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IoT-Based Solar Monitoring

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Abstract: *An Internet of Things (IoT) based Solar Monitoring System is designed to enhance the efficiency and reliability of solar power generation. This system employs a network of connected sensors and devices to collect real-time data from solar panels, inverters, and other relevant components. By utilizing IoT technology, the system enables remote monitoring and control, allowing users to access critical information about solar power generation from anywhere in the world.*
The core functionality of the system involves monitoring key parameters such as solar irradiance, panel temperature, and energy output. These data points are transmitted to a centralized platform where they are processed and analyzed. Through advanced analytics, the system can identify patterns, predict potential issues, and optimize performance to maximize energy yield..

Keywords: IOT- Internet Of Things, Cloud Platform, Monitoring, and Real-Time Performance.

I. INTRODUCTION

One of the most fundamental demands in everyone's life in the modern world is access to electricity. Electricity is required for all household appliances, transit systems, lighting, refrigeration, and warmth. Daily energy use is rising quickly, but energy resources are also declining at the same time. Due to its availability and lower cost in terms of conversion technology,solar energy has become quite fashionable. In this technology, the photovoltaic effect also known as solar energy converts light energy into electrical energy.

We can keep trace of this system's state and get alerts when an issue arises by keeping an eye on it, which is quite beneficial. An IoT-based solar power monitoring system is described in the suggested system. In this arrangement, solar cells found in solar panels transform sunlight into electricity. Sensors are used to measure the current and voltage parameters, and the results are shown on the LCD screen. With the use of the cloud server network and the internet of things, an object might be sensed, tracked, and managed remotely. With the aid of this technology, machines may talk to one another and be managed without the need of people. An IOT-based system for solar power monitoring keeps track of things like for maximum power generation.

For maximum power generation, solar power plant need to be closely watched. This assists in recovering effective power output from power plants while checking for damaged solar panels, connections, and dust buildup on panels that could affect their efficiency. Output and other such issues affecting solar performance. Dark outside, when solar production is zero.

To develop a solar power monitoring system with use of sensors. By using humidity and temperature sensor monitor the weather condition.

In the realm of renewable energy, IoT-based solar power monitoring plays a pivotal role in advancing the efficiency and sustainability of solar installations. By integrating smart sensors with solar panels and associated equipment, a comprehensive data ecosystem is established. This ecosystem continuously gathers information on key parameters such as energy production, temperature, and overall system health. Through real-time connectivity, users can access this data remotely, providing a detailed insight into the performance of their solar energy infrastructure.

II. LITERATURE SURVEY

- Solar Energy Monitoring System by IOT, Dr.S.Chakravarthi the Internet of Things is a vision where the Internet extends into the real world, involving everyday objects. IoT enables the detection or remote control of objects through existing network infrastructure, creating opportunities for a clean integration of the physical world with computer

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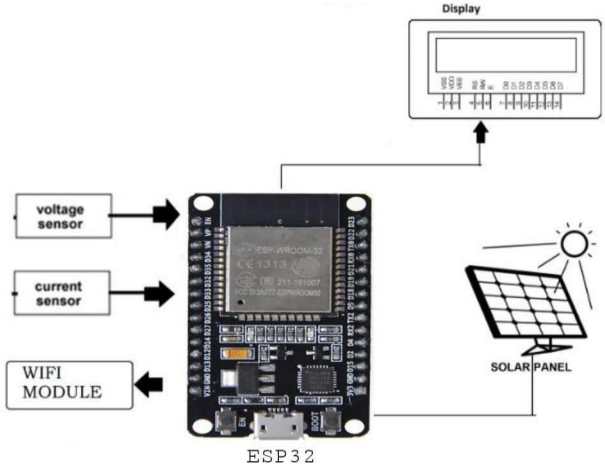
systems, resulting in improved efficiency, accuracy and economic benefits, and reduced human effort. This technology has many applications such as solar cities, smart villages, micro- grids and solar street lights, etc. Renewable energy grew faster than at any other time in history during this period. The proposed system refers to the online display of solar energy use as renewable energy. This tracking is done with a Raspberry pi using a bottle frame. Smart Monitoring shows the daily use of renewable energy. It helps the user to analyze the energy usage. Analysis of the effects on the use of renewable energy and electricity.

STUDY OF SOLAR POWER MONITORING SYSTEM USING INTERNET OF THINGS (IOT), MAY 2021, SRILAKSHMIMADADI

Renewable energy sources are practical solution to address the current supply shortage energy industry. Due to the availability of solar energy anywhere in the world, unlike anywhere else geographically limited resources, solar energy is the most useful sources of renewable energies. A complex framework for remote facility monitoring online interface is needed for this vast solar system commissioning Because most of them are placed inside in areas that do not have access and are therefore monitored it is not possible from a specific location.

III. PROPOSED SYSTEM

The proposed system for IoT-based solar power monitoring integrates a range of hardware and software components to facilitate comprehensive data collection, analysis, and visualization of solar energy generation. At its core, the system incorporates solar panels equipped with sensors to monitor vital parameters like voltage, current, and temperature. analytics tools leverage the collected data to identify trends, patterns, and anomalies, empowering users to make informed decisions regarding energy optimization and system performance. Users access a user-friendly web application or dashboard to visualize real-time and historical data, configure system settings, and receive alerts or notifications. Security measures are implemented to safeguard sensitive data and ensure secure user authentication. Overall, this proposed system enables efficient energy management, remote monitoring, and optimization of solar power generation across various applications, from residential to commercial and industrial settings.



eFigure 1: Circuit Diagram.

IV. DESIGN AND DEVELOPMENT

A) LCD Display

Liquid crystal display is spelled LCD. It is one kind of electronic display module that is used in a wide variety of circuits and devices like computers, mobile phones, televisions, and others. Seven segments and multi-segment light-emitting diodes are the primary uses for these displays.

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Figure 2: LCD Display

B) Input Voltage Sensor

In an IOT based solar power monitoring system, The input voltage sensor monitors the voltage generated by the solar panel. This sensor is often used in conjunction with a voltage divider circuit to scale down the high voltage from the solar panel to a level compatible

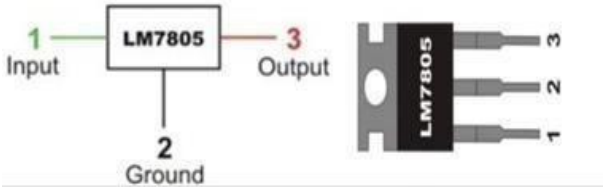

Figure 3: Input Voltage Sensor

C) Current Sensor

A current sensor is one of the key components used to measure the current flowing from the solar panel to the load. A current sensor is an electronic device that detects the current flowing througha wire and converts it into an electrical signal that can be used for further processing. It is a crucial component in the IoT-based solar power monitoring system as it plays a critical role in ensuring the efficient functioning of the solar panel and load.

Figure 4 : Current Sensor

V. HARDWARE SPECIFICATIONS

A) DC Motor

Integrating a 12V DC motor into an IoT-based solar power monitoring system involves meticulous planning and execution to ensure its seamless functionality within the system. Firstly, the purpose of incorporating the motor must be clearly identified, whether it's for indicating system status, triggering alerts, or activating physical mechanisms such as ventilation systems or trackers. Next, meticulous attention is required in system integration, determining the communication protocols and interfaces needed to connect the motor to the microcontroller or SBC managing the IoT system.

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Figure 5: DC Motor

B) ESP 32

The ESP 32 is a versatile, low cost microcontroller that's widely used in IOT apllications due to its integrated wifi and Bluetooth connectivity, low power consumption and dual-core-processor it is cost effective.

Key-Features:-

- Connectivity: Built-in Wi-Fi (802.11 b/g/n) and Bluetooth (classic and Low Energy) for wireless communication.
- Low Power: Designed for energy efficiency, making it suitable for battery-powered devices.
- Dual-Core Processing: Offers increased processing power for handling complex IoT tasks.
- Versatile GPIO: Provides numerous GPIO pins for connecting and controlling external devices and sensors.
- Programming Flexibility: Supports Arduino IDE and other frameworks like ESP-IDF and MicroPython.
- Cost-Effective: ESP32 is a relatively inexpensive option compared to other microcontrollers with similar feature

VI. RESULT AND ANALYSIS

The benefits of IoT-based solar power monitoring extend to detailed performance analytics and environmental reporting. By analyzing historical data, these systems can identify trends and inefficiencies, enabling operators to make data-driven decisions to enhance system performance. For example, the system might reveal that certain panels are consistently underperforming due to shading or dirt accumulation, prompting timely cleaning or adjustments to improve output. Furthermore, predictive maintenance capabilities mean that potential issues, such as inverter malfunctions, can be detected and addressed before they lead to significant downtime or costly repairs. This proactive approach not only extends the lifespan of the equipment but also ensures consistent energy production. Energy management is another critical advantage, as these systems provide comprehensive insights into energy production versus consumption. This helps operators to better understand their energy needs, optimize energy storage solutions, and even manage the distribution of excess power back to the grid. This balance is crucial for maintaining an efficient and sustainable energy ecosystem. Additionally, by providing detailed environmental impact reports, IoT-based monitoring systems highlight the positive contributions of solar power installations, such as reductions in carbon emissions, thereby supporting broader environmental and sustainability goals.In summary, IoT-based solar power monitoring systems offer a robust framework for maximizing the performance and sustainability of solar installations. Through real-time data monitoring, predictive maintenance, and detailed analytics, these systems ensure that solar power installations operate at peak efficiency, contributing to significant cost savings and a reduced environmental footprint.

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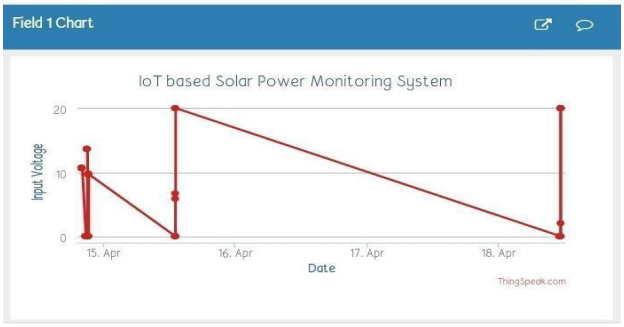

Figure 6. Input Voltage Solar Panel

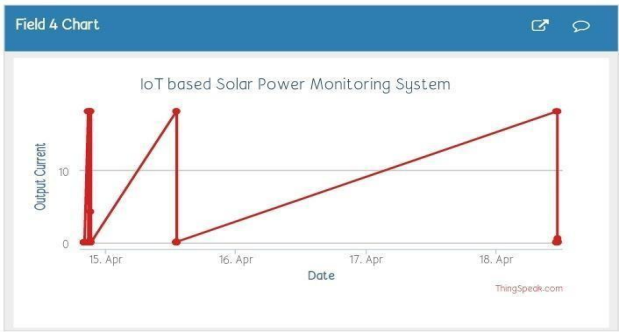

Figure 7. Output Current Solar Panel

VII. CONCLUSION

In conclusion, IoT-based solar power monitoring systems significantly enhance solar energy management by enabling real-time data collection, predictive maintenance, and grid optimization. This technology empowers users with comprehensive system insights, leading to improved efficiency, reduced costs, and a more sustainable energy future.

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