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Article Title: IOT Based Sun Tracking Solar Panel Monitoring and Solar Power Management System

IOT Based Sun Tracking Solar Panel Monitoring and Solar Power Management System

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ABSTRACT

One of the most interesting and promising clean technologies in the modern era with no carbon emissions is solar photovoltaic electricity. It is true that if solar electricity is to be utilized, both its application and maintenance must be carefully thought out. This project suggests building a solar tracker using an Arduino and a servo motor. The Solar Panel Tracker is designed to move with the sun in order to maximise the quantity of light that the solar panel receives and hence boost power efficiency. The design of a dual-axis solar tracking system. In this method, the entire solar panel rotates once a day from east to west to face the sun. The efficiency of energy generation will rise with the usage of a solar tracker circuit. Solar energy measurements are gathered and analysed by the proposed Internet of Things (IoT)-based solar energy tracking technique in order to forecast performance and guarantee steady generation of electricity. The system's key benefit is that it can be used to analyse performance to improve solar PV maintenance. (Photovoltaic). A cost-effective solution that continuously shows remote energy yields and its performance on computers or smart phones is what the PV monitoring system's main goal is to provide. With a solar module, the proposed system is put to the test for voltage, current, temperature, and humidity. This smart, Wi-Fi-enabled Arduino microcontroller with an ESP8266 processor is used to create the PV monitoring system. It interfaces with the cloud platform and uploads data using the Blynk app. Additionally, a wireless monitoring system maximises a PV system's operational reliability while using the least amount of system resources.

Keywords: Photovoltaic (PV), Light Dependent Resistor (LDR), Arduino, Servo Motor, Blynk App.

1 Introduction

According to estimates, 1.1 billion people worldwide do not currently have access to electricity. Most of these people live in rural areas of Southeast Asia, Middle East, Central Asia, and sub-Saharan Africa, as well as to a lesser extent, Central Asia, and Latin America [1]. An electrical network known as a "smart grid" is capable of providing reliable, cost-effective, and secure power supply by carefully balancing the needs of all generator users, consumers, and users who fulfil both functions [2]. Environmental sensors and data recorders have undergone technological advancements that enable continuous data collecting for management decision-making [3]. The inaccurate sensor measurements are compensated by the ability to collect large amounts of data at relatively low costs, which can be enhanced. Statistical techniques can be used to investigate temporal and spatial trends in the data in a variety of ways to explore the effects of both local pollutant sources and long-range pollutant drift. [4]. In order to keep the VRFB operating safely, the charging system may need to be prematurely thermally shut down during fast charging operations of the VRFB since the high current causes an excessive rise in temperature inside the VRFB stack [5]. A data collection and transmission system built on the well-known electronic development platform Arduino enables the assessment of photovoltaic modules' (FV) temperature using up to 16 sensors. [6]. The PV operation determines the performance of the technology, which is defined as producing power, PR, and efficiency. [7]. An interface circuit between the load being harvested and the harvester is necessary for both the input and the output to stay controlled. [8]. Less solar radiation will result in lower power and profit production, 100 which may not be enough to offset depreciation and lead to 101 investment losses [9]. A CS-VCO was used in place of a polynomial VCO, greatly expanding the tracking range [10]. Additionally, the PV systems are located in difficult and arid environments. Because systems are not adequately maintained and cleaned on a daily basis, they produce varying voltages as a result of environmental effects. As a result of this, a system will never give the data collector true data. When the weather or the amount of sunshine changes, the system will deliver updated information. It suggests building a solar tracker using an Arduino and servo motor. So as to maximise the amount of light that the solar array receives and hence increase power efficiency, the Solar Panel Tracker is made to move with the sun. The list that follows outlines the paper's structure: The introduction is provided in Section I. Section II describes the most recent works. Part III provides an explanation of the suggested model and description. Section IV presents the findings. The conclusion is offered in Section V.

2 Recent Works

Renata I. S. Pereira *et al* [2019] [11] describes the design, development, deployment, and examining of an Internet of Things (IoT) network to track dispersed PV systems. By eliminating the need for proprietary software for control and data storage, the system aims to lower the cost of commercial data loggers and sensing modules. Applied IoT monitoring network in three PV facilities installed in the Brazilian cities of Fortaleza and Maracana as well as the German city of Cologne. The employed embedded solutions, notably the ESP 8266 and ESP 32, are based on open-source software as well as hardware and link to a cloud server through Wi-Fi. PHP was used to create a website called Web Monitor that allows users to view charts of real-time data online. The primary goal of the concept is to gauge the PV module's temperatures, providing information for efficiency analysis and defect detection in the event that the PV cells overheat. Monitoring the sun's radiation levels, the surrounding temperature, the relative humidity of the air, and the wind velocity provides more data for analysing how climatic elements affect the performance of the PV module.

Ascensión López-Vargas *et al* [2019] [12] Consider using a data logger in regions without an electricity grid or conventional wired telecommunications networks. Owing to the Internet of Things (IoT) integration in solar measurement systems, small standalone solar panels (PV) may be remotely monitored, which enhances system efficiency and maintenance utilizing 3G technology made it possible to remotely monitor the standalone PV system via the internet or a mobile application for very little money. The data logger measures electrical and environmental parameters with the IEC61724 standard-required accuracy (up to 14 parameters, extensible). The new data logger was tested outdoors for more than a year in challenging environmental circumstances at various sites, confirming the system's reliability and robustness under various real-world scenarios.

Xinyang Zhou *et al* [2020] [13] we provide a gradient-based multi-area strategy to precisely and successfully tackle the WLS problem. The strategy supports synchronous and distributed processing based on state predictions problem without compromising performance. 4,521-node test feeder numerical results demonstrate that the suggested approach has quick convergence and reliable estimation outcomes. When compared to the conventional Gauss-Newton approach, it is clear that the method performs significantly better in distribution systems with few accurate measurement points. The algorithm's real-time implementation accurately monitors time-varying system states.

Jiecheng Zhao *et al* [2020] [14] explains three methods for solving these problems. First, a better zero-crossing algorithm was created to monitor the system dynamics' rapidly varying frequency. Second, put forth a technological solution that can withstand system transients and eliminate outliers. Third, a technique for effectively exporting high time-resolution frequency predictions was invented. Each method is implemented in hardware and contrasted with traditional frequency estimation techniques. The outcomes of the testing show that the methods perform quite well. They can be incorporated into next PMUs and offer accurate data with for use in smart grid applications, with exceptional time resolution.

Qunlong Duan *et al* [2020] [15] presents an improved framework for data security and energy transactions for managing and operating smart cities. The idea of a Smart metropolitan areas within the context of electricity systems has recently gained the stage. Although the smart city idea ensures complete monitoring and accessibility of the electricity system, the risk of cyber-attacks on the system has been greatly increased. In light of this, a practical smart city model is described in this article, which includes the smart grid, smart transportation systems (STSs), which include the metro and electric vehicles (EVs), micro grid, and smart energy hub (EH). To increase the security of data transactions within the smart city, an improved DAG technique is proposed in the model. This approach adds a layer of protection to the blockchain. To stop cyber hackers from accessing system data. Additionally, a schedule for efficient energy management is created. In order to accomplish this, an intelligent priority selection (IPS)

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system founded on complex math operators is proposed to distribute the MCSs owned by the metro in the best possible way. In order to deal with the system's specifications' ambiguity, the unscented transform (UT) is also used.

3 Proposed Work Explanation

An experimental solar module is used to track the voltage, current, temperature, and humidity of the proposed system. An Arduino-based system is used to track the parameters of a 10W solar panel. This technology leverages the internet to transmit data to an IOT system while also continuously monitoring the solar panel's power output. Sensors that detect voltage and current separately keep an eye on both variables. A current sensor is a device that detects current and converts it into an easily measurable output voltage. 24/7 monitoring is provided by voltage sensors, which are continually on the lookout for voltage data that can point to a problem. A DHT11 sensor is used to monitor the temperature and humidity of the air. In this Prototype, the Arduino microcontroller controls the motors that rotate the panel automatically while the LDR sensor measures the intensity of the light (sunlight). The motor is controlled by an Arduino Uno board using the LDR sensor's output. This PV monitoring system's intelligent Wi-Fi enabled Arduino microcontroller and ESP8266 processor communicate with one other and upload data to a cloud platform using the Blynk application.

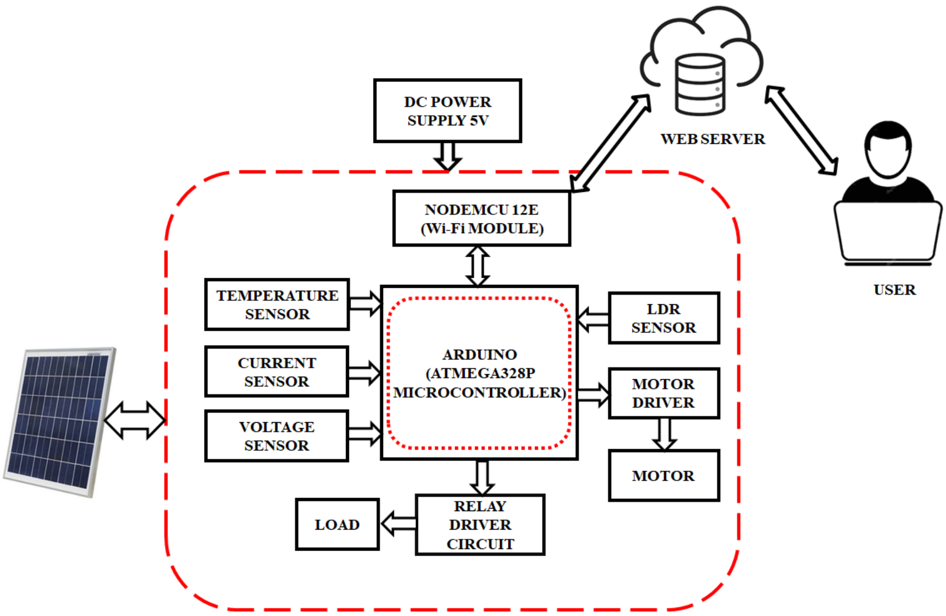

Figure 1: *Block Diagram of Proposed System*

3.1 Solar Panel

Light is converted into power by solar panels. The sun is the most potent source of usable light, which is why they are sometimes known as solar or "Sol" systems. They are sometimes referred to as photovoltaic, which is short for "light-electricity." The photovoltaic effect is used by solar

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cells, also known as PV cells, to capture solar energy and generate current between two layers with opposing charges. A solar panel is made up of many solar cells.

3.2 Arduino UNO

The Arduino UNO is a microcontroller MCU platform with additional features, including limited memory storage, and a variety of I/O pins for analogue and digital operations. One USB connector on the Arduino UNO is utilised for power connections and uploading programmes. For power connection, battery and main power choices are provided.

3.3 DTH11 Sensor

A straightforward and affordable digital temperature and humidity sensor is the DHT-11. It monitors the airspace around it using a thermistor and a capacitive humidity sensor, and it outputs a digital signal on the data pin.

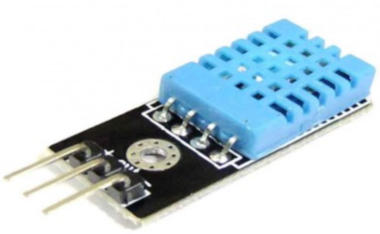

Figure 2: *DTH11 Sensor*

3.4 LDR Sensor

The terms photo resistor, photocell, and photoconductor are also used to refer to LDRs, or light dependent resistors. It is a specific form of resistor, and the resistance varies depending on how much light is shining on its surface. The terms photo resistor, photocell, and photoconductor are also used to refer to LDRs, or light dependent resistors.

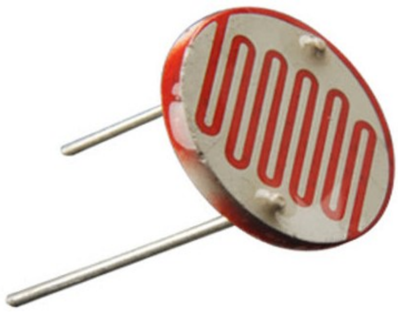

Figure 3: *LDR Sensor*

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3.5 Current Sensor

Hall Effect-Based Constant Current Sensor, model number ACS712. Both Alternative Current and Direct Current can be measured using this sensor. (Alternating Current). Along with a built-in low-resistance current conductor, it features 2.1kVRMS voltage isolation.

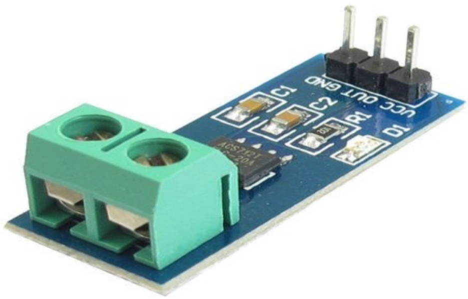

Figure 4: *Current Sensor*

3.6 Motor Driver

A motor rotates forward or backward when voltage is fed into it, depending on the polarity of the voltage. The voltage changes directly in relation to the spinning speed. Its components include a stator that contains a permanent magnet, a rotor with a coil, a brush, and a commutator.

4. Results and Discussion

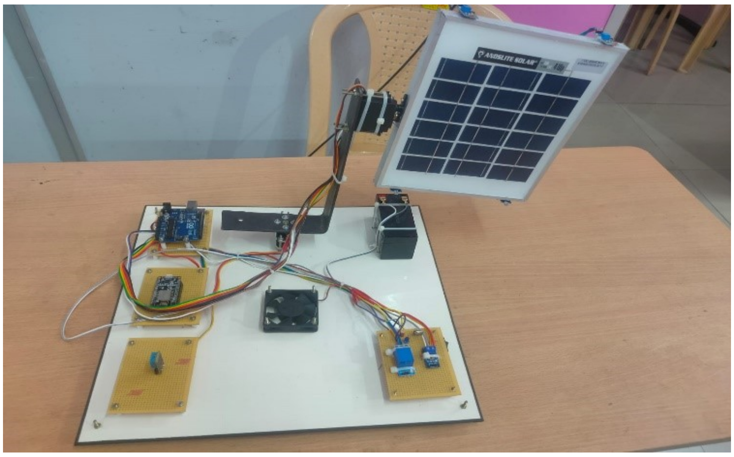

Figure 5: *Hardware Setup*

In the above arrangement, the prototype's components are powered by a battery that initially has 12V. The LDR (Light Detector Sensor) monitors the strength of solar rays coming from various directions and transmits that data to the ATmega328 microprocessor. The ATmega328 determines the direction of the sun rays with the greatest intensity and instructs the DC motor to shift the orientation of the solar batteries in accordance with that direction. The battery stores

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the electrical energy generated by the solar cells. Moreover, the configuration in Figure 5 includes voltage, temperature, and humidity sensors. These sensors measure temperature, atmospheric humidity, and the voltage that the panel produces. These sensors' output values are shown on the IOT server. Additionally, they are shown in digital mode on the LCD.

5 Conclusion

Renewable energy sources have shown to have reliable and are viewed as the best solution for supplying the world's expanding energy needs. An Arduino-based solar tracker employing LDR and a servo motor is demonstrated in this project. So as to optimise the solar panel's exposure to light and hence improve power efficiency, the Solar Panel Tracker is made to move with the sun. The design of a dual-axis solar tracking system. With this technique, the complete solar panel rotates once every day to face the sun, moving from east to west. The efficiency of energy generation is increased by the usage of solar tracker circuits. Voltage, current, temperature, and humidity can all be observed by a solar module. We developed a PV tracking system using an ESP8266 processor and an Arduino micro-controller with Wi-Fi capability. The system interfaces with a cloud platform and uploads data using the Blynk application.

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