREDDY BABUL REDDY
VISVODAYA INSTITUTE OF TECHNOLOGY & SCIENCE


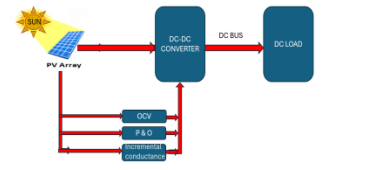
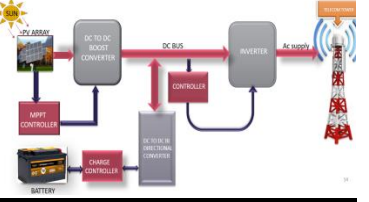

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

I. Projects developed under R&D

S.No	Name of the Project	Project Model	Name of the Students	Year
1	Electrical fault detection and analysis using Arduino - based on household appliances		Ch. Veera Reddy (21735A0220) Y. Sai Santhan (21735A0216) P. Divya (20731A0221) J. Maneesha (21735A0213)	2022-2023
2	Performance Analysis of Advanced MPPT Based Solar Energy System		M. Koushik Reddy (21735A0206)	2022-2023
3	Design and Simulation of Alternative Power Supply System for Telecom towers		Sd. Muzahid G. Sai Kalyan k. Vinay Kumar Sk. Abdul Farookh P. Pavan Kumar	2022-2023
5	Advanced Filter topologies for mitigating the common mode voltage and electromagnetic interference of and induction motor vehicular drives		Mr. A. Bhaktha Vachala (UGC funded)	2018-2019

Sd/- Head of the Department

This Project Developed under
Department of Electrical and Electronics Engineering
R&D LABORATORY



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ELECTRICAL FAULT DETECTION AND ANALYSIS USING ARDUINO - BASED ON HOUSEHOLD APPLIANCES

Abstract:

The purpose of this project is to develop an Arduino-based preventive device for household appliances that can detect and analyze electrical faults. The device utilizes various sensors to monitor the electrical parameters of appliances and employs IoT module to detect abnormal patterns and potential faults. The methodology involved designing and building a prototype device, integrating sensors and microcontrollers, and developing the necessary software for data analysis. Through extensive testing and experimentation, key findings include the device's ability to accurately detect faults such as short circuits, overloads, and voltage fluctuations. The project aims to enhance the safety and reliability of household appliances, reducing the risk of electrical accidents and prolonging their lifespan.

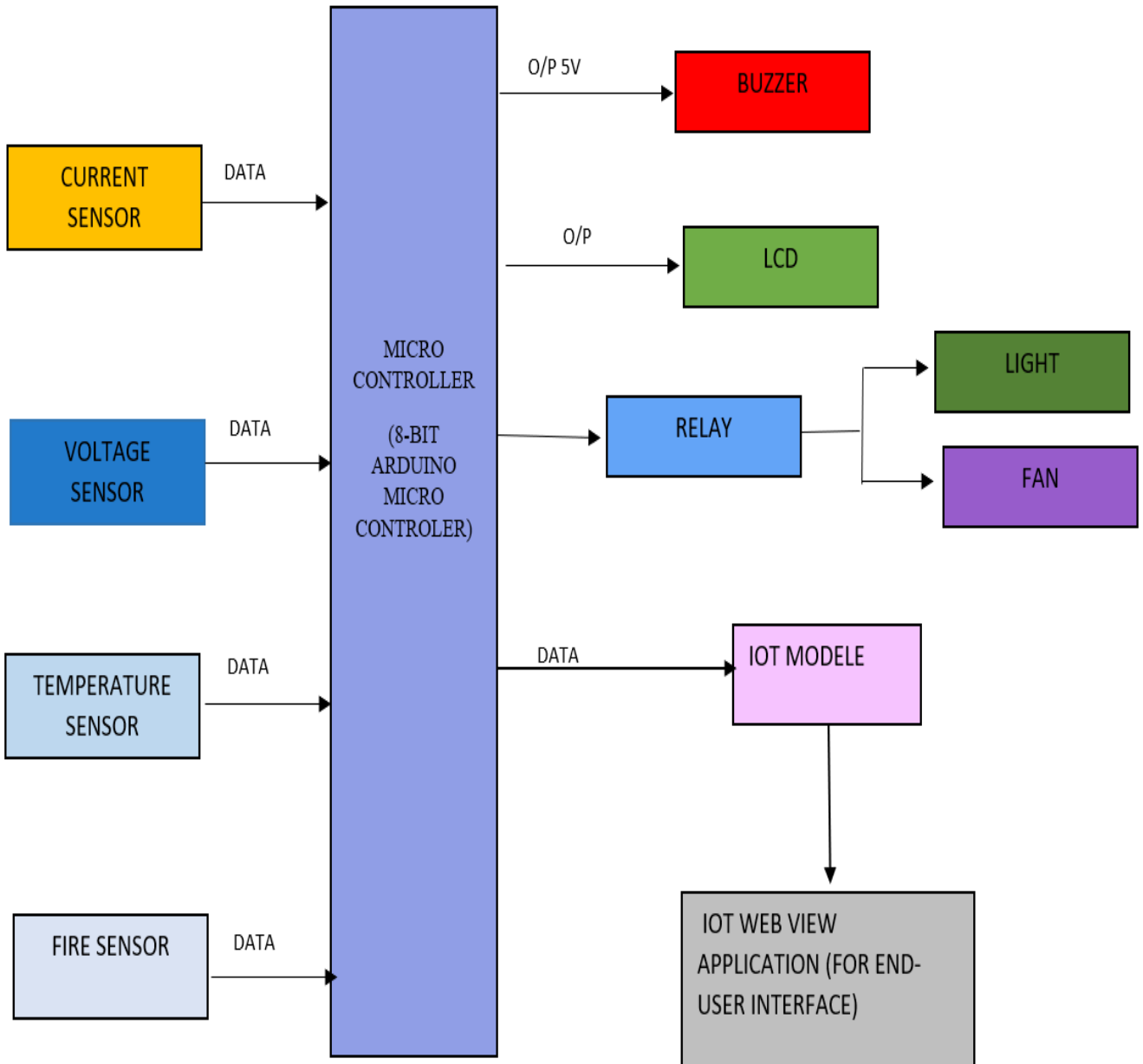
Existing Method:

In the existing system, households in the Philippines rely on conventional electrical systems without specific monitoring devices for household appliances. This system lacks real-time monitoring capabilities to detect electrical faults such as overloading, short circuits, and overheating in appliances. As a result, users may not be aware of potential hazards until a significant problem occurs, leading to safety risks such as electrical fires and shocks. Additionally, conventional systems do not provide data on current usage and wire temperature, making it difficult for users to assess the safety status of their electrical appliances accurately.

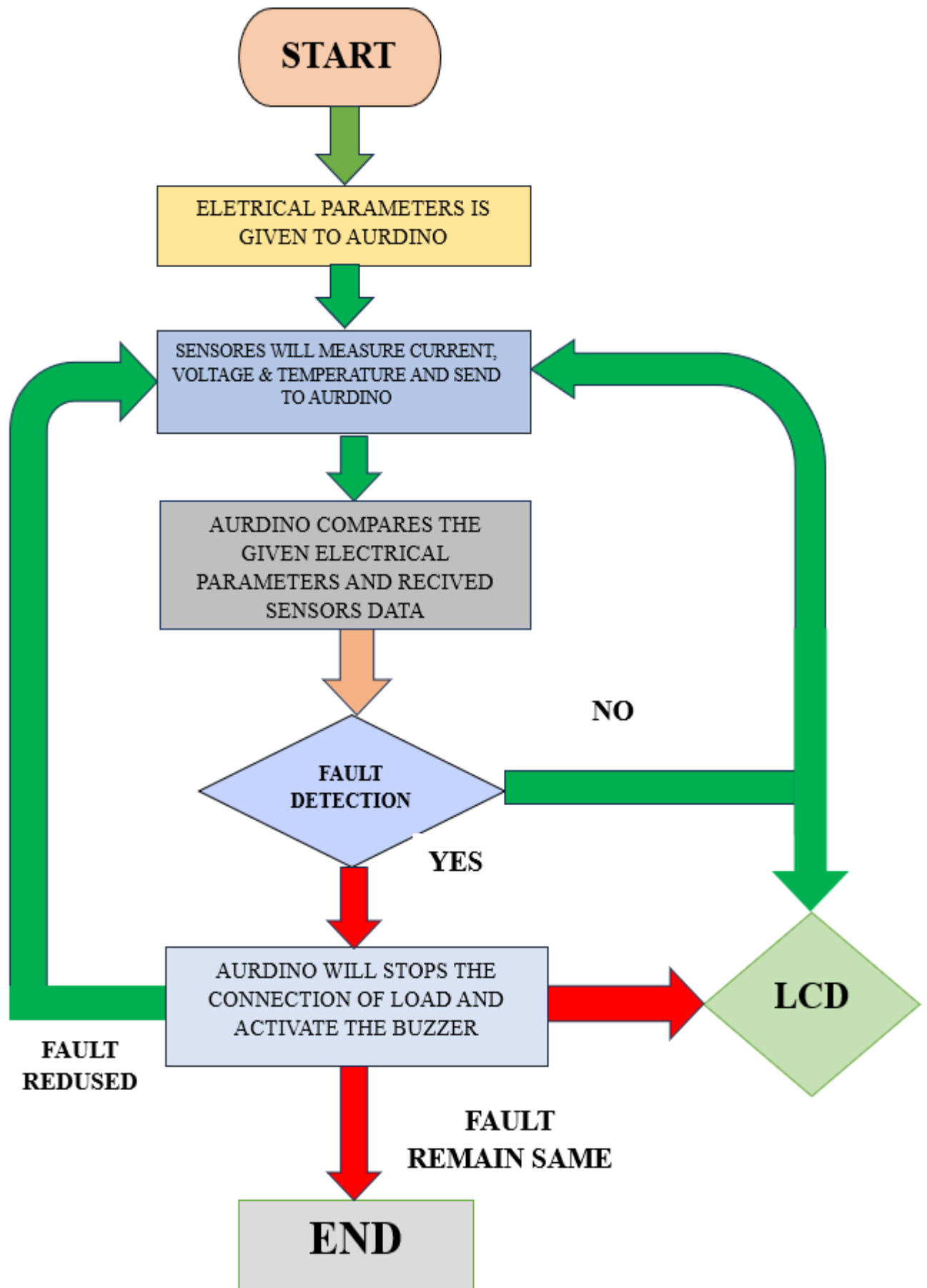
Proposed Method:

The proposed system introduces a novel device designed to enhance electrical safety in households by providing real-time monitoring and early detection of electrical faults in commonly used appliances. The device incorporates sensors for monitoring current, voltage, and wire temperature, allowing users to track the operational status of their appliances continuously. Through a user-friendly interface, the device provides alerts and notifications to users in case of abnormal electrical conditions, enabling timely intervention to prevent potential hazards. Moreover, the device is equipped with statistical analysis capabilities to identify patterns and trends in electrical usage, helping users make informed decisions to optimize energy consumption and ensure safety. Overall, the proposed system offers a proactive approach to electrical safety, potentially reducing the risk of accidents and promoting peace of mind among users.

Block Diagram



Flow Chart



Components Used

Hardware Components:

1. Arduino Uno (or similar microcontroller)
2. Liquid Crystal Display (LCD)
3. DHT11 Temperature and Humidity Sensor
4. Flame Sensor
5. Voltage Sensor
6. Current Sensor
7. Buzzer
8. LEDs (for Load)
9. Fan (for cooling)
10. Optional: External Power Supply

Software Components:

1. Arduino IDE with necessary libraries (Liquid Crystal, DHT, etc.)
2. Ubidots IoT Platform for data visualization and monitoring.

Description

Hardware Setup:

- 1. Arduino Uno:** It acts as the brain of the system, receiving input from sensors, processing data, and controlling output devices.
- 2. Liquid Crystal Display (LCD):** The LCD provides a user interface for displaying information such as temperature, humidity, fault status, and system messages.
- 3. DHT11 Temperature and Humidity Sensor:** This sensor measures ambient temperature and humidity levels. It communicates with the Arduino to provide data for monitoring environmental conditions.
- 4. Flame Sensor:** The flame sensor detects the presence of fire or flames in the surrounding area. When it detects a flame, it sends a signal to the Arduino, triggering appropriate actions such as activating the buzzer and fan for safety.

- 5. Voltage and Current Sensors:** These sensors measure the electrical parameters of the circuit, including voltage and current levels. They provide data to the Arduino for monitoring the health of the electrical system and detecting faults.
- 6. Buzzer:** The buzzer is used for audible alerts. It can be activated by the Arduino in response to detected faults or unsafe conditions, such as fire or abnormal voltage levels.
- 7. LEDs:** LEDs serve as visual indicators of system status. They can be programmed to light up or blink in different patterns to signify normal operation, fault conditions, or specific alerts.
- 8. Fan:** The fan is employed for cooling purposes in case of fire detection. When a flame is detected, the fan can be turned on by the Arduino to help mitigate the risk of fire spreading.

Hardware Interaction:

- 1. Data Acquisition:** The Arduino reads data from the sensors (DHT11, flame sensor, voltage sensor, and current sensor) periodically to monitor temperature, humidity, flame status, and electrical parameters.
- 2. Fault Detection:** Based on the sensor readings, the Arduino analyzes the data to detect potential faults or unsafe conditions such as high temperature, humidity, flame presence, or abnormal voltage/current levels.
- 3. Alerting Mechanism:** When a fault or unsafe condition is detected, the Arduino triggers appropriate actions such as activating the buzzer for audible alerts, turning on the fan for fire mitigation, and controlling LEDs for visual indications.
- 4. User Interface:** The LCD screen provides real-time feedback to the user, displaying relevant information such as temperature, humidity, fault status, and system messages. Users can monitor the system's status and respond to alerts accordingly.
- 5. Integration with IoT Platform:** The Arduino can also transmit sensor data to an IoT platform (such as Ubidots) via Wi-Fi or Ethernet module for remote monitoring and data logging. This enables users to monitor the system remotely and receive notifications/alerts on their smartphones or computers.

Project Benefits:

1. Early detection of electrical faults helps prevent potential hazards and minimize downtime.
2. Real-time monitoring enables remote management and intervention, enhancing safety and efficiency.
3. Integration with an IoT platform provides data analytics and insights for proactive maintenance and optimization of the electrical system.

OUTPUT

MODE 1: HIGH VOLTAGE DETECTION

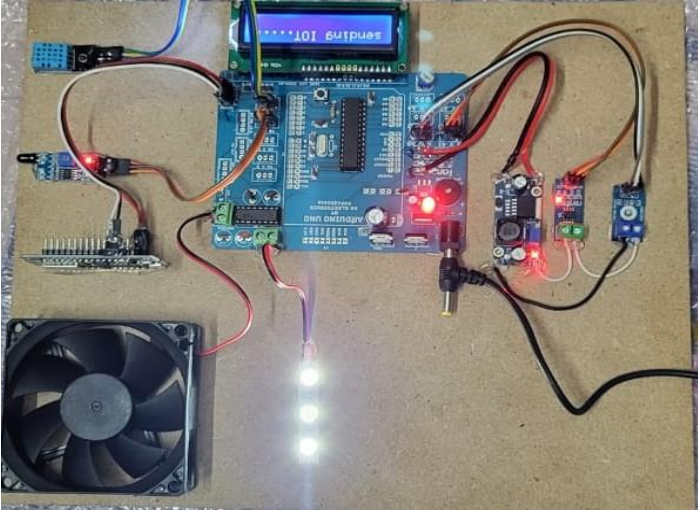


Fig.1

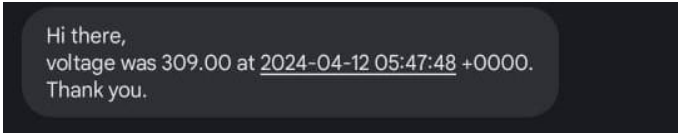


Fig.2

MODE 2: LOW VOLTAGE DETECTION

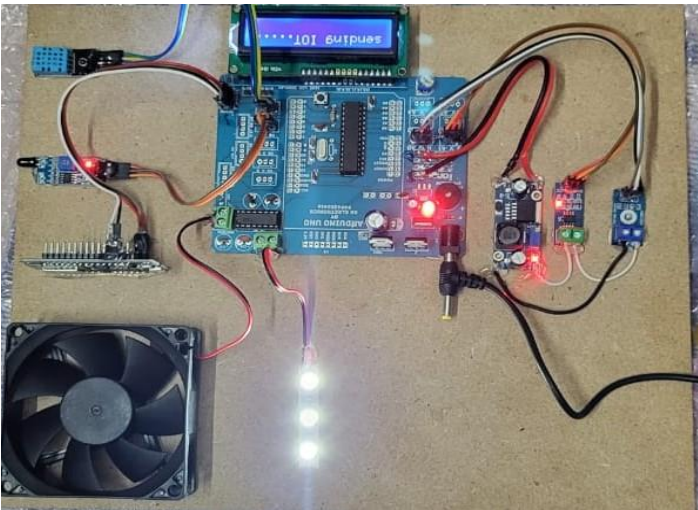


Fig.3

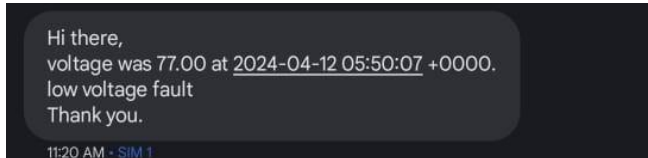


Fig.4

MODE 3: FLAME DETECTION

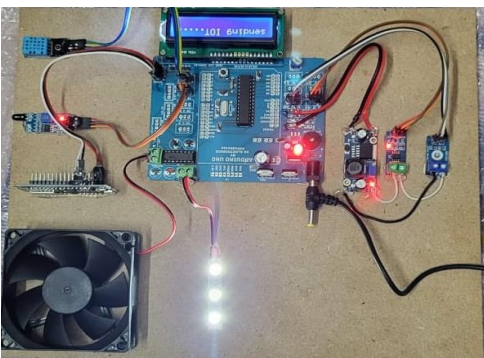


Fig.5

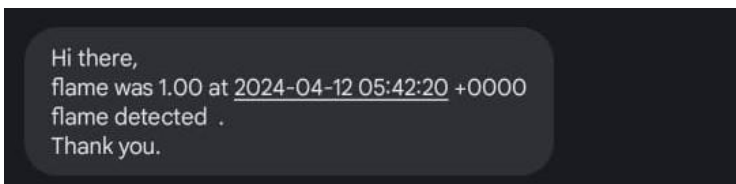


Fig.6

Conclusion:

In conclusion, the Electrical Fault Detection System represents a vital advancement in safety and monitoring within electrical circuits. By integrating various hardware components such as sensors, an Arduino microcontroller, and output devices like LEDs and a buzzer, the system effectively detects and responds to potential faults such as high temperature, humidity, flame presence, and abnormal voltage levels. The utilization of the Liquid Crystal Display (LCD) provides a user-friendly interface for real-time data visualization and system status feedback. Furthermore, the incorporation of an IoT platform enables remote monitoring and data logging, enhancing accessibility and enabling proactive maintenance. Overall, this project demonstrates the synergy between hardware and software components to create a robust and efficient solution for electrical fault detection and mitigation. With its ability to detect faults early, provide timely alerts, and facilitate remote monitoring, the Electrical Fault Detection System contributes significantly to ensuring the safety and reliability of electrical systems in various applications, including industrial, residential, and commercial settings.

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This Project Developed under
Department of Electrical and Electronics Engineering
R&D LABORATORY



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PERFORMANCE ANALYSIS OF ADVANCED MPPT BASED SOLAR ENERGY SYSTEM

Abstract:

To enhance the output efficiency of the photovoltaic (PV) arrays, it is indispensable to track the maximum power point (MPP) to extract maximum power in the energy conversion process. However, this has become a challenging issue in the past many years due to the nonlinear characteristics of the PV cell and the adverse impact of temperature variation, irradiance change, partial shading, dust, and aging effect on the output generation. In maximum power point tracking (MPPT), the duty cycle of the DC-DC converter is adjusted in a way that the maximum possible power is extracted from the PV system. This paper has two major objectives to present as a brief review of the methods suggested in recent times and comparing the two classical techniques Perturb & Observe (P&O) and Incremental Conductance (IC) technique used most in real-time applications. A discussion on possible challenges and issues has been entailed at the end to serve as a vital reference to guide the system engineers to develop better techniques for MPPT control in the future.

Existing Method:

In the existing methods of Maximum Power Point Tracking (MPPT), Open Circuit Voltage (OCV) is a fundamental parameter used for determining the optimal operating point of solar panels. OCV refers to the voltage across the solar panel terminals when no load is connected, representing the maximum voltage the panel can produce under specific conditions. The OCV method involves periodically measuring the open circuit voltage of the solar panel to estimate its maximum power point. By tracking the changes in OCV under varying environmental conditions such as sunlight intensity and temperature, the MPPT system adjusts the operating point of the panel to maximize power output.

Proposed Method:

The proposed method for enhancing Maximum Power Point Tracking (MPPT) efficiency represents a significant advancement in the field of solar energy system optimization. By integrating the Perturb and Observe (P&O) algorithm with the Incremental Conductance (IncCond) algorithm, this innovative approach aims to overcome the limitations of traditional MPPT methods and achieve unprecedented levels of efficiency and adaptability. Solar energy systems rely heavily on the ability to capture the maximum available power from the photovoltaic (PV) panels, especially considering the variability of environmental conditions such as sunlight intensity and temperature. The existing methods, such as Open Circuit Voltage (OCV) tracking, Perturb and Observe (P&O), and Incremental Conductance (IncCond), each have their strengths and weaknesses in optimizing

Block Diagram

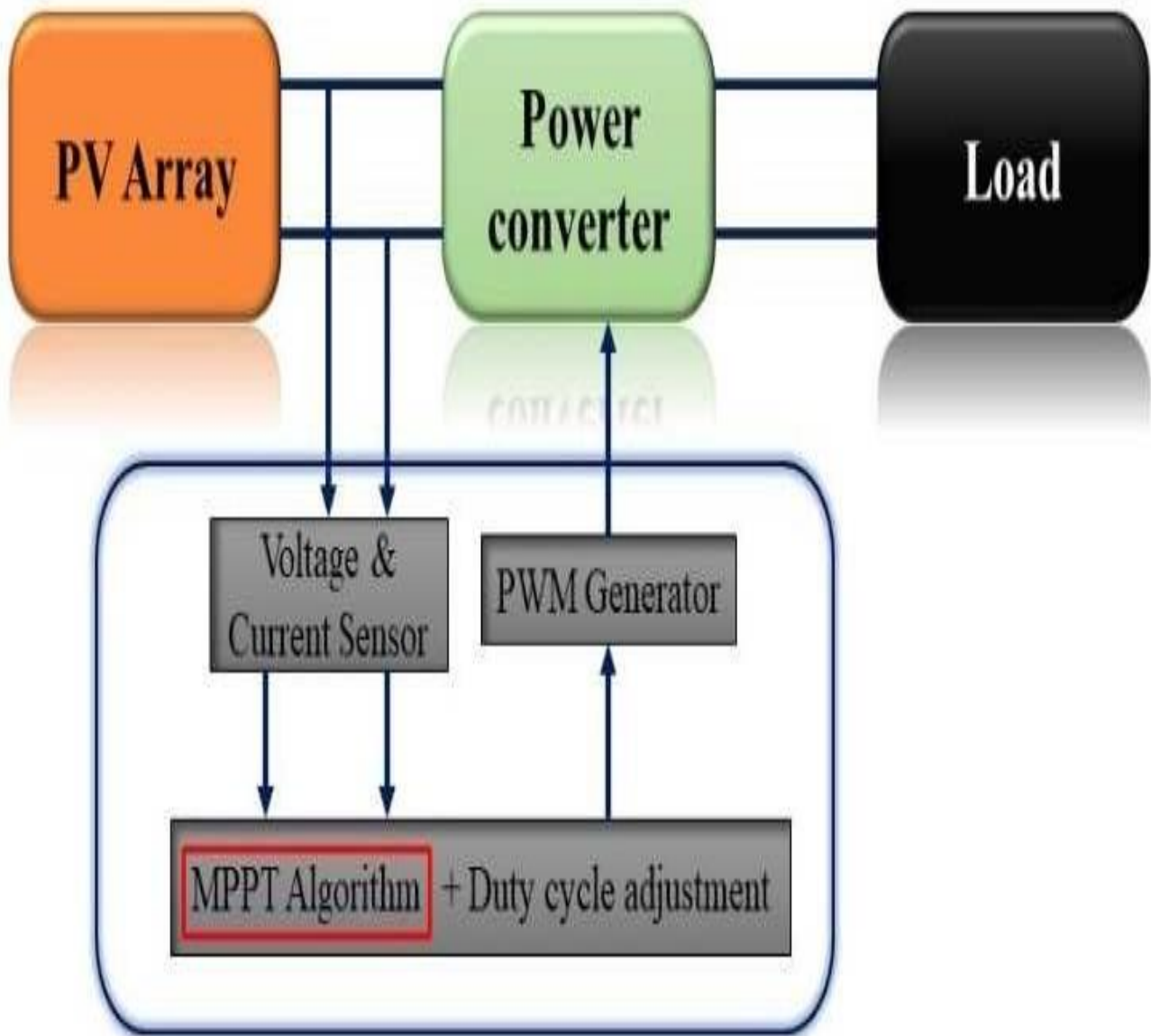


Fig.1 Block diagram representation of MPPT control

Components Used

Software Components:

1. MATLAB
2. MATLAB Simulink
3. MATLAB GUI (Graphical User Interface)
4. MATLAB Scripting
5. MATLAB Data Analysis and Plotting Tools
6. MATLAB Optimization Toolbox
7. MATLAB Control System Toolbox
8. MATLAB Simulations and Simulink Models

Description

1. MATLAB:

Description: MATLAB is a high-level programming language and computing environment used for algorithm development, data analysis, and visualization.

Function: MATLAB will serve as the primary platform for developing, implementing, and simulating the components of the advanced MPPT-based solar energy system.

2. MATLAB Simulink:

Description: MATLAB Simulink is a graphical programming environment for modeling, simulating, and analyzing dynamic systems.

Function: Simulink will be used to create models of the solar PV panel, MPPT algorithms (P&O and IncCond), and the real-time monitoring and control system.

3. MATLAB GUI (Graphical User Interface):

Description: MATLAB allows for the creation of custom GUIs to interact with simulations and data.

Function: A MATLAB GUI will be developed to display real-time data from the solar energy system, allowing for manual or automated control adjustments.

4. MATLAB Scripting:

Description: MATLAB scripts are used for creating custom functions, algorithms, and analysis procedures.

Function: MATLAB scripts will implement the MPPT algorithms (P&O, IncCond, and hybrid fusion), adaptive parameter tuning logic, and performance metrics analysis.

5. MATLAB Data Analysis and Plotting Tools:

Description: MATLAB provides powerful tools for data analysis, visualization, and plotting.

Function: These tools will be utilized to analyze simulation results, plot performance metrics (efficiency, stability, etc.), and generate visual representations of the system's behavior.

6. MATLAB Optimization Toolbox:

Description: The Optimization Toolbox in MATLAB provides functions for solving optimization problems.

Function: The toolbox will be used for optimizing the MPPT algorithms' parameters based on real-time inputs such as solar irradiance and temperature.

7. MATLAB Control System Toolbox:

Description: The Control System Toolbox in MATLAB offers functions for designing and analyzing control systems.

Function: This toolbox will be used to design and implement the real-time monitoring and control system for the solar energy system.

8. MATLAB Simulations and Simulink Models:

Description: MATLAB enables the creation of simulations and Simulink models for system-level analysis.

Function: Simulations and Simulink models will be developed to simulate the behavior of the solar PV panel, MPPT algorithms, and the overall energy system.

Project Benefits:

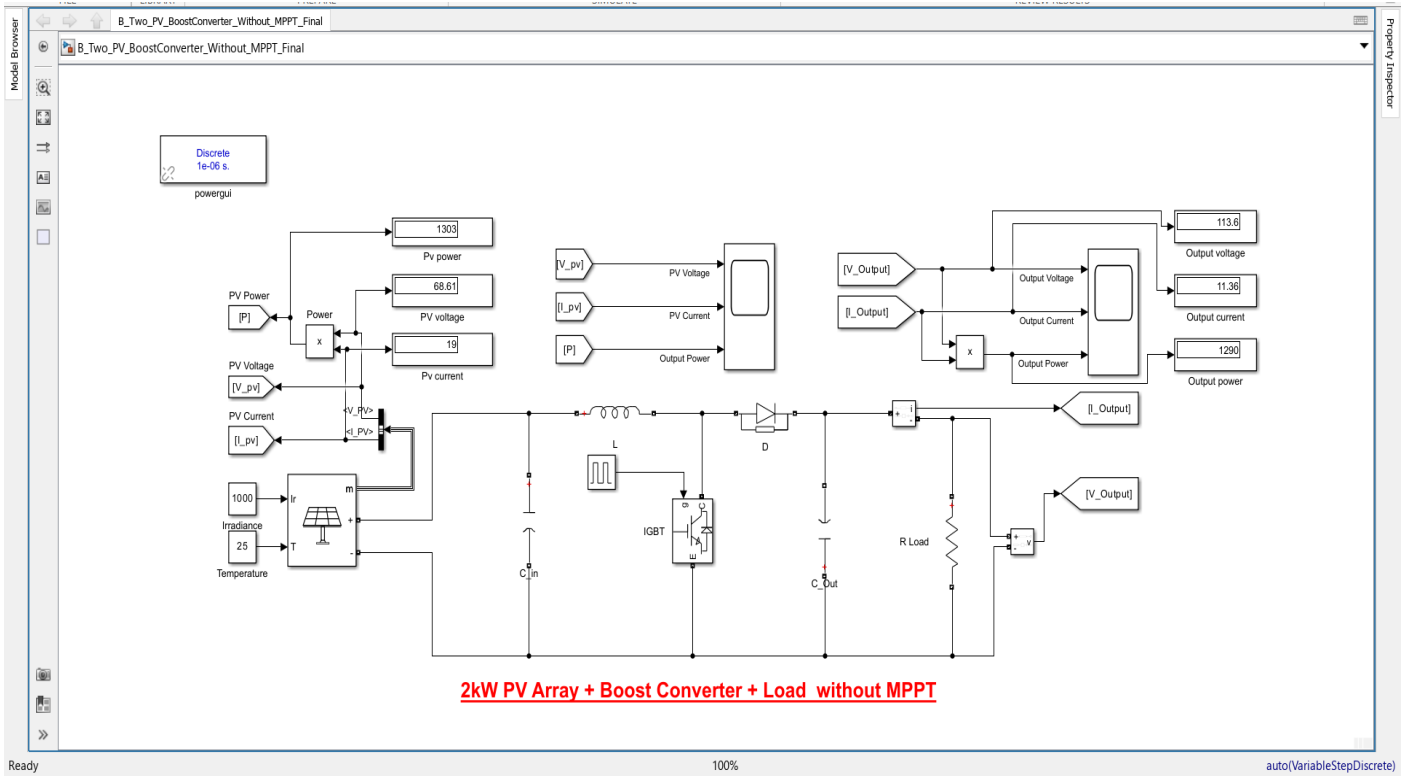
1. **Improved Efficiency:** The advanced MPPT-based solar energy system aims to significantly improve the efficiency of energy harvesting from solar panels. By dynamically adjusting the operating point of the panels, the system can maximize power output under varying environmental conditions.
2. **Enhanced Energy Yield:** The project's algorithms and control systems will enable the solar energy system to capture a greater amount of available solar power. This translates to increased energy production and improved overall performance.
3. **Optimized Performance:** Through the fusion of Perturb and Observe (P&O) with Incremental Conductance (IncCond) algorithms, the system achieves a balance between speed and precision in tracking the maximum power point. This optimization ensures that the solar panels operate at peak efficiency.
4. **Adaptability to Environmental Changes:** The project includes adaptive parameter tuning, allowing the system to dynamically adjust its parameters based on real-time inputs such as solar irradiance and temperature. This adaptability ensures optimal performance even in changing weather conditions.
5. **Reduced Energy Costs:** By maximizing energy yield from solar panels, the project helps to reduce energy costs for end-users. This is particularly beneficial for residential, commercial, and industrial applications looking to decrease reliance on grid power.

6. **Enhanced Sustainability:** The use of renewable energy sources such as solar power contributes to a greener and more sustainable environment. The project's focus on optimizing solar energy systems promotes the adoption of clean energy technologies.
7. **Reliable Power Supply:** The real-time monitoring and control system ensures that the solar energy system operates efficiently and reliably. This translates to a stable and consistent power supply, reducing the risk of interruptions or downtime.
8. **Research and Development Contribution:** The project contributes to the advancement of MPPT techniques and renewable energy technologies. The findings and methodologies developed can serve as a basis for further research and development in the field.
9. **Demonstration of Technological Innovation:** By integrating state-of-the-art algorithms and control systems, the project showcases technological innovation in the renewable energy sector. This demonstration highlights the potential for advanced MPPT systems to reshape the future of solar power.
10. **Promotion of Renewable Energy Adoption:** Ultimately, the project aims to promote the widespread adoption of renewable energy sources, particularly solar power. By demonstrating the benefits and effectiveness of advanced MPPT-based systems, it encourages more individuals and organizations to invest in sustainable energy solutions.

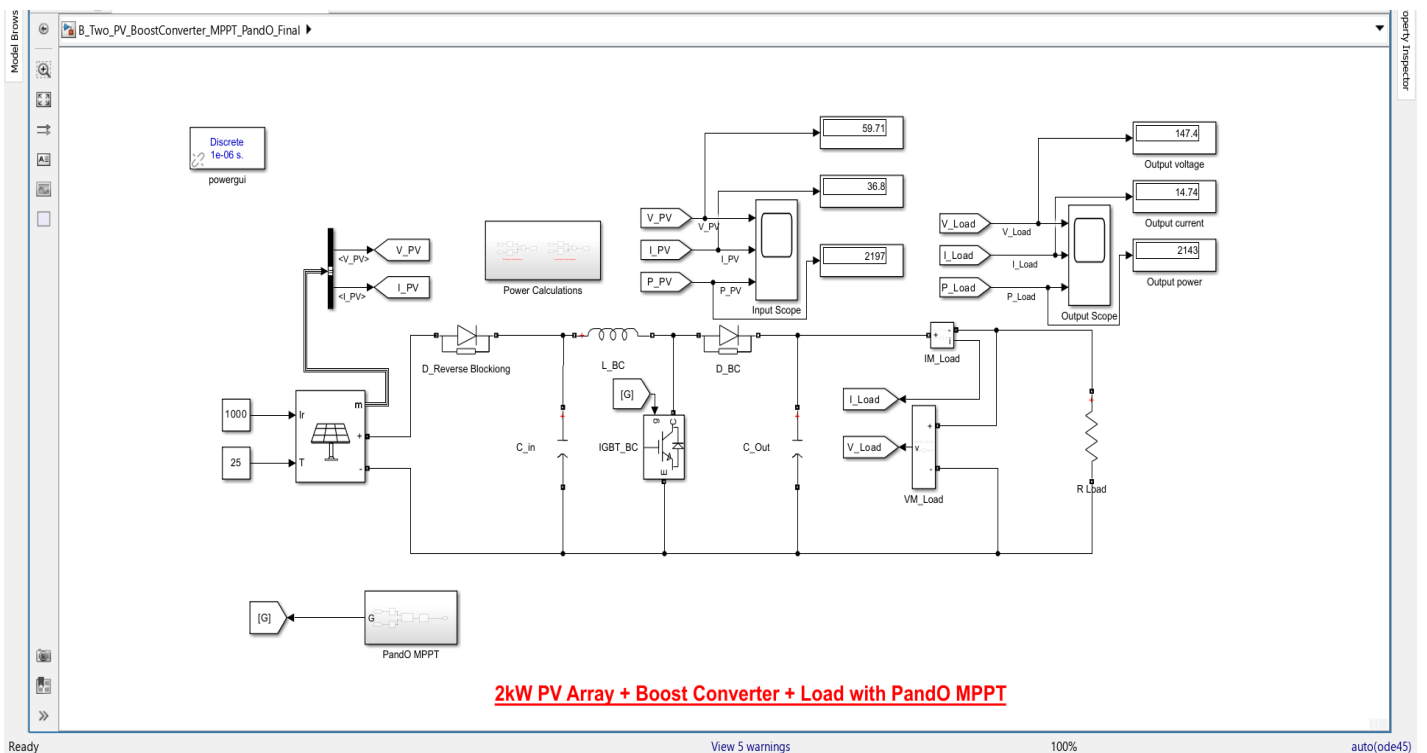
These benefits collectively contribute to a more efficient, reliable, and sustainable solar energy system, paving the way for a greener and cleaner future.

Simulation diagrams

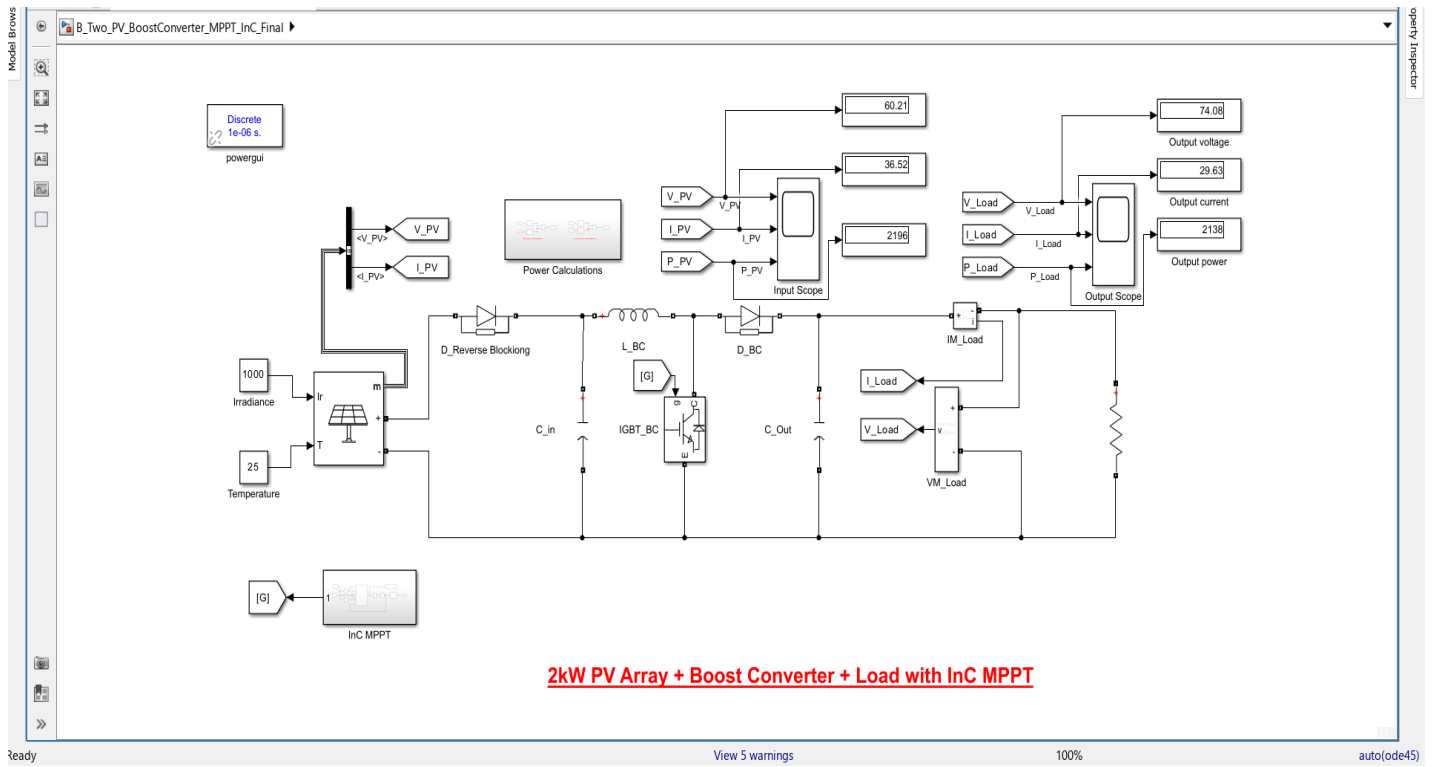
MODEL 1: OFFLINE MPPT TECHNIQUE (OCV)



MODEL 2: ONLINE MPPT TECHNIQUE (P & O)

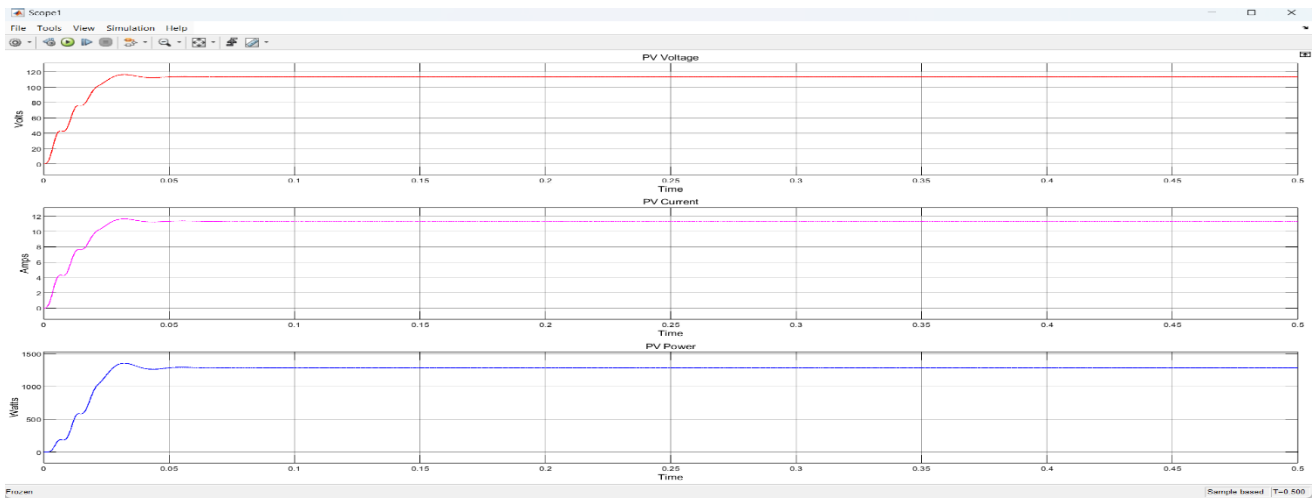


MODEL 3: ONLINE MPPT TECHNIQUE (INC)

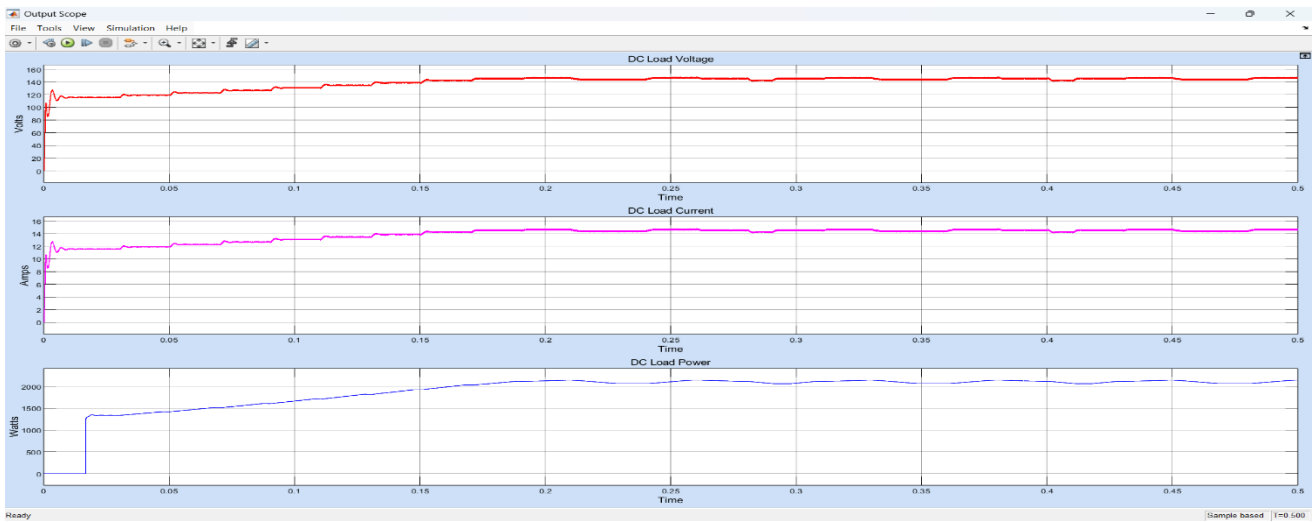


OUTPUT WAVEFORMS

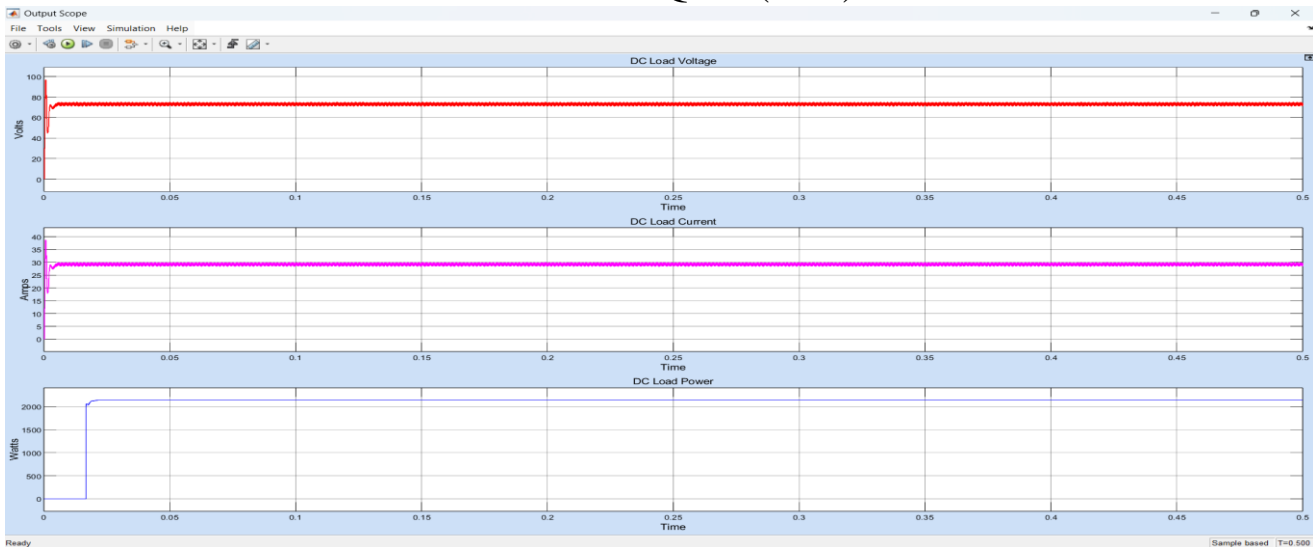
MODEL 1: OFFLINE MPPT TECHNIQUE (OCV)



MODEL 2: ONLINE MPPT TECHNIQUE (P & O)



MODEL 3: ONLINE MPPT TECHNIQUE (INC)



Conclusion:

This study provides a quick overview of several MPPT control methods proposed over the last few decades for PV arrays. It is found that the MPPT control technique is a challenging field of research, because none of the techniques can be accepted as the optimal one. Firstly, most of the techniques are not tested and validated under real-time conditions. Secondly, all the operating constraints are not considered, and results are provided either considering few or not considering simultaneously. Thirdly, looking at the cost of electricity produced by PV array in comparison to other possibilities, it is necessary to design the MPPT technique considering the cost-effectiveness. Apart from the above few other gaps need to be focused extensively in future related to degradation of performance of PV array under poor dust condition and aging effect. There is an adverse effect of harmonic produced by integrated Power electronics devices on MPPT and its response is not exploited in many cases.

**Design and Simulation of Alternative
Power Supply System for Telecom towers**

Abstract

Telecom towers or BTS are crucial in connecting people across the world by providing a cellular network. To operate these towers, we need a power supply. Generally, we use supply from the electric grid. However, during power cuts, the electric grid supply is absent. Traditionally, we use diesel generators to power the telecom towers during such situations. However, these generators are costly, require fuel to operate, and produce pollution and noise. To solve this problem, we are planning to replace diesel generators with renewable energy sources, specifically solar energy. With the help of solar arrays and different converters, we will create an alternative supply for telecom towers. This will provide power to the telecom towers during supply cut-off from the electric grid. By utilizing sun radiation, we can produce clean energy and reduce pollution caused by diesel generators.

1. introduction

The usage of mobile phones has significantly increased with the growth of technology. However, cellular networks need to be improved to provide uninterrupted connections to their users. To achieve this goal, more research and advanced devices are required. Our project focuses on implementing renewable energy sources in the field of mobile networks, which predominantly rely on traditional methods. We chose solar energy as the renewable energy source due to its recent advancements and availability in every corner of the country. We understand that the supply from the grid is not always available, causing network issues for users. This problem can cause users to lose hope in their network provider. To solve this, we have come up with an alternative power supply system that is reliable and emits fewer pollutants into the air than the present traditional methods. We used Matlab simulation software to test different controllers and algorithms that go into this project. This simulation can simulate controllers without practical testing, allowing us to get an overview of the controller's performance. We can also simulate solar panels, which are quite costly. The primary source of power for this alternative system is Photo Voltaic Arrays (PV arrays). We have focused on both AC and DC loads of the telecom towers. Generally, most telecom towers use 40V DC for electronic devices such as transmitters, receivers, and filters, while the AC supply is used for the surrounding area of the towers, such as lights and other AC applications. The PV system can only provide power during the availability of sunlight. When it's absent, there is no voltage from the PV system. To overcome this, we use a battery with controllers to charge the battery during sunlight and use the battery when there is no radiation from the sun. The maximum irradiation from the sun is seen in March, and the power rating according to the month is as follows: JAN (64,500 KWH), FEB (68,000 KWH), MAR (71,500 KWH), APR (65,500 KWH), MAY (62,500 KWH), JUNE (61,000 KWH), JULY (54,500 KWH), AUG (57,500 KWH), SEPT (57,000 KWH), OCT (50,500 KWH), NOV (47,500 KWH), DEC (43,500 KWH). However, we cannot estimate the power delivery from the PV system for the entire year using this data. The peak sun energy is in March, with 71,500 KWH. The months and solar radiation are shown in the figure below.

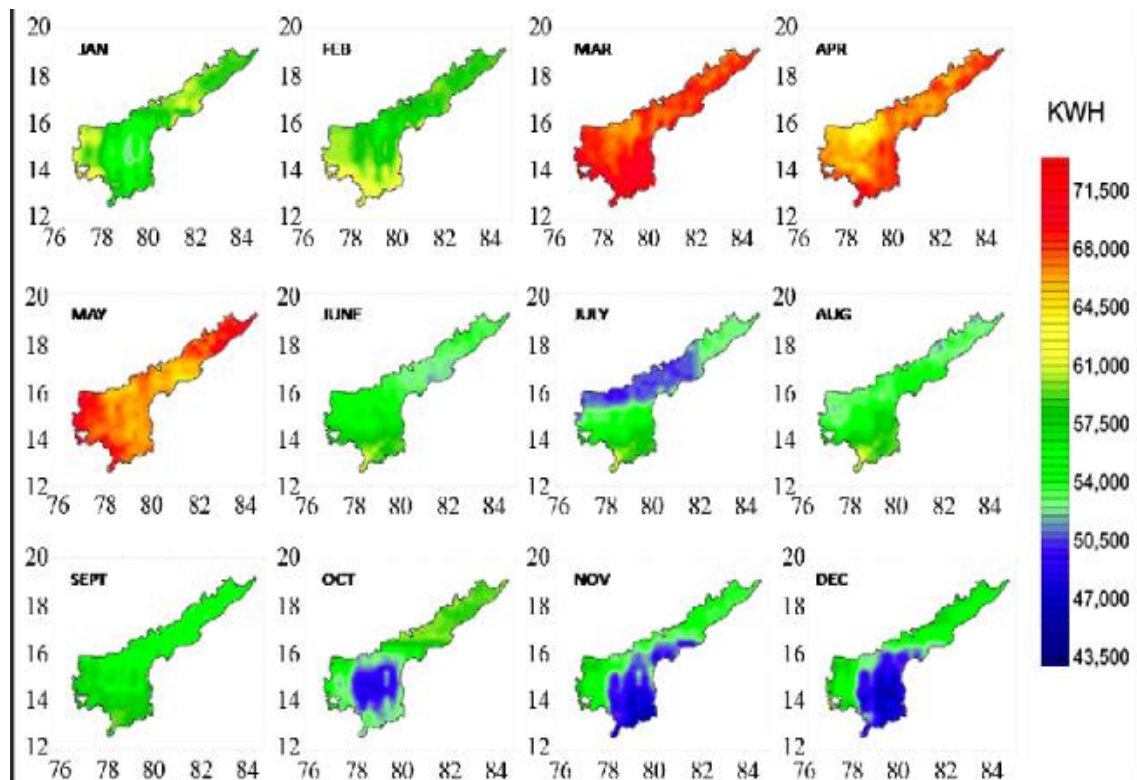
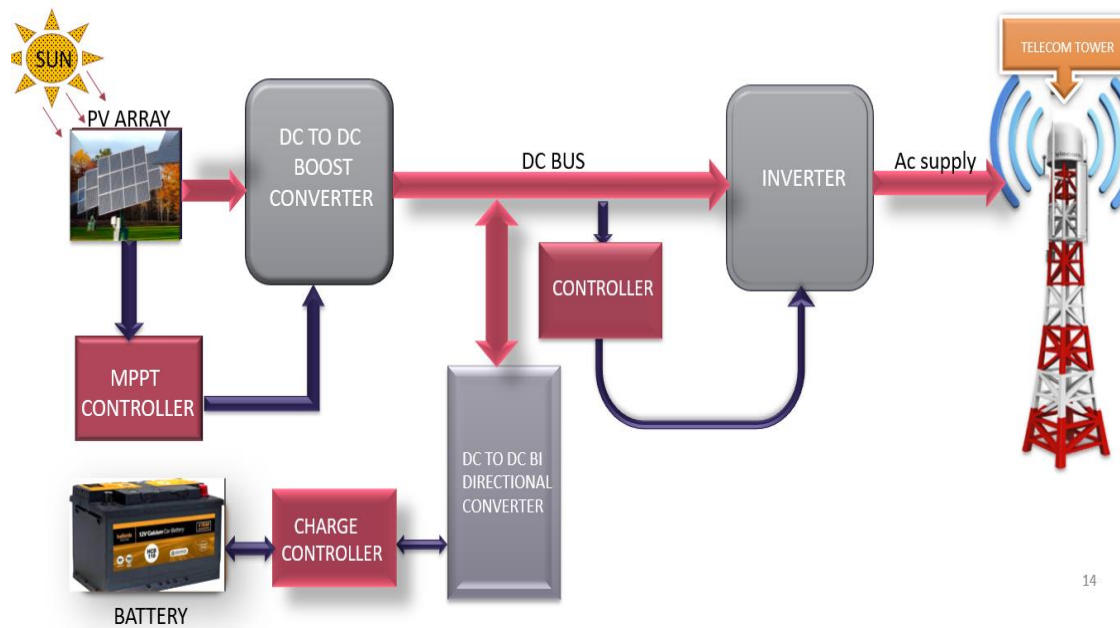


Figure 1: solar irradiance of Andhra Pradesh in a year

2. alternative power supply system for telecom towers:

This system is comprised of several components, including PV modules, DC-DC converters, batteries, bi-directional converters, inverters, DC loads, and AC loads. Its primary function is to convert solar irradiance into usable AC and DC voltage. During the day, the PV modules generate voltage to power the tower, while on overcast days and at night, the system relies on charged batteries. The power flow begins with the conversion of solar irradiance into electricity via solar panels. The voltage generated is initially low and requires boosting with a boost converter. Additionally, the load requires less voltage than the generated voltage, necessitating a buck converter to reduce the voltage level. The obtained voltage is DC, so it must be converted to AC to use with AC applications. This is where the inverter comes in. The battery is also used, so a bi-directional converter is necessary to charge and supply power. All of these components are illustrated in the block diagram.



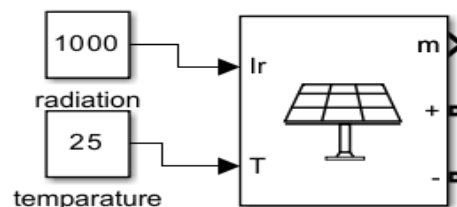
3. explanation of the block diagram:

The overall system's supply begins with the PV array or module, which provides the input voltage. This voltage is then increased to a higher value using a boost converter. The boost converter is operated based on the MPPT controller, which ensures that maximum power is obtained from the PV array. After this, the obtained DC voltage needs to be converted into AC for usage. To achieve this, we use an inverter that converts the supply from DC into AC. During the night when there is no illumination, a backup supply is needed. In this case, a battery is used with a bi-directional converter, so that it can be charged and discharged at different voltages. The function of each block is illustrated below.

4. Functions of each block from the block diagram

➤ PV array

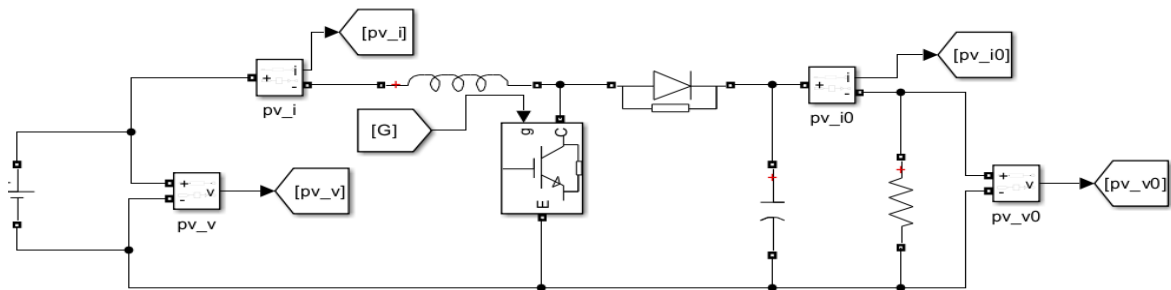
The photovoltaic array, or PV array, is a combination of solar panels connected in series or parallel to achieve the desired output voltage for the application. We are utilizing Matlab simulation to simulate the components. The pictures and explanations are shown below.



To create a PV array, you can use the PV array block available in the Simulink browser. The voltage requirement can be configured through this block. Based on your needs, you can connect a certain number of panels in either series or parallel.

➤ **DC to DC Boost Converter:**

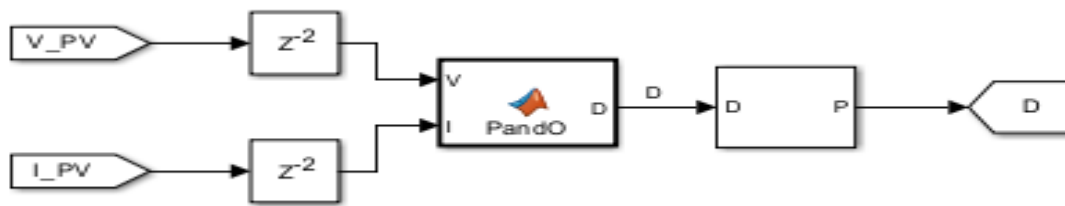
The DC to DC Boost Converter is a type of boost converter that takes a low-voltage supply as input and converts it to a higher voltage. It can be simulated in Matlab using a semiconductor switch, inductor, and capacitor with proper gate pulses. The detailed simulated diagram is shown below.



The boost converter can be developed by connecting the required components to obtain the function of a boost converter. The following components are used: an inductor, IGBT, diode, capacitor, and resistive load. The connected circuit is shown above.

➤ **MPPT Controller:**

The MPPT controller is used to provide gate pulses to the boost converter by which the maximum power can be obtained from the solar panel during any time of weather it helps to improve the efficiency of the overall system the MPPT controller and its functioning algorithm are shown in the simulation in Matlab software



The figure displays the operating block of the MPPT controller in the MATLAB software. The function block contains the main algorithm of MPPT. In this controller, we utilized the P and O type of MPPT techniques, which is reliable in most cases. The algorithm by which the controller function operates is shown below.

➤ **Algorithm:**

```

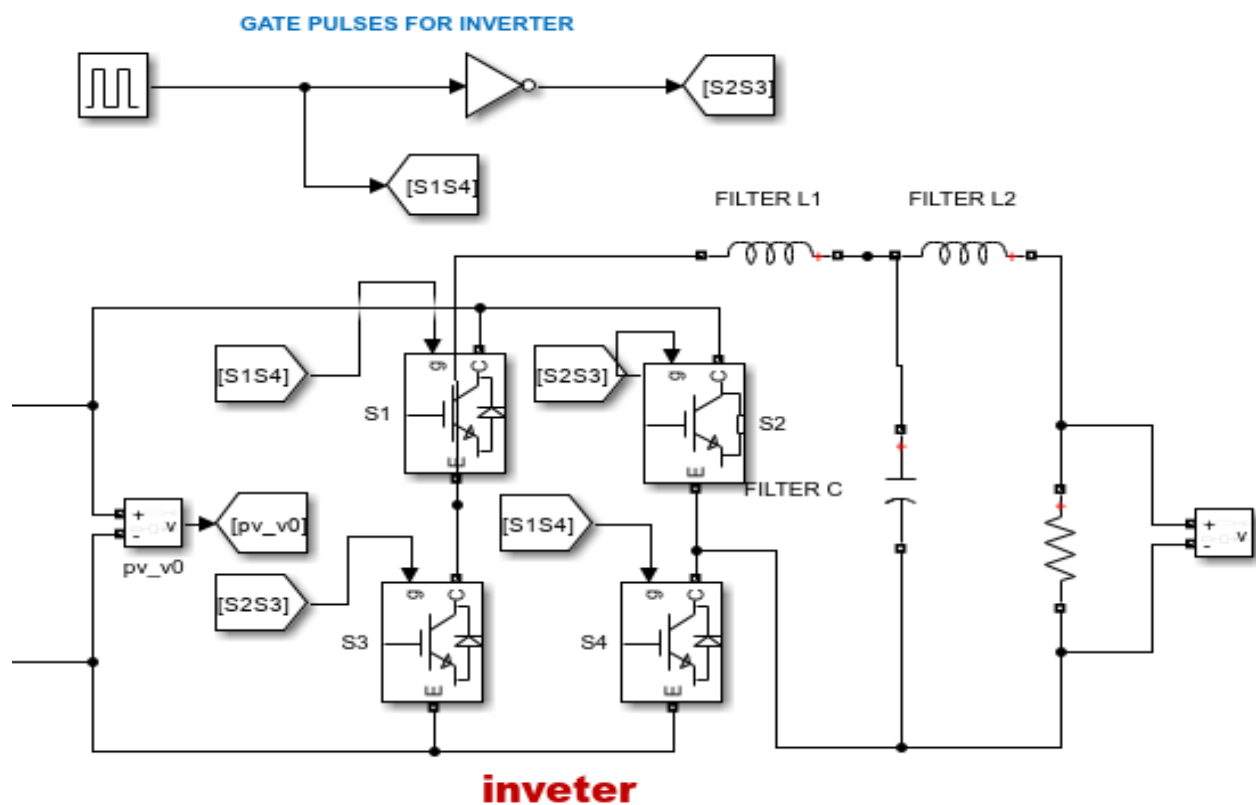
➤ function D = PandO( V, I)
➤
➤ Dinit = 0.41;
➤ Dmax = 0.9;
➤ Dmin = 0.4;
➤ deltaD = 0.01;
➤
➤ persistent Vold Pold Dold;
➤
➤ dataType = 'double';
➤
➤ if isempty(Vold)
➤     Vold=0;
➤     Pold=0;
➤     Dold=Dinit;
➤ end
➤ P= V*I;
➤ dV= V - Vold;
➤ dP= P - Pold;
➤
➤ if dP ~= 0
➤     if dP < 0
➤         if dV < 0
➤             D = Dold - deltaD;
➤         else
➤             D = Dold + deltaD;
➤         end
➤     else
➤         if dV < 0
➤             D = Dold + deltaD;
➤         else
➤             D = Dold - deltaD;
➤         end
➤     end
➤ else D=Dold;
➤ end

```

-
- `if D >= Dmax | D <= Dmin`
- `D=Dold;`
- `end`
-
- `Dold=D;`
- `Vold=V;`
- `Pold=P;`

➤ **Inverter:**

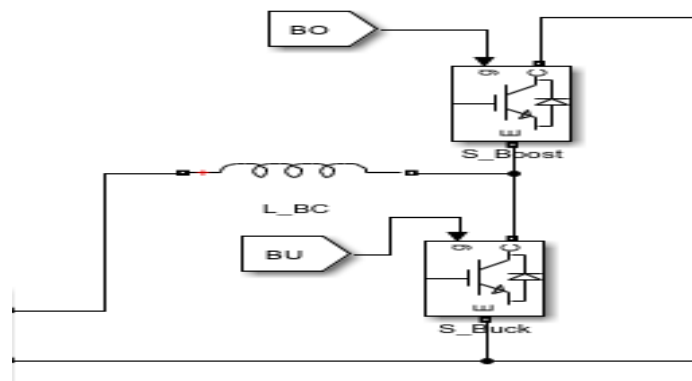
The main function of the inverter in this project is to convert the DC voltage that we have been using so far into AC supply, which is required for practical applications. To achieve this, we introduced an inverter into the project that can convert the DC source into the desired AC output. The MATLAB simulated diagram for the application is shown below.



The inverter is typically used to convert the DC voltage generated by solar panels into AC. This requires the use of four switches that operate in different cycles, based on the gate pulses they receive. The inverter we are discussing here has been designed with a filter that helps to remove any harmonics that may be present.

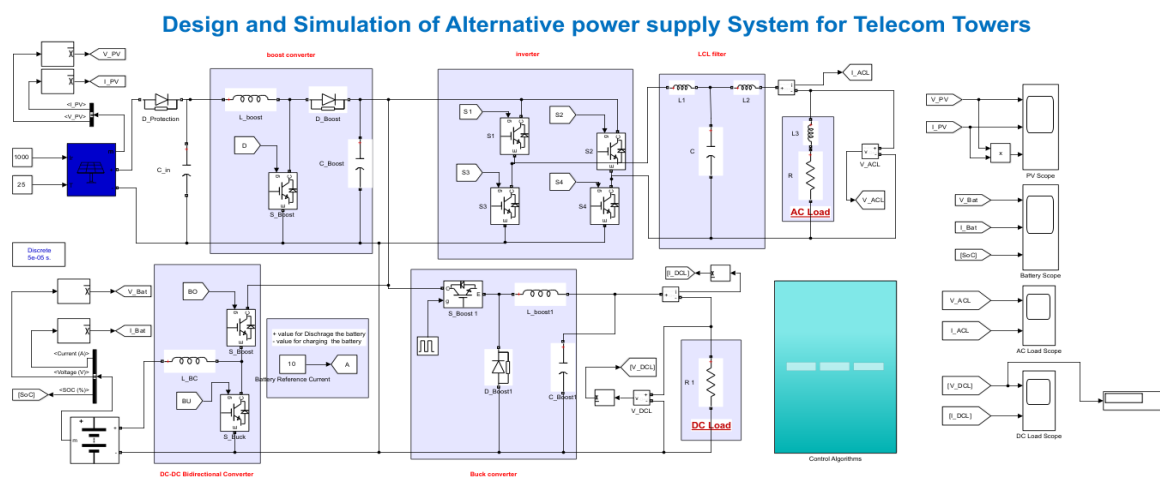
➤ **Bi-Directional converter:**

The name itself suggests that a bi-directional converter can convert the power in both directions. This converter is generally used to charge the battery, which requires less voltage to charge than the input voltage. The voltage obtained from the battery is also less for the application. In both cases, the bi-directional converter works perfectly. A MATLAB simulated diagram of the bi-directional converter is shown.

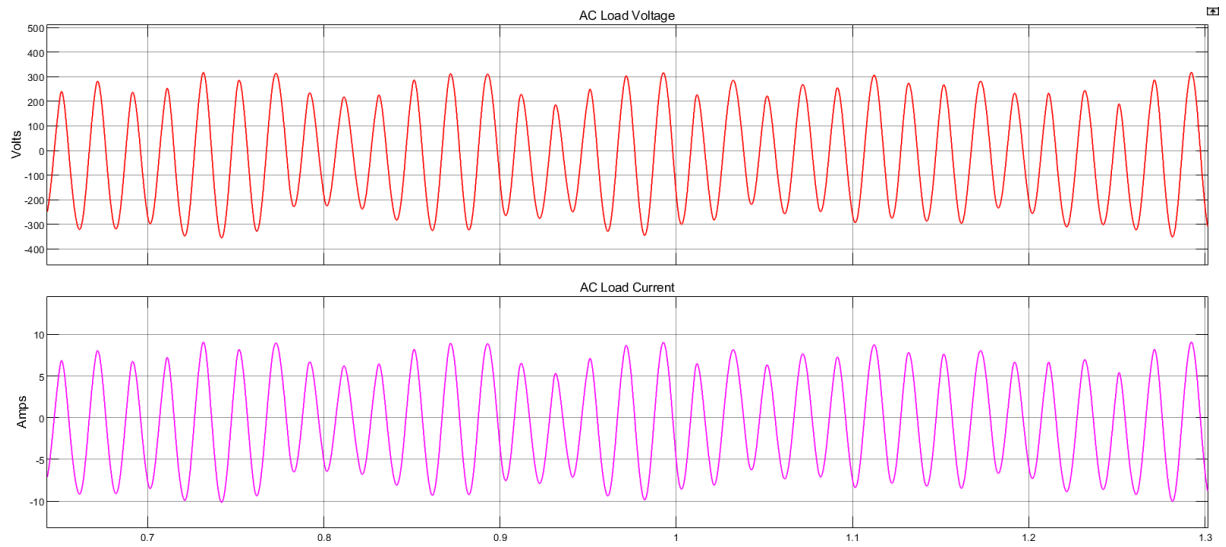


The bi-directional converter combines the operation of both buck and boost converters. It reduces the voltage to charge the battery and improves the voltage for the application. To ensure the correct operation of the bi-directional converter, a controller is required. This controller is given to the gate of the two switches present in the MATLAB block diagram, as shown in the figure above.

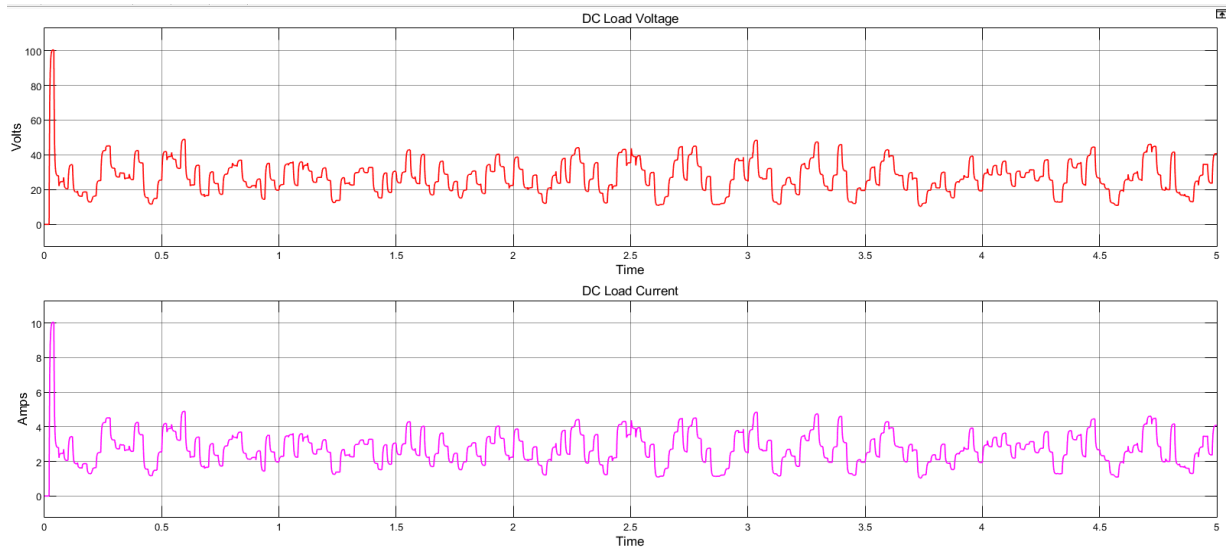
➤ **Overall simulated diagram of project:**



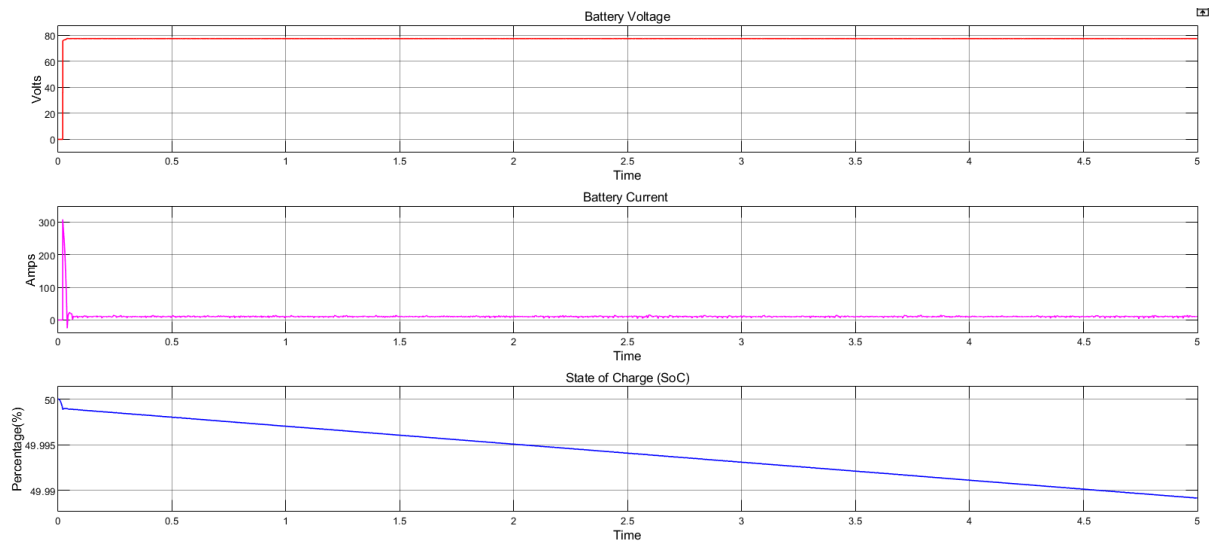
➤ **Output waveforms of AC load:**



➤ **Output waveforms of DC load:**



➤ **Output waveform of Battery:**



➤ **Project batch:**



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