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Detection of Electrical Faults in Partial Shaded Photovoltaic Array

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ABSTRACT: As we know, increase in the population causes an increase in high power demand. There are many renewable energy generation sources, but solar is one of the most used for the generation of electricity. If any fault occurs in the panels, it results in less output. Hence, to improve efficiency, the fault should be detected. Various technologies are used for detecting those faults, but they are time-consuming techniques and are of high cost. This project processes faults automatically in the PV array using the Internet of Things. In this setup, solar panels are connected to voltage sensors and current sensors. If a fault occurs due to an open circuit or short circuit, the current values and voltage values vary. These values are then sent to the monitoring platform through the Wi-Fi module. This way, the fault can be easily detected, and information can be sent to the engineer.

KEY WORDS: IoT, Solar Cells, Arduino Nano, ESP 8266, Voltage Sensors, Relay Module.

I. INTRODUCTION

In recent years the power demand through the renewable energy sources, such as solar photovoltaic (PV) system, is increasing from day to day. Among all, solar photovoltaic (PV) system is more reliable, efficient and economical in nature. However, the intermittent nature of environmental circumstances may cause problems for PV systems. The project aims to develop a system for the detection of electrical faults in Photovoltaic (PV) arrays using Arduino microcontrollers. PV arrays are susceptible to various faults such as open circuits, short circuits, and shading, which can significantly degrade their performance. Detecting these faults early is crucial for maintaining the efficiency and reliability of the PV system. Electrical faults can be caused by corrosion, loose connections, or damaged connectors. Visual inspection and routine maintenance can assist in identifying and averting these problems. We can combine visual inspections, routine maintenance, and sophisticated monitoring systems to efficiently find these electrical faults in a PV array. Early warning systems of problems can be given by monitoring systems that continuously measure theperformance of individual panels and the entire array.

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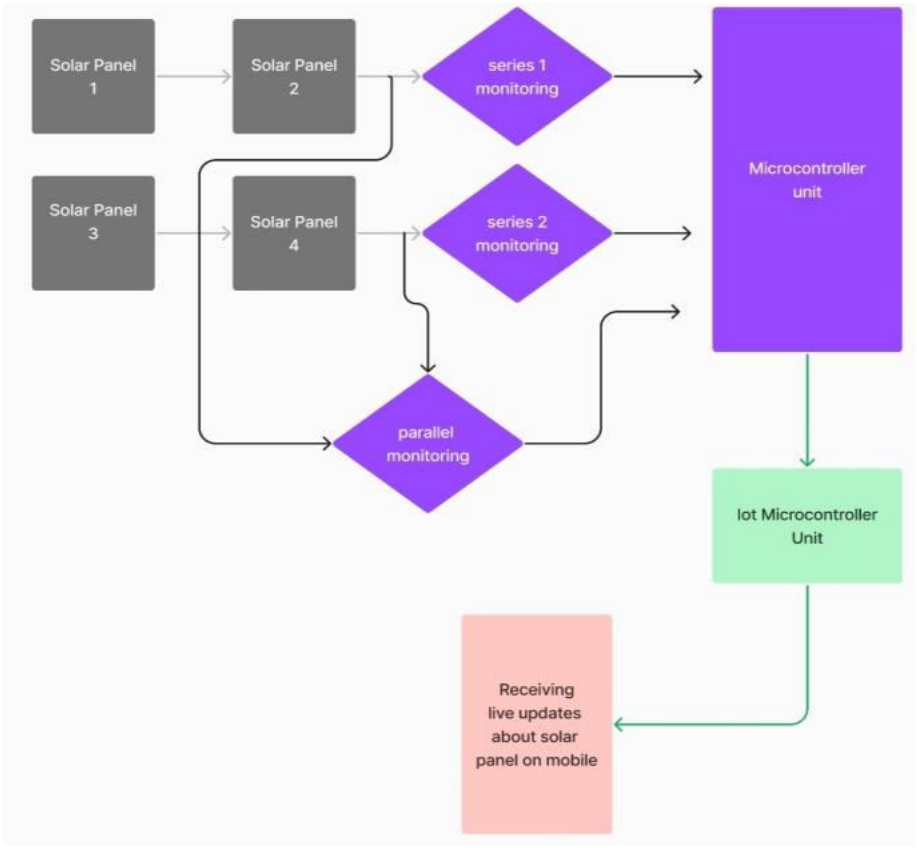

FIGURE 1 Block Diagram of Proposed System

II. PROPOSED SYSTEM

This is the block diagram for Detection of Electric Faults in Partial Shaded Photovoltaic Array as shown in figure. It consists of many components such as solar cells, voltage sensors, current sensors, relay, arduino nano, etc. The black line represents the interconnection of sensors to detect the faults in the array. The block diagram of the detection of electrical faults in partial shaded photovoltaic array by using arduino project illustrates the interconnected components and functionalities crucial for its operation. The block diagram shows the proposed IoT based system. All the components are built in PV model for performance evaluation and fault detection, both of which programmed using the Arduino IDE software. Internet of things is the idea of connecting any contraption to the web and other associated GES. The web of things is a gigantic urbanization of interconnected things and individuals.

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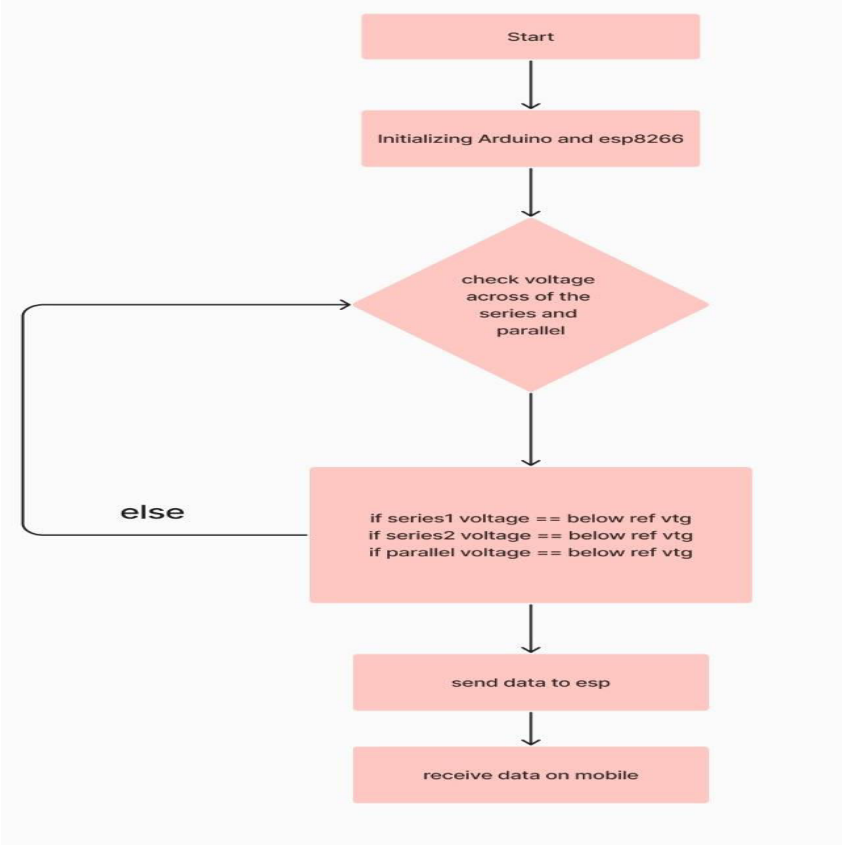

FIGURE 2 Flow chart

The design of the Detection of electrical faults in partial shaded photovoltaic array using arduino system is well thought out integration of various elements to create a sustainable, efficient and user-friendly mode of operation. The frame and chassis are engineered for stability and durability of various sensors.

The system's algorithm flowchart is displayed as it is seen in the figure. First, the Arduino and ESP 8266 Wi-Fi module receive the sensing data from the PV devices on their irradiance, cell temperature, operating voltage, and output current. The Arduino incorporates the gathered data. The relay will turn on if the voltage level is higher or lower than the threshold settings. The same procedure will be carried out automatically for additional errors. Via the UART Tx/Rx (Pins 8 and 10) interface, the ESP 8266 module receives data from the main board. All gathered and computed data is then transmitted to the host and displayed via the Blynk platform.

Specification of solar panel
Dimension: 70x70x03mm
Maximum Power Output: 1.2W
Maximum Voltage Output: 6 V
Maximum Current Output: 100mA
Short Circuit Current: 0.42mA
Open Circuit Voltage: 0.72V

III. REQUIRED COMPONENTS

A) Solar Cells:

To detect and perform pro active maintenance on solar panel in case of any electrical fault occurs. It acts as a source for proposed system. Solar panel generates electricity when panel is exposed towards sunlight utilizing radiation energy. In this case monitoring of voltage and output current of individual panel or abnormalities such as short circuit or open circuit can also be done. A 1.2-watt solar cell typically refers to a small photovoltaic cell capable of producing 1.2 watts of power under standard test conditions (STC), which usually include sunlight intensity of 1000 watts per square meter, a temperature of 25°C, and the AM 1.5 spectrum.

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B) Voltage Sensor:
Voltage Sensor Module 25V is a simple but very useful module which uses a potential divider to reduce any input voltage by a factor of 5. This allows you to use the analogue input of a microcontroller to monitor voltages much higher than it capable of sensing. For example with a 0-5V analogue input range you are able to measure a voltage up to 25V. The module also includes convenient screw terminals for easy and secure connection of a wire.

C) Arduino Nano:
Arduino nano is works as a controller here. Arduino nano is interfaced with various sensors collects real time data. It not only collects data but also process data and detects deviation in expected values which may indicate electrical faults like short circuit faults, open circuit faults etc. Algorithm is set in such a way that it identifies patterns or signatures associated with certain fault. Further it is set to trigger alert and notification whenever fault is detected. The sensors we have connected such as voltage sensors, current sensors and temperature sensors are interfaced with Arduino Nano.

D) LDR Sensor Module
The LDR sensor module is used to gauge light intensity and detect its existence. When there is light, the module's output increases, and when there is no light, it decreases. The potentiometer can be used to change the signal detection sensitivity. By adjusting the onboard variable resistor (potentiometer), you can change the digital output's threshold (sensitivity). Easy to use because it is a digital output; you can determine what to do with the light by knowing whether it is present.

IV. SYSTEM IMPLEMENTATION

The completed detection of electrical faults in partial shaded photovoltaic array by using arduino system is shown in figure. a figure shows the main board consists of the sensing interface, voltage sensor, current sensor, relay, solar cells, arduino nano, ESP8266 board, temperature sensor, toggle switches and peripherals. The device includes sensors system for measuring solar irradiance, cell temperature, operating voltage, and PV output current. Additionally, it has an ST-LINK in-circuit debugger and programmer for downloading code from the Arduino IDE to the microcontroller. Finally, the Blynk display shows and compares the measured and simulated results, allowing for testing of the electrical characteristics of commercial PV devices. The data are transferred to the ESP 8266 through the UART Tx/Rx interface, and then forwarded and saved to the cloud server. An Android mobile app can view the sensing information.
FIGURE 3 Photographs of proposed IoT-based system.

Using arduino to detect electrical faults in photovoltaic cells typically involves monitoring parameters such as voltage, current and the temperature. We can program the arduino to continuously measure these parameters and set the threshold for normal operation. if any parameter exceeds or falls below the set thresholds, it could indicate a fault in pv cells. The arduino can trigger an alert or perform a specific action, such as shutting down the system to prevent further damage.

V. RESULT

The detection of electrical faults in partial shaded photovoltaic array by using arduino system measures and stores data on solar irradiance as well as the cell temperature, operating voltage, and output current of the PV devices. All observations of the solar irradiance as well as the back-surface cell temperatures, operating voltage, and output current of PV devices and the faults were recorded at interval. For fault detection we are going with manmade disconnection through the toggle switches. Figure shows the fault one that is Open circuit fault in the array.

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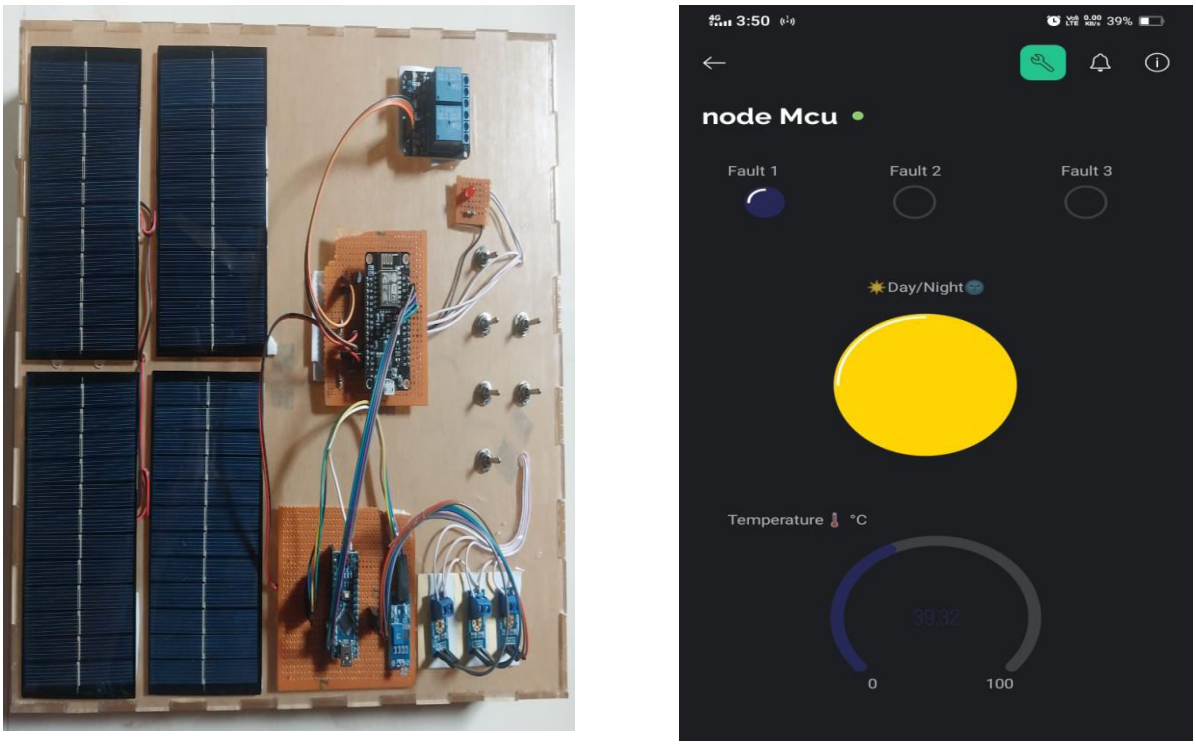

FIGURE 4 Screenshot of Android App for indication

VI. CONCLUSION

The detection of electrical faults in partial shaded photovoltaic arrays is covered in this work. Use an Arduino system that is based on the Internet of Things (IoT) framework. For PV modules that are sold commercially, an integrated mathematical model is utilized to simulate functions related to fault detection and PV performance assessment. Measured and simulated data can be sent to the cloud server via a Wi-Fi network, and the suggested system has been verified experimentally in real-world settings. The results demonstrate the accuracy and reliability of the proposed system, which makes it a valuable tool for PV system engineering. In particular, the system offers a number of benefits, including as affordability, simplicity of installation, and the ability to quickly identify problems with PV systems.

VII. FUTURE SCOPE

The future scope of detecting electrical faults in PV arrays using Arduino presents numerous opportunities for advancement and application. Potential areas of focus include:

1. **Enhanced Fault Detection Algorithms:** Developing more sophisticated algorithms to improve fault detection accuracy and reliability, particularly for complex fault scenarios or under varying environmental conditions.
2. **Integration with IoT and Cloud Computing**: Integrating Arduino-based fault detection systems with IoT platforms and cloud computing.
3. for real-time monitoring, remote management, and data analytics, enabling proactive maintenance and optimization of PV systems.
4. **Scalability and Adaptability:** Designing Arduino-based solutions that are scalable and adaptable to different PV array configurations, sizes, and types, catering to both residential and commercial installations.
5. **Fault Classification and Predictive Maintenance**: Implementing machine learning techniques to classify different types of faults and predict potential failures, facilitating predictive maintenance strategies to minimize downtime and maximize energy yield.

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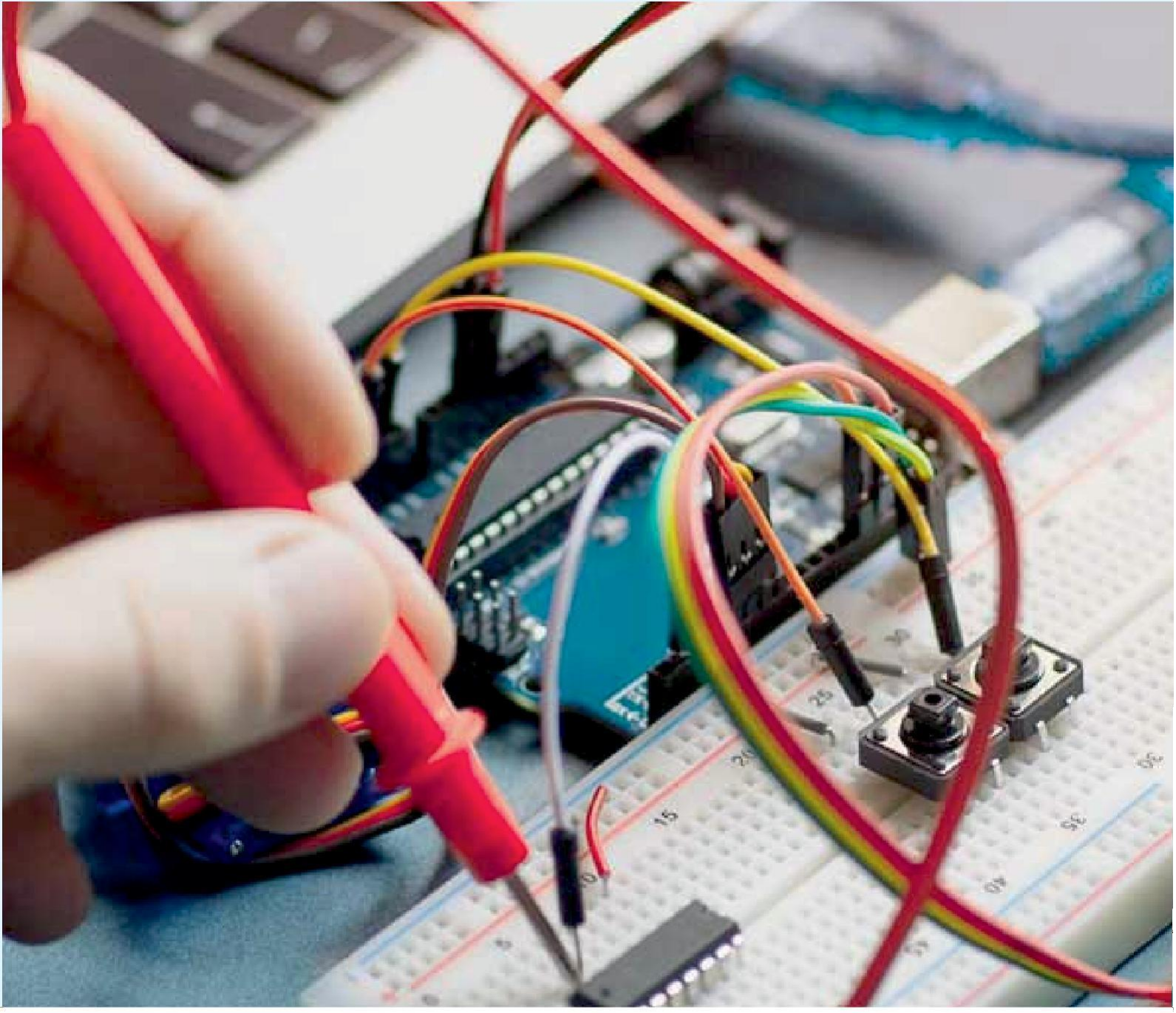

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