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Solar Panel and Battery Maintenance Using IOT

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Abstract

The use of solar energy has increased significantly over the world.They are well-liked due to their endlessness and purity.It also stands out for being low maintenance.Yet,if a little issue with the panel or circuit is not identified promptly, it could cost a lot to maintain.Another challenging task is finding the flaw inside the vast solar field.This study examines the viability of employing IOT for real-time fault detection.

Reducing the maintenance expense and detection time,panel temperature,light intensity,and current are monitored and maintained continuously,respectively, using temperature,light,and current sensors.In the proposed study to maintain the standard level of voltage,battery voltage is constantly monitored to meet the industrial need and to increase the life span.The study also aims to measure efficiency concerning the increase and decrease in power levels.

INTRODUCTION

Further, the study involves a cleaning system that can be integrated into the solar panel to clean the dust layer accumulated on the panel.Cleaning dust is an important factor in solar panel maintenance to improve efficiency and reduce corrosion.The novelty of the system lies in the comprehensive approach towards solar panel maintenance through the integration of IOT technology,smart cleaning systems,and rigorous analysis of efficiency factors.

Solar energy is a leading source of clean,renewable power.Widely used in residential, commercial, and industrial sectors.Solar panels and batteries require regular monitoring for optimal performance. Common issues include dust accumulation,shading,wiring faults,and battery degradation.Manual inspections are time-consuming and inefficient.Delay in fault detection can lead to power loss and equipment damage.

IOT enables real-time monitoring of solar panels and battery systems.Sensors collect data such as voltage,current,temperature,sunlight intensity, and battery status.Data transmitted to cloud platforms for analysis.IOT system can detect anomalies early and send automated alerts.

Increasing demand for sustainable energy sources has led to wide spread adoption of solar power systems. Proper maintenance ensures maximum efficiency and longevity of solar panel and batteries.Traditional maintenance involves physical inspections,which are slow,costly,and sometimes inaccurate.Increasing energy demand and environmental concerns have led to the widespread adoption of solar energy.

Solar panels and battery systems play a key role in off-grid and smart energy systems.Proper maintenance ensures high efficiency and longevity of solar panels and storage batteries. Manual monitoring is often inefficient, time-consuming,and prone to human error.IOT enables real-time monitoring, predictive maintenance, and remote diagnostics.Sensors collect data such as voltage,,current,temperature,dust accumulation, and battery charge levels.

I. EXISTING SYSTEM

Traditional solar panel and battery maintenance methods typically involve periodic manual inspection and maintenance checks, which can be time - consuming labor-intensive, and may not detect issues promptly, leading to reduced efficiency and potential downtime.Issues like dirt accumulation,overheating,or battery faults may go unnoticed until failure

occurs.Limited efficiency and high labor costs.Traditionally,technicians inspect solar panels an batteries manually.Battery voltage,charge/discharge status, and temperature.Environmental factors like sunlight intensity and panel surface temperature.

PROPOSED SYSTEM

The proposed system utilizes IOT technology for continuous monitoring and maintenance of solar panels and batteries,enabling real-time data collection and analysis to proactively identify and address issues,thereby enhancing efficiency,reducing maintenance costs, and ensuring optimal performance. Use of high-precision sensors to monitor solar panel voltage,current,and power output.Battery state of charge state and temperature.Environmental conditions like solar irradiance and dust levels on panels.

II. METHODOLOGY

Manual inspection of solar panels and batteries is inefficient.Faults and inefficiencies often go undetected until system performance is affected.Design a system and battery units. Sensors for data collection .IOT microcontroller for processing and communication.Cloud platform for storage and visualization.Ensuring sensors and microcontrollers draw minimal power from the system.Use of Wi-Fi,GSM or Lo-Ra module based on location and range.

Use sensors voltage,current,temperature,and solar irradiance connect sensors to a microcontroller read and process data.Transmit data wirelessly using Wi-Fi,GSM,or Lora modules to a cloud platform.Store and display data using platforms like Things peak,Firebase,or Blank.Continuously track panel performance and battery health remotely.Set limits for parameter and battery health if values exceed safe ranges.Provide user interface for remote access via mobile app or web dashboard.Record historical data for analysis and predictive maintenance.

Test the entire system in system in real conditions and calibrate sensors for accuracy.Continuously tracks the performance of solar panels and battery systems using sensors.Voltage,current,temperature,and light sensors collect essential data for system health.Devices like arduino or ESP32 process sensor data and handle communication tasks.Data is transmitted wirelessly via Wi-Fi,GSM,or Lo Ra to cloud servers or mobile apps.Platforms such as Thing Speak or Firebase display live system performance and store historical data.

BLOCK DIAGRAM:

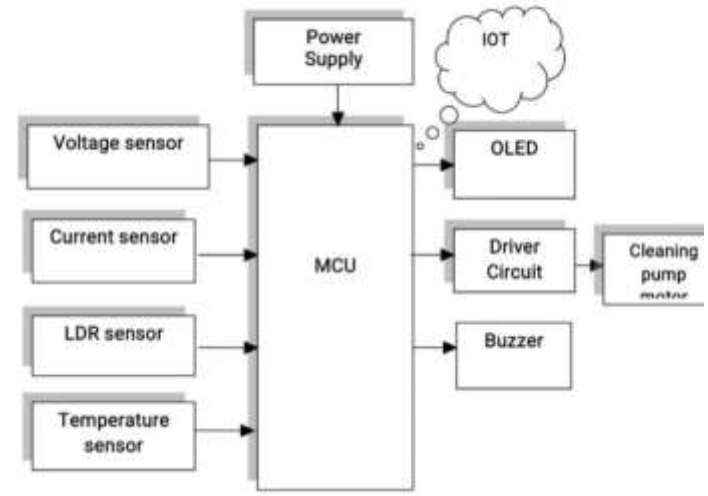

Fig.1 Block Diagram of Solar Panel and Battery Maintenance Using IOT

Applications

- Automates solar energy monitoring and battery usage for efficient power management in households and commercial buildings.
- Enables real-time monitoring and monitoring and maintenance of off-gird solar systems in rural or efficient operation.
- Ensures continuous power supply to telecom towers by monitoring solar and battery system remotely.
- Optimizes the use of solar power and battery storage in EV charging setups.
- Supports solar-powered irrigation systems and equipment in smart farming.
- Maintains solar power system in emergency shelters or remote relief centers where power reliability is critical.

III. HARDWARE DETAILS

Microcontroller:microcontroller board, designed especially for physical computing. It is the successor of the popular Raspberry Pi Pico board. Similar to the Pico board, which we discussed earlier, the Pico W board is also built around the Raspberry Foundation in-house ARM chip

RP2040.

Voltage Sensor: The Voltage Sensor is a device that converts voltage measured between two points of an electrical circuit into a physical signal proportional to the voltage.

Current Sensor:A current sensor is a device that detects and converts current to an easily measured output voltage, which is proportional to the current through the measured path.

LED Sensor: Light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity or vice versa. As the name suggests, LDR is a type of resistor whose working depends upon only on the light falling on it.

Temperature Sensor: Temperature is the most-measured process variable in industrial automation. Most commonly, a temperature sensor is used to convert temperature value to an electrical value.

OLED(Organic Light Emitting Diode):OLED is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays.

Bluetooth: Bluetooth allows wireless communication between the solar system and nearby devices like smartphones,tablets,or local control units.Useful in mobile solar setups solar-powered camping for quick diagnostics.

Driver Circuit: The driver circuit acts as an interface between the microcontroller and high-power components .Commonly used to control relays for connecting /disconnecting the battery,solar panel system conditions.

Cleaning pump motor: It can be completely submerged into the fluid and the motor is hermetically sealed. The motor is close-coupled to the body of the water booster pump. It pumps the water to the surface by energy conversion that works in a cycle. The rotary energy is converted into kinetic energy that is further converted into pressure energy.

Buzzer:A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, house hold appliances such as a microwave oven, or game shows.It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound.

SOFTWARE DETAILS

Read the data temperature,light,connected to

system .Calculates power out, battery state of charge ,and detects system anomalies.Uses Wi-Fi,Bluetooth or GSM with protocols like MQTT or HTTP to send data to cloud platforms.

Embedded C: Embedded C is used to write the core firmware that runs on microcontrollers like arduino pic or esp32.Code is written in embedded C to interface with sensors using analog and digital pins.

Arduino IDE:Arduino IDE is used to write compile, and upload code to microcontrollers like arduino Uno,Mega,or ESP32.It provides a simple and easy- to-use environment for beginners and professionals alike.Built-in tools help debug sensor readings and visualize data in real time.Arduino IDE supports IOT cloud communication protocols like HTTP,MQTT,and web Socket.

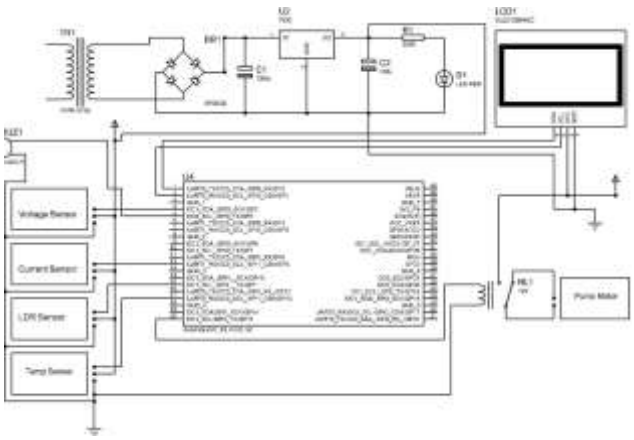

Fig.2 Schematic Diagram of Solar Panel and Battery

Maintenance Using IOT

FIG 3 Prototype of Solar Panel and Battery Maintenance
Using IOT

IV. CONCLUSION

The IoT-based solar power monitoring system is an innovative project that provides real-time monitoring and analysis of various parameters of a solar panel. The system has several advantages, including efficient energy management, improved solar panel performance, reduced maintenance costs, and increased system reliability. The system's hardware components include the solar panel, voltage sensor, current sensor, microcontroller, LCD display, and other components.

The system's working is straightforward, with the solar panel generating electrical energy that is measured by the voltage and current sensors. The microcontroller processes and displays the collected data on the LCD display, the Blynk mobile application, and the computer program. The system continuously monitors and updates the data, providing real-time analysis and monitoring of the solar panel's performance.The IoT-based solar power monitoring system has several advantages, including efficient energy management, improved solar panel performance, reduced maintenance costs, and increased system reliability. The system can also help users make informed decisions regarding their energy consumption and reduce their carbon footprint. In conclusion, the IoT-based solar power monitoring system is a valuable tool for efficient energy management and real-time monitoring of solar panel performance.

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