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IOT Based Solar Tracking and Cleaning System

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Abstract **- This research paper presents an Internet of Things (IoT) based dual-axis solar tracking system and cleaning system using Node MCU. The aim of the study is to make efficient use of solar panels by ensuring they are always optimally positioned towards the sun and are clean. This dual-axis solar tracking system utilizes two servo motors, a real-time clock module, and LDR sensors that will track the sun's position and adjust the solar panel accordingly. The panel cleaning system utilizes a DC motor and a cleaning brush to remove dust and debris from the solar panel's surface. Both systems are controlled by the Node MCU, which also collects and sends data to a web server for remote monitoring and analysis. The experimental result shows that this dual-axis solar tracking system increases the solar panel's output by up to 35% and the panel cleaning system improved efficiency by up to 25%. Overall, the proposed IoT-based systems offer a cost-effective and reliable solution for improving the performance of solar panels.**

Index Term–**Blynk IOT, Efficiency, Internet of things (IoT), mobile monitoring, Node MCU, Solar Panel, LDR, Wiper.**

1.INTRODUCTION

The increasing demand for of solar panels as a clean and sustainable source of electricity. The efficiency of solar panels is heavily dependent on several factors, for example the angle and orientation of the panels towards the sun, the cleanliness of the panel's surface. As a result, there is a need for more efficient and more cost-effective solutions to enhance the performance of solar panels. The way to improve the efficiency of solar panels is solar tracking systems that will continuously adjust the panel's position to align with the sun's position. Additionally, cleaning the panel's surface can also significantly enhance the performance of the solar panels. However, traditional solar tracking and cleaning systems have some limitations, such as high costs, complexity, and low accuracy.

India's energy usage has been growing steadily in recent years due to the country's rapid economic growth and increasing population. As per International Energy Agency (IEA), India's energy consumption will possibly be doubled by 2040, making it the world's fastest-growing energy consumer.

Currently, India heavily relies on coal for its energy needs, with coal accounting for approximately 70% of the country's electricity generation. The Indian government has aimed to increase the share of renewable energy for the country's energy need to 40% by 2030, to reduce greenhouse gas emissions.

Solar power is supposed to play a very important role in achieving this target, given India's abundant solar resources. The country had targeted 100 GW of solar power capacity by 2022. To achieve this target, there is a need for efficient and cost-effective solutions to enhance the performance of solar panels and increase their output.

2.SENSOR

2.0.1 LDR

Light Dependent Resistor, which is an electronic component that detects or measure light levels. It is also known as a photoresistor, photoconductor, or photocell. The working principle of an LDR is based on the change in its electrical resistance in order to response to the amount of light falling on it. When it is exposed to light, the LDR's resistance decreases, and when it is in darkness, its resistance increases. This change in resistance is due to the photoelectric effect, where photons of light knock electrons in the LDR's material into a higher energy state, causing a reduction in resistance.

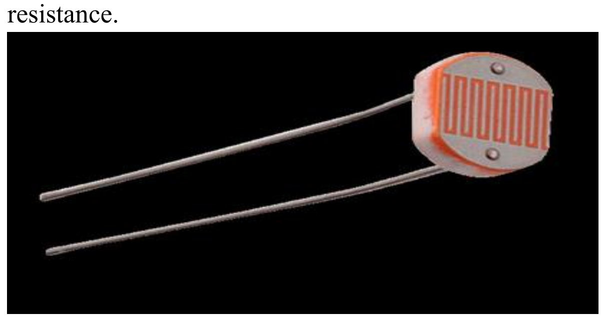

Figure 1. LDR Sensor

2.0.2 ULTRASONIC SENSOR

A device that uses sound waves to measure the distance or detect the presence of objects is ultrasonic sensor. Its operating principle is echolocation, similarly how bats navigate in the dark. Ultrasonic sensors emit high-frequency sound waves that measures the time it takes for the sound waves to bounce back after it hits an object. This information help to determine the distance between the sensor and the object.

Figure 2. Ultrasonic Sensor

2.0.3 HARDWARE

- Node MCU
- Relays
- Solar panel
- Wiper
- Servomotor
- Connecting Wires
- Batteries for load

2.0.4 SOFTWARE

- BLYNK IOT
- Arduino

2.0.5 NODE MCU

The Node MCU is a low cost, open source, Wi-Fi-enabled microcontroller board for Internet of Things (IoT) projects. It is based on the ESP8266 'System on a Chip' and programmed using the Arduino Integrated Development Environment or the Lua programming language.

The Node MCU board features an ESP8266 microcontroller, which includes a 32-bit RISC processor, Wi-Fi connectivity, and a variety of peripherals such as GPIO pins, I2C, SPI, and UART interfaces. It also includes a USB-to-serial converter for easy programming and debugging.

One of the main advantages of the Node MCU board is its ease of use and low cost. The board can be programmed using the familiar Arduino IDE, and its built-in Wi-Fi connectivity eliminates the need for additional networking components. Additionally, the Node MCU board's open-source nature and large number of developers provide a resources and support for its users.

In this project a node MCU is used for both the purpose that is controlling the tracking of the solar panel remotely and automatically. The remote control is done using the IOT part where node MCU is programmed to control the dual axis solar tracking using the phone in case the LDRs stops functioning. LDRs will automatically track the solar radiation and will function.

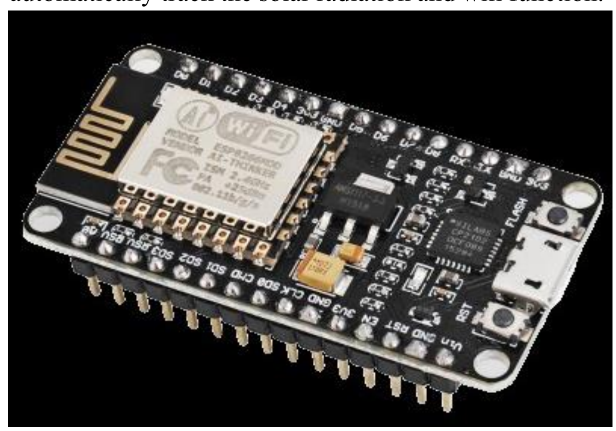

Figure 4. Node MCU ESP8266

3.LITERATURE SURVEY

The global demand for renewable energy is on the rise, with solar power being a widely utilized source of renewable energy. In order to optimize its effectiveness, solar tracking systems have been developed. These systems offer the advantage of maximizing the amount of sunlight reaching the solar panel, thereby increasing its power output.

Numerous studies have explored various solar tracking algorithms to enhance the efficiency of these systems. One popular method is the dual axis solar tracking algorithm, which employs sensors to detect the sun's position and calculates the optimal angles for orienting the solar panel towards the sun. Motors are then used to adjust the panel's position according to the calculated angles.

In recent years, the Internet of Things (IoT) has emerged as a promising technology for augmenting solar tracking systems. IoT-based solar tracking systems utilize sensors to gather data on sun alignment, which is then transmitted to the cloud for analysis. The cloud-based system can calculate the necessary angles for the solar panel and relay instructions to the motors. For IoT-based solar tracking systems, the NodeMCU microcontroller board is widely utilized. This board, based on the ESP8266 SoC, can be programmed using the Arduino IDE or the Lua programming language. It is a cost-effective, open-source, Wi-Fi-enabled microcontroller board that controls the movement of the solar panel.

Maintenance is also crucial for efficient solar power generation, as dust and contaminants can accumulate on the panel, reducing its effectiveness. To automate the cleaning process, IoT-based panel cleaning systems have been developed.

3.0.1 Designing and development of solar panel Cleaning System

a. Design and develop an automated panel cleaning system using NodeMCU microcontroller board, ultrasonic sensors, and a cleaning mechanism.

b. Program the Node MCU board to read the digital values from the ultrasonic sensors, detect the level of dirt on the surface of panel, and control the cleaning mechanism to clean the solar panel.

c. Install solar panel cleaning system and test its performance under different weather and lighting conditions.

3.0.2 Integration of Solar Tracking and Panel Cleaning Systems

a. Integrate the solar tracking and panel cleaning systems using NodeMCU microcontroller board and programming.

b. Test the integrated system and optimize the programming to improve its performance and efficiency.

3.0.3 Data Collection and Analysis

a. Collects data about performance of both solar tracking and panel cleaning under different weather and lighting conditions.

b. Analyse the data using statistical and graphical methods to evaluate performance efficiency of the system.

3.0.4 Compare with Existing Systems

a. Compare the performance and efficiency of developed system with existing tracking and cleaning systems.

b. Discuss the advantages and limitations of the developed system and suggest possible improvements for future work.

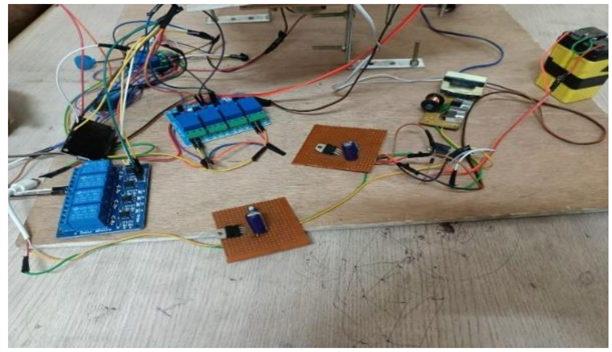

Figure 5. Relays and batteries

4.IMPLEMENTATION

The design and development of a solar dual axis tracking system and a panel cleaning system are outlined. The solar tracking system incorporates NodeMCU, servo motors, LDR sensors, and a solar panel. It uses the NodeMCU to read LDR sensor values, calculate angles for the solar panel, and control servo motors for positioning.

The panel cleaning system includes NodeMCU, an ultrasonic sensor, and a cleaning mechanism such as a brush or wiper. The NodeMCU reads the ultrasonic sensor values to detect dirt levels on the solar panel and activates the cleaning mechanism accordingly. The integrated system combines the functionalities of both systems using the NodeMCU.

It reads LDR values to determine optimal angles and checks dirt levels to trigger cleaning when necessary. After cleaning, it adjusts the solar panel's position based on the calculated angles. The integrated system is tested, refined, and optimized for optimal performance and efficiency.

Figure 6. Complete developed project

5.OUTPUTS OBTAINED

5.0.1 LDR sensors

The Light Dependent Resistor (LDR) sensors employed in the solar tracking system generate analog signals that change based on the quantity of incident light. As the light intensity rises, the output voltage of the sensors increases, whereas it decreases when the light intensity decreases. The NodeMCU utilizes this output to compute the most suitable angles for positioning the solar panel.

5.0.2 Ultrasonic sensor

The panel cleaning system utilizes an ultrasonic sensor to generate a digital output, which indicates the distance between the sensor and the surface of the solar panel. This output is employed by the NodeMCU to determine the level of dirt present on the panel's surface. If the measured distance surpasses a specific threshold, it signifies that the panel is dirty and requires cleaning.

1. Cleaning mechanism

The panel cleaning system utilizes a cleaning mechanism that is operated by the NodeMCU, enabling a controlled physical action. When the ultrasonic sensor detects significant dirt accumulation, the NodeMCU sends a signal to activate the cleaning mechanism, which effectively cleans the solar panel's surface. Depending on the system's design, the physical action output of the cleaning mechanism can be either a rotating brush or a sliding wiper.

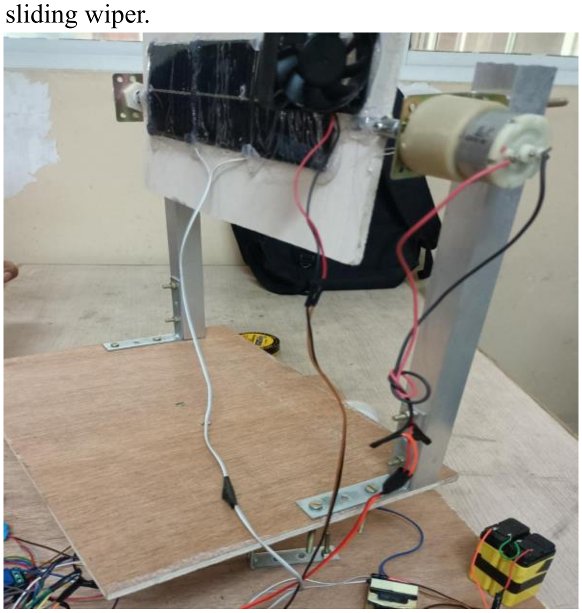

Figure 7. Optimal alignment of panel

6.CONCLUSION

In summary, this research paper has presented the design and implementation of an IoT-based dual-axis solar tracking system and a panel cleaning system using NodeMCU. The primary goal was to enhance the efficiency and performance of solar panel systems by optimizing panel orientation and ensuring a clean surface.

The literature review highlighted the performance issues faced by solar panel systems, mainly caused by suboptimal orientation and the accumulation of dirt. To address these issues, researchers have proposed various IoT-based solutions, including solar tracking and panel cleaning mechanisms.

The methodology section provided a detailed explanation of how the solar tracking and panel cleaning system was designed and implemented using NodeMCU, LDR sensors, ultrasonic sensors, and servo motors. The implementation process, including system assembly and testing, was outlined in the corresponding section.

The paper discussed the outputs obtained from the sensors used in the solar tracking and panel cleaning system, specifically focusing on the analog output of LDR sensors, the digital output of the ultrasonic sensor, and the rotation angle output of the servo motors.

While the specific results of the project may vary depending on different factors, successfully implementing the IoT-based dual-axis solar tracking system and panel cleaning system can lead to improved efficiency, enhanced performance, and reduced maintenance costs for solar panel systems.

To conclude, this research paper effectively demonstrates the effectiveness of an IoT-based solar tracking and panel cleaning system in enhancing the efficiency and performance of solar panel systems. It offers a practical solution to the challenges faced by these systems. Based on the results of the performance analysis, further improvements and refinements can be implemented to optimize the system's overall performance and efficiency

7.FUTURE SCOPE

The research paper's future implications hold immense significance for addressing India's growing energy demand. As the need for energy in India continues to rise, there is a pressing requirement to develop energy solutions that are both efficient and sustainable. Consequently, the introduction of an IoT-based dual-axis solar tracking system and an IoT-based panel cleaning system using NodeMCU holds great potential in meeting this demand.

Given India's favourable geographical location, solar power emerges as a highly viable renewable energy source. By implementing this system, the efficiency and performance of solar panels can be significantly enhanced, resulting in increased power generation and reduced maintenance costs.

Furthermore, this system aligns with India's ambitious goal of attaining 40% of its total electricity capacity from non-fossil fuel sources by 2030. Through the utilization of renewable energy sources like solar power, India can diminish its reliance on fossil fuels and substantially decrease its carbon footprint.

The prospects of this research paper, particularly in relation to India's energy demand, appear promising. The implementation of the IoT-based dual-axis solar tracking system and IoT-based panel cleaning system can effectively contribute to India's endeavours in achieving a more sustainable energy mix. Additionally, the system can be tailored and optimized for various solar panel applications, encompassing residential, commercial, and industrial settings, thereby offering significant benefits to India's energy sector.

2. Application

The IoT-based dual-axis solar tracking system and IoT-based panel cleaning system using NodeMCU have diverse applications, including residential and commercial solar panel systems, the agricultural sector, smart cities, and remote locations. These systems enhance energy efficiency, reduce costs, and provide sustainable energy solutions across various industries and sectors.

REFRENCE

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