International Journal of Advanced Trends in Engineering and Management (IJATEM)
Vol. 1(05), October 2022, pp. 1-8

Article Title: **IOT Based PV Monitoring System**

IOT Based PV Monitoring System

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ABSTRACT

Renewable energy sources are acknowledged as the best solution for the world's expanding energy needs because they have proven to be dependable. Solar photovoltaic energy, which emits no carbon emissions, is one of the most attractive and innovative sustainable technologies available today. It is important for both application and maintenance. The proposed solar energy monitoring system is built on the Internet of Things (IoT) and is intended to collect and evaluate solar energy data in order to forecast productivity and ensure steady renewable power. A system's main advantage is that it can pinpoint optimum efficiency for improved solar PV maintenance. The efficiency of remote energy yields should indeed be constantly shown on computers or mobile devices. This is one goal of a PV monitoring system.

Keywords: Internet of Things (IoT), solar photovoltaic energy, Blynk mobile application.

1 Introduction

A significant factor in many developing nations is power generation. Energy demand peaks as a result of the expansion of the industrial and commercial sectors. The raw data is collected, irrelevant values are filtered away and forecasts are produced using a simple forecasting database created using MySQL without the aid of any modern automated technologies. Furthermore, artificial intelligence methods are applied to predicting in order to achieve reliable performance [1]. With LABVIEW, a real-time monitoring and data collection method for solar PV modules is provided with the goal of evaluating the effectiveness of various solar PV ratings. This is an effective tool for investigating how various PV modules operate in relation to real-time data [2-3]. To track the various elements that influence the performance of PV panels, a microcontroller based displaying system is suggested [4]. A monitoring system for a solar plant is now easily made, doesn't cost much, and is necessary for the PV system's proper oversight and fault detection [5]. It is possible to track the location of the defect and do preventative maintenance [6]. For distant PV plants, a suggested and created IoT-based cloud monitoring solution uses the Raspberry Pi [7]. A vital characteristic of a PV system is studied utilizing the real-time measuring tool to investigate the problem diagnostics in PV plants.

LABVIEW [8]. To develop a smart monitoring system with solar trackers and achieve maximum efficiency, Lab view and a microcontroller are used [9]. To maximise the utilization of Solar PV for residential power management, a HEM algorithm-based smart controller is used to determine source prioritization [10].

The proposed study also establishes a real-time monitoring system for solar PV systems utilizing inexpensive smart devices that communicate with a cloud platforms offer massive storage capacity and quick data access. The organization of the paper is shown in the list below: The traditional work is described in Section II. Section III details the intended work as well as its completion. In Section IV, examples of the solar monitoring system's results are provided. An overview of the proposed work and its applicability is given in Section V.

2 Recent Works

Chao-Lin Kuo et al [2017] [11] have suggested a method for defect identification in PV energy conversion systems (PVECS) in micro distribution networks. To keep track of physical events involving adjustments in a PV array's circuitry, output power degradation which is based on an electrical evaluation tool is employed. Temperatures and sun radiation affect a PV array's power output. Calculating the difference in maximum output between the highest output power and the power detected by the metre requires the use of fractional order dynamical errors.

Younes Seyedi et al [2019] [12] provides a ground-breaking technique for the centralised detection of these anomalies based on time series analysis of the data produced by phasor measurement units. This method generates real/reactive power datasets that are time-aligned for a number of zones using a network controller. A measure of the spatiotemporal link between the DER events' average lifespan and uniqueness degree, are among the features that the network controller calculates.

Renata I. S. Pereira et al [2019] [13] suggested a monitoring decentralised photovoltaic (PV) plants and it was suggested that an IoT network with sensors and signal conditioning circuits be designed, developed, implemented, and validated. The method aims to lower the cost of commercialized data loggers and sensor modules, which need proprietary software for control and data storage. The primary goal of the concept is to evaluate the temperature of the PV module, providing information for efficiency analysis and defect detection in the event that the PV cells overheat. The monitoring of solar irradiance, relative air humidity, ambient temperature and wind speed provides additional information for examining the impact of climatic factors on the operation of the PV module.

Xinyang Zhou et al [2020] [14] suggested a multi-area gradient based approach to precisely and quickly solve the WLS problem. With no performance loss, the suggested approach effects similar and parallel computation state estimation issue. According to numerical findings on a 4,521 node test feeder, a suggested technique converges quickly and produces reliable estimates. This method outperforms conventional Gauss Newton method by a significant margin in distribution systems with a limited number of accurate measurements. The method's real-time application successfully tracks changing system parameters.

Jiecheng Zhao et al [2020] [15] have provided a three solutions to deal with these problems. To track the rapidly varying frequency in system dynamics, an improved zero-crossing method was first created. The second method we suggest can both suppress outliers and endure system transients. Third, a methodology was created to efficiently export high time-resolution frequency estimations. The results of the testing show that the suggested methods perform quite well. They can be incorporated into next PMUs and offer accurate data with high time resolution for smart grid applications.

3 Proposed Work Explanation

The proposed real-time monitoring system for solar energy is developed on a three-layer IOT architecture. Figure 1.1 depicts the architecture's three stages. The lowest layer includes sensors, actuators, controllers, and RFID as a combination of a processing and sensing layer as operating various devices. A next layer is the middle layer, which has a network layer with wired and wireless networks like ANN, Bluetooth, Zigbee, etc. Delivering the user interface and cloud platform from the application layer completes the process.

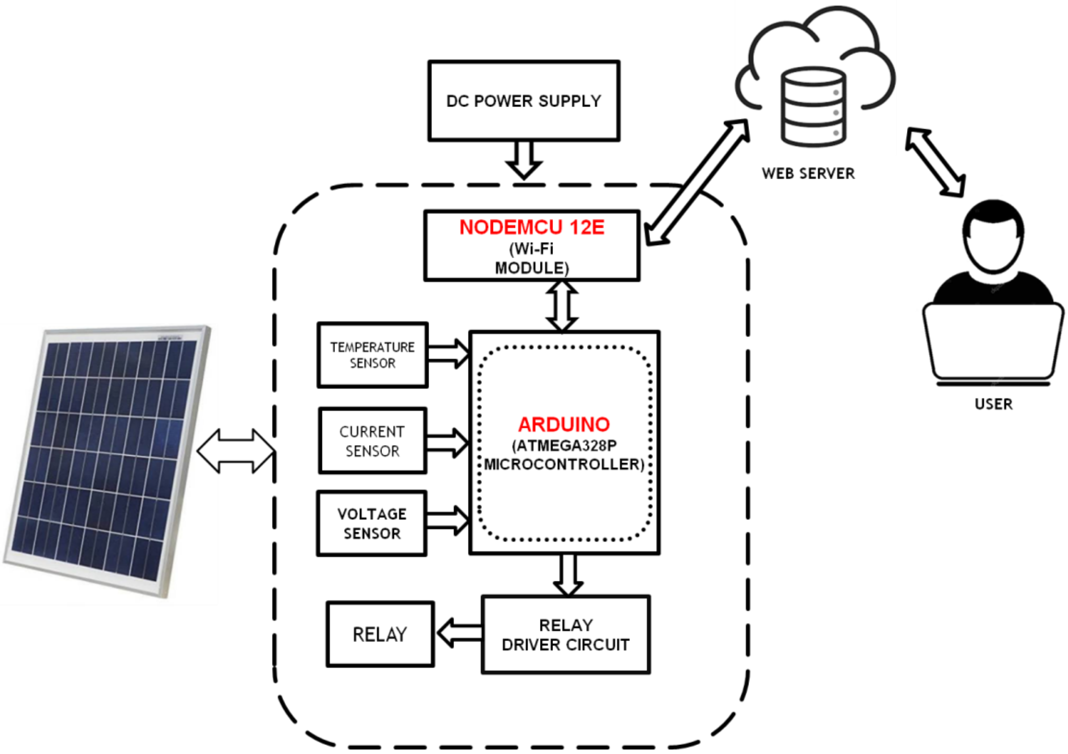

Figure 1: *Block diagram for proposed system*

International Journal of Advanced Trends in Engineering and Management (IJATEM)
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Figure 1.1 shows block diagram for this system which depicts the general layout of the work. A monitoring system is installed on a 125-watt solar panel made of polycrystalline silicon. The PV module's temperature, which is monitored by a temperature sensor, has a substantial impact on the solar panel's performance. The processing of measured data and its transmission to the cloud platform for real-time monitoring and decision-making via the Wi-Fi module are crucial functions of the microcontroller.

3.1 Lower Layer

Voltage, current and temperature sensors are the sensor components. A divider in the circuit of a voltage sensor uses series resistance to regulate the voltage drop. The resistance factor and reference voltage are used to compute the voltage. As seen in Figure 2, the voltage divider circuit. Measuring voltages by using this expression as follows

$$\text{Voltage} = (\text{Analog value} / \text{Resistance Factor}) * \text{Reference Voltage} \tag{1.1}$$

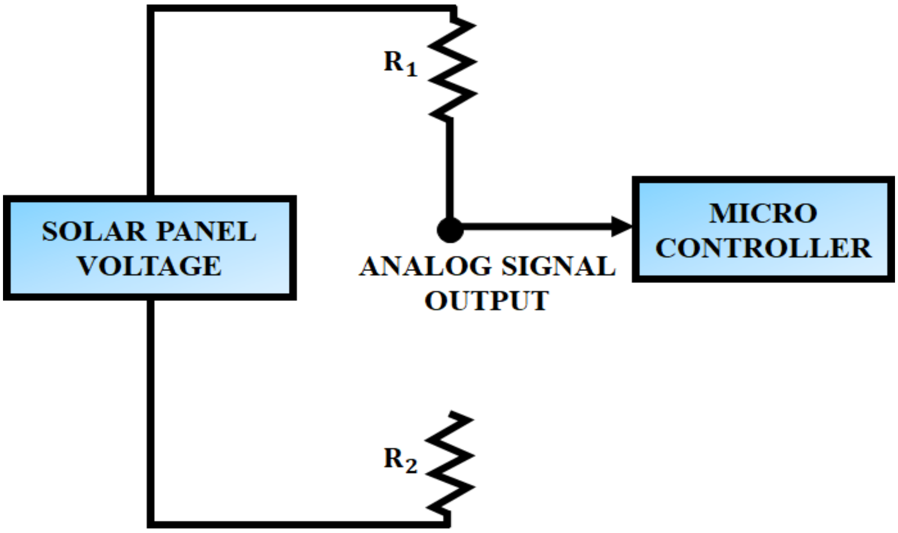

Figure 2: *Voltage divider circuit*

The ACS712 Hall Effect sensor, a current sensor that can detect up to 20 Amps, is utilized to detect solar PV panel current. In Figure 3, the current sensor module is displayed.

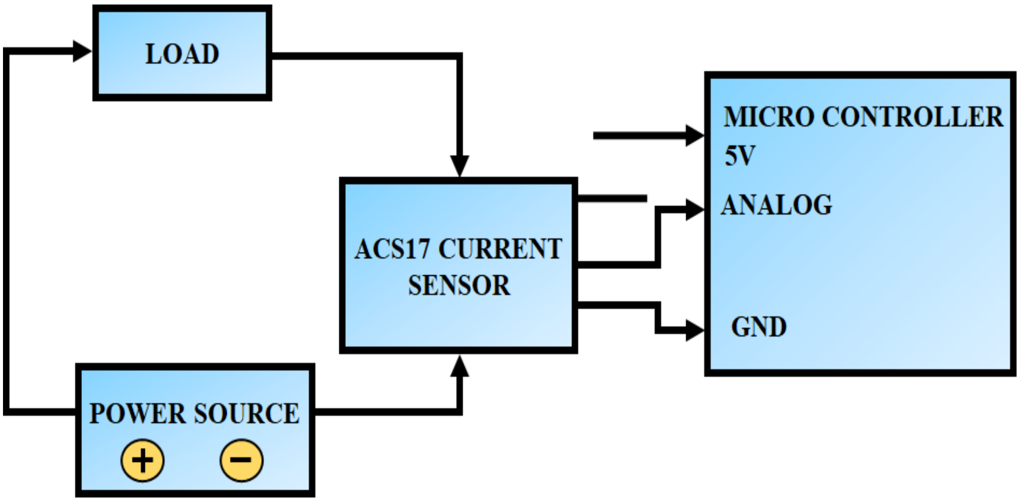

Figure 3: *Schematic layout of the current sensor*

Due to both direct and scattered solar radiation, the sun brightness of a planar surface can be measured with good precision using the CM21 pyrometer. Directional inaccuracy is reduced to less than 10 W/m2 by high-grade optical domes. For data acquisition systems, it has excellent sensitivity and offers low resistance to interference and noise. With a sensitivity range between 7 and 17 V/Wm-2, its maximal spectral range is 300-1200 nm. This gadget may be used in temperatures between -40 and +80 degrees Celsius. The output voltage and sensitivity of the pyrometer are typically used to calculate the global radiation. To determine the solar irradiance

E = Uemf / Sensitivity (1.2)

E = solar irradiance in W/m2 (1.3)

Uemf = output voltage of pyrometer in µV Sensitivity =Sensitivity of pyrometer in µV/W/m2

LM35 analogue sensor is used to gauge the solar panel's temperature. It is a small, inexpensive sensor that can measure temperatures in the environment between -50°C and +150°C. This IC's working voltage is 5 volts. For every degree that the temperature rises, there is an increase of 0.01 v. Voltage to temperature conversion is done using the formula

Temperature = Voltage / 10mV/°C (1.4)

3.2 Middle Layer

The Wi-Fi protocol is used by middle layer of the smart controller to process any sensed data before supplying it. This protocol acts as a bridge for communication with the higher end. In a manner similar to TCP/IP, the UDP communication protocol stipulates rules to guarantee secure data transmission at operating system level.

3.3 Upper Layer

By using proposed methods, a cloud-based mobile application Blynk is able to track solar PV performance in real-time. A user-friendly IoT application is available on the cloud platform

Blink, which is open source and free. We can create a safe, quick, scalable application with pre designed components to examine data virtually. For the deployment of virtually any number of devices online, it supports a wide range of hardware platforms and connectivity kinds. It offers a continuous solution for distant applications, saving money, time, and resources.

4 Results and Discussion

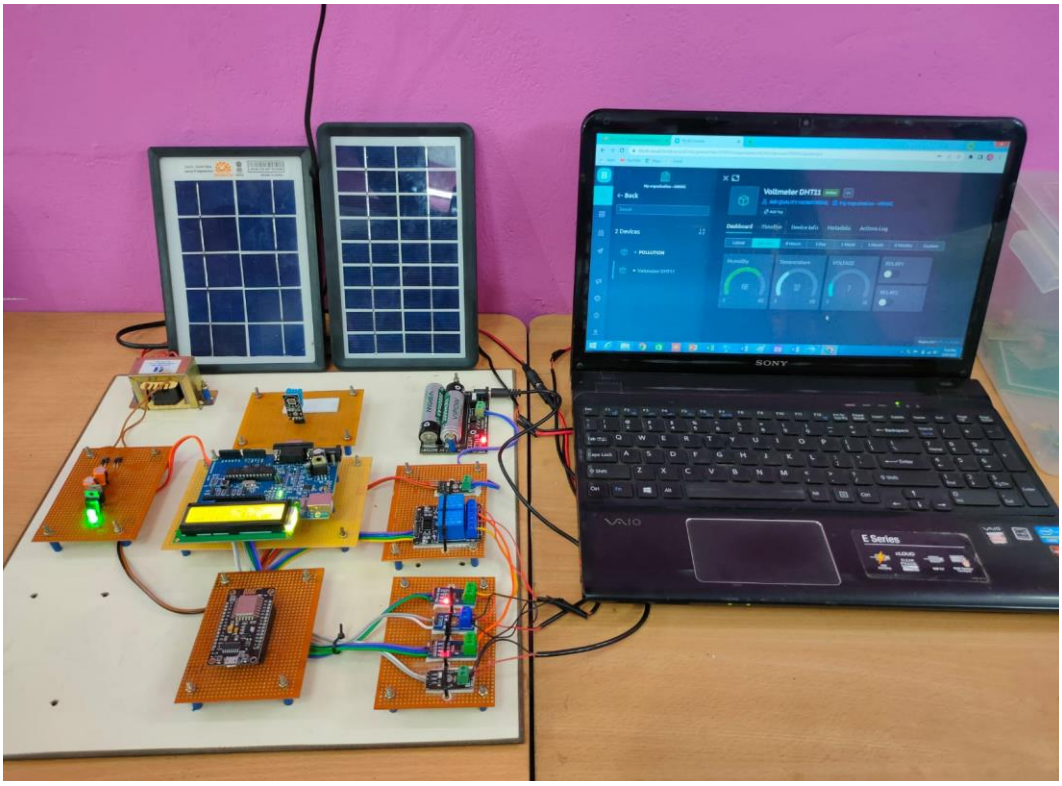

Figure 4: *Hardware Setup*

The programming function incorporates the blynk modules to facilitate communication and the uploading of sensed values to the cloud service. An application for smartphones effectively tracks and displays the electrical parameters. The technique used by Blynk to monitor solar PV in real time is presented in the result in Figure 1.4. According to the research, rising temperatures make PV systems produce less voltage, while increasing irradiance only slightly increases current. The typical working temperature of a solar panel is 30 °C. Generally a solar panel's performance is impacted by temperature levels above the norm. As a result of the environment, there are frequent high-low and low-high temperatures fluctuations during the period, as well as varying levels of solar radiation. As a result, the output demonstrates the solar panel's maximum power output, which is approximately comparable to the PV standard rating. Because temperatures and irradiance have an impact on the solar module's voltage, respectively. As a result, both temperature and irradiance are necessary for the solar panel to generate power. When an inverter or charge controllers that is connected to the grid needs 12 volts or more, series connected solar panels are typically employed. As a result, the mobile Blynk application, which is cloud-based, displays the detected solar component in real time.

5 Conclusion

Using a low cost smart microcontroller for the IoT, a detected solar parameter is displayed in real time using the cloud based Blynk mobile application. The measurements yield the best result, which is typically related to the solar module's electrical ratings as determined by standard test Conditions (STC). The suggested method aids in remote access estimation of solar PV module performance. This can be prolonged to include large scale solar plants so that they can take preventative action by routinely evaluating their performance. It will be very beneficial for commercial and industrial uses.

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