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MPPT CONTROLLED SOLAR POWER MONITORING SYSTEM USING IOT

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Abstract - When it comes to solar panels, the output power of the panels must be checked in order to achieve the best power production from the panels. This is why a real-time monitoring system is required. It may also be used in a big solar power plant to monitor the power output from each panel, which aids in the identification of dust accumulation. It also prevents any fault conditions from occurring during operation. We aim to create an IoT-based Solar Power Monitoring System in this project by adding the MPPT (Maximum Power Point Tracker)-based battery charging technology, which will assist to minimize charging time and boost efficiency. In addition, we will measure the panel temperature, output voltage, and current to optimize the circuit's safety. To top it all off, we will leverage the blynk cloud services to monitor the output data from anywhere.

Index Terms: solar power monitoring, renewable energy, IoT and cloud.

I. INTRODUCTION

The Internet of Things (IoT), one of the most important modern technologies, allows people to live better and more intelligently. An IoT device is a piece of hardware that allows machines to connect to the cloud. This technology allows connected devices on the available network to share data. The user may access data and manage devices from anywhere on the earth via the internet. It is a web-enabled ecosystem comprised of devices that transmit and receive data via CPUs, sensors, and other communication hardware. Several emerging nations rely largely on renewable power. As the commercial and industrial sectors advance, energy consumption peaks. As a result, we are all dependent on renewable energy sources in order to produce green energy to meet our energy demands. For the benefit of future generations, this can help society reduce greenhouse gas emissions and ozone depletion. Due to its wide availability, low cost, straightforward installation process, and minimal maintenance requirements, solar photovoltaic technology is becoming more and more popular. When connected via a communication protocol and a cloud platform, the Internet of Things (IoT) is an emerging technology that makes items smarter and more user-friendly. The efficiency of a solar panel is affected by basic elements such as current, voltage, irradiance, and temperature. As a result, a real-time solar monitoring system is essential. In recent years, there have been a number of attempts to investigate solar energy. The development of a low-cost IoT-based monitoring system for solar panels will allow for online viewing and performance enhancement. This assists in tracking the location of issues and preventative maintenance. An IoT-based cloud monitoring solution based on the Arduino and node MCu is recommended and constructed for remote PV facilities. The use of sun trackers is monitored intelligently using a microcontroller and Blynk app to maximize effectiveness.

This article describes an intelligent an intelligent solar power monitoring system based on the Internet of Things. The primary goal of this suggested project is to maximise the power production of the solar panels. Furthermore, if the solar panels are not operating properly, it will be shown, and characteristics such as voltage and current are monitored and presented using IoT technology. This paradigm is presented using solar radiation, in which sunlight from the sun is caught by solar panels, which subsequently catch sunlight and convert it into usable energy sources such as heat and electricity. After that, the generated electrical energy is monitored by sensors like voltage sensors, which use the voltage divider idea to sense the voltage made by the solar panel, and current is computed using mathematical calculations.

II. LITERATURE

There are two strategies for creating electricity: one employs renewable resources, and the other does not. Non-renewable sources include coal, natural gas, and other fossil fuels, whereas renewable sources include the sun, wind, and tidal energy, which can all be reused [3], [5], and [11]. As a result, solar energy is viewed as an indestructible power source. To solve the challenges associated with electricity scarcity, an Internet of Things (IoT)-based solar power monitoring system is being developed. Solar energy has gained popularity due to its availability and reduced cost in terms of conversion technology. Light energy is turned into electrical energy in this technique, which is known as the photovoltaic effect, and this is referred to as solar energy. Pollution will be decreased by utilizing solar electricity, and productivity will be increased by monitoring energy forecasting, homes, and communities [4], [2].

III. HARDWARE

This section provides a description of the model's intended layout and design. The next section provides an in-depth look at the model and all of its constituent parts.

Block diagram of proposed weather station

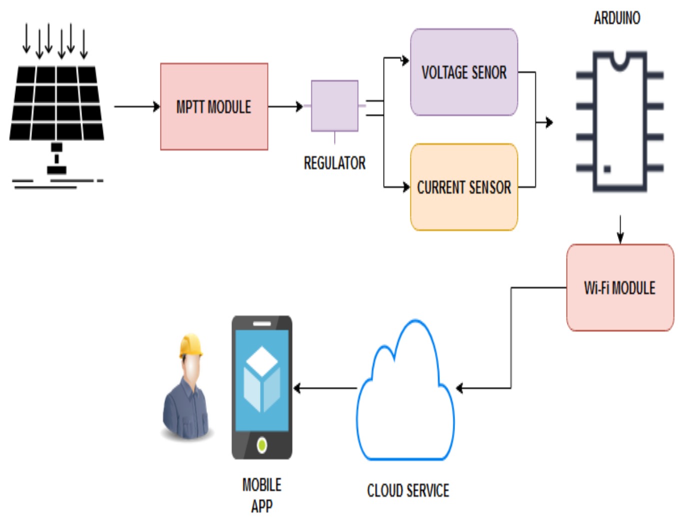

Fig.1. Block Diagram of solar monitoring system

A. Arduino UNO-328

Arduino, the organization, is responsible for developing the microcontroller that is housed on the board known as the Arduino Uno. The Atmega328 from AVR serves as the primary inspiration for this open-source microcontroller platform for electrical projects. The most up-to-date version of the Arduino Uno board features a USB connector, in addition to six analogue input pins and 14 digital I/O ports. These ports provide users the opportunity to connect the board to a variety of different electrical circuits. Out of a total of 14, PWM output may be obtained from six of the I/O ports. It enables the designers to handle and monitor in real time any electrical equipment that is situated in an external environment. This board has all of the components necessary to run the controller, and it can be immediately connected to a computer by means of a USB cable. In addition to this, it possesses all of the capabilities that are essential for the controller to operate properly. When transmitting code to the controller from the computer, the IDE software, which was built exclusively for the purpose of programming Arduino, is utilized. This software was developed specifically for the purpose of programming Arduino. Languages such as C and C++ are utilized in the development process to write the IDE's code. The circuit board may take its power not just from a USB port, but also from a battery or an AC-to-DC converter if any of those options are used. The version that is regarded as being the most official is the Arduino Uno. It has an Atmega328 8-bit AVR Atmel CPU and 32KB of RAM already installed in it.

B. Solar Panel

Fig.2. Solar panel

PV (Photovoltaic) panels, as illustrated in the figure, are used to convert the light energy from the sun. Solar panels are made up of several separate solar cells that are created by mixing layers of silicon, phosphorus, and boron. These panels collect photons from sunlight and combine them with electrons present in the panels to create energy, which may subsequently be utilized for a variety of applications.

C. MPTT Module

Fig3. MPTT module

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This solar charger for single-cell LiPo batteries complies with the maximum power point tracking (MPPT) standard. With the help of this MPPT solar charger, you can maximize the power generated by your solar panel or other photovoltaic equipment.

D. Voltage Sensor

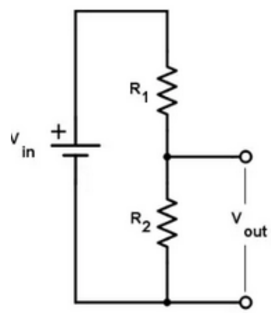


Fig4. Voltage divider circuit

When compared to measuring current, measuring voltage is much easier with any microcontroller. Whether working with batteries or building our own adjustable power source, measuring voltages becomes vital. Whilst this approach applies to any uC, we will learn how to measure voltage using Arduino in this article. A microprocessor cannot directly interpret analogue voltage. That's why we need an Analog to Digital Converter, or ADC for short. The Arduino Uno's brain, the Atmega328, features a 6-channel (A0 to A5), 10-bit ADC.This implies that it will translate input voltages ranging from 0 to 5V into integer values ranging from 0 to (210)-1, or 1023, with a precision of 4.9mV per unit.0 represents 0V, 1 represents 4.9mV, 2 represents 9.8mV, and so on to 1023.

E. Node MCU

Fig.5. Node MCU

An embedded WiFi module is a component of the Node MCU WiFi microcontroller unit. The arduino microcontroller serves as the board's base, and it includes an ESP8266 WiFi Module. The ESP8266 WiFi Module is a self-contained system-on-a-chip (SoC) that includes an integrated TCP/IP protocol stack and can connect to your WiFi network (or acting as an access point itself). One of the most essential characteristics of the Uno WiFi board is its support for over-the-air (OTA) programming. This might be used to send Arduino sketches or WiFi firmware.

F. Arduino IDE

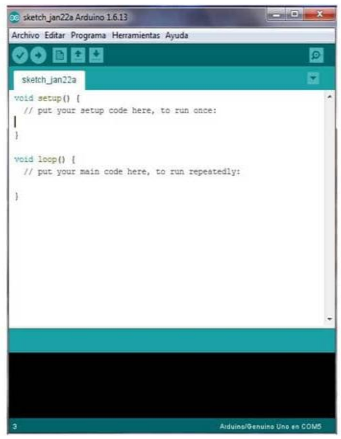


Fig.6. ARDUINO SOFTWARE

The Arduino Integrated Development Environment (IDE), sometimes known as the Arduino Software (IDE), has a code editor, a message area, a text terminal, a toolbar with basic action buttons, and a menu system. It connects with the Arduino hardware and uploads programmes to it.

G. Blynk cloud

Blynk is an Internet-of-Things platform for iOS or Android smartphones that allows users to remotely operate devices like Arduino, Raspberry Pi, and NodeMCU.With this programme, you may compile and provide the right address on the various widgets to construct a graphical interface or human machine interface (HMI).

IV. WORKING

The goal of the proposed project is to maximize the solar panels' power production. Also, any issues with the solar panels' performance will be indicated, and IoT technology is used to monitor and display characteristics like voltage and current using sensors. The solar radiation is used to illustrate this paradigm; specifically, how sunlight from the sun is caught by solar panels, which subsequently convert the sunlight into useful energy forms like heat and electricity. Then, using voltage divider concept, sensors such as voltage sensors sense the voltage created by the solar panel, and current is calculated using mathematical formulas, the acquired electrical energy is perceived. The below flow chart shows the work flow of proposed system.

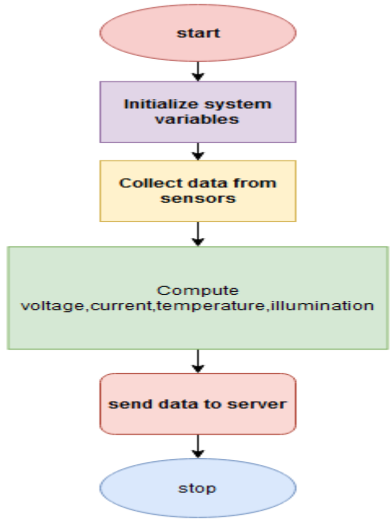


Fig.7. Proposed flow diagram

V. RESULTS

Here's an IoT-based solar power monitoring system where the data can be viewed remotely when connected to the internet through the IoT cloud app. Our project incorporates an Arduino UNO, WIFI module, MPTT module and temperature sensor, LDR. First, sensors were connected to the Arduino Uno and to Wi-Fi module. The sensors communicated data effectively.

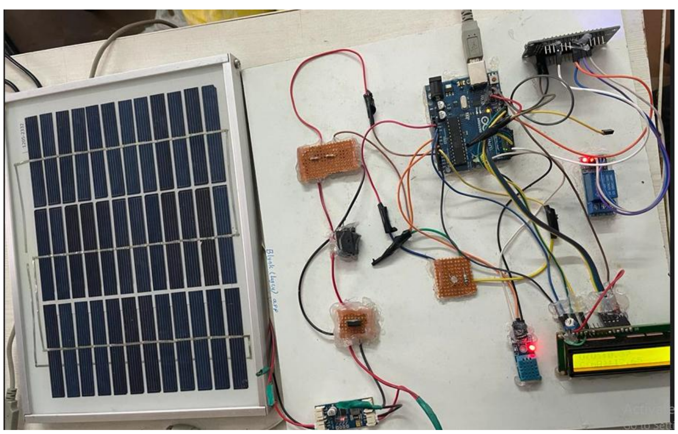


Fig. 8. Figure showing the proposed system

Fig.8. LCD showing monitored luminance and temperature.

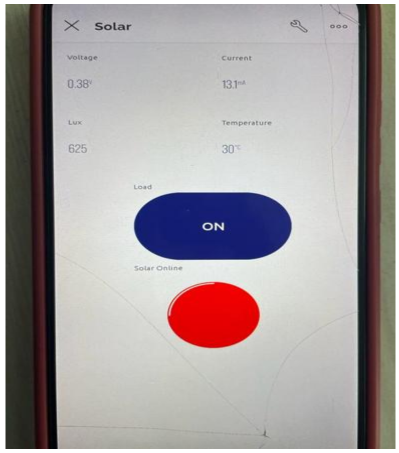
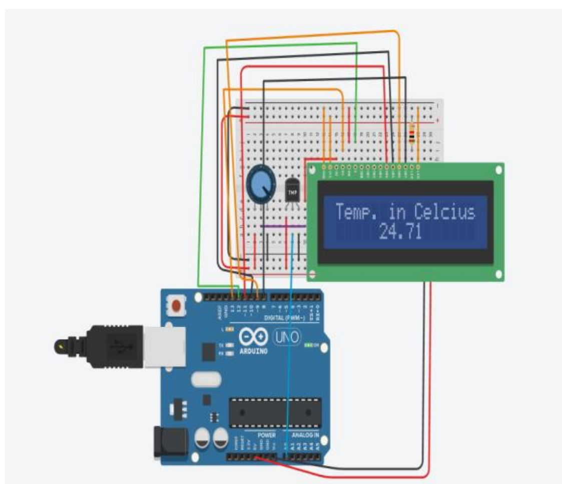


Fig.9.Mobile application showing received data via cloud.

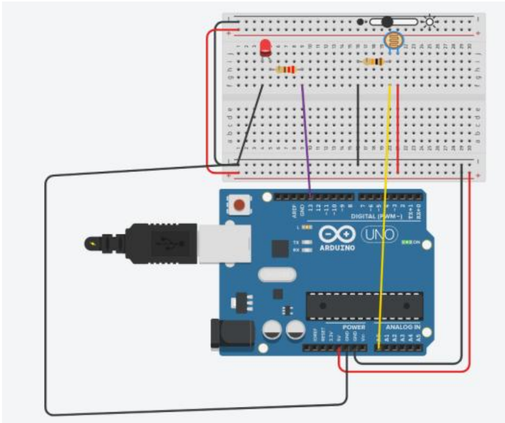
SIMULATION:

Temperature sensor:



Open Tinkercad and create a new circuit.
From the Components panel, search for "Arduino Uno" and drag it onto the workspace.
Search for "TMP36" (a common temperature sensor) and drag it onto the workspace.
Connect the TMP36 to the Arduino Uno as follows:
Connect the TMP36's VCC pin to the Arduino's 5V pin.
Connect the TMP36's GND pin to the Arduino's GND pin.
Connect the TMP36's OUT pin to the Arduino's analog pin A0.
Open the Code panel and select the "Arduino" tab.
Click the "Start Simulation" button to run the simulation.
Open the Serial Monitor by clicking the Serial Monitor button at the top right of the screen.
The Serial Monitor will display the temperature readings in Celsius.

LDR and LED:



Open TinkerCad and create a new circuit design.
From the Components panel, search for "Arduino UNO" and add it to the workspace.
Add an LDR (Light Dependent Resistor) to the workspace. You can find it in the Components panel under the "Sensors" category.
Add an LED (Light Emitting Diode) to the workspace. You can find it in the Components panel under the "LEDs" category.
Connect one end of the LDR to the 5V pin of the Arduino and the other end to the A0 pin of the Arduino.
Connect the positive leg of the LED to pin 13 of the Arduino and the negative leg to GND.
Add a 220-ohm resistor to the circuit by dragging it from the Components panel to the workspace.
Connect one end of the resistor to the negative leg of the LED and the other end to GND.
Connect the Arduino to your computer using a USB cable.
Open the Arduino IDE and write the code to control the LED based on the LDR's value. Here is a sample code:
Upload the code to the Arduino by clicking on the "Upload" button in the Arduino IDE.
Go back to TinkerCad and click on the "Start Simulation" button to run the simulation.

VI. CONCLUSION

A low-cost smart microcontroller is used to build a virtual solar energy monitoring system based on the Internet of Things (IoT). The cloud-based mobile Blynk application displays the measured solar parameter in real-time. The monitored parameters show the best result, which generally correlates to the electrical ratings of the solar module evaluated under Standard Test Conditions (STC). The proposed work aids in remote access prediction of solar PV module performance. This might be expanded to encompass large-scale solar facilities, allowing them to take preventative measures by routinely analyzing their performance. It will be extremely useful for commercial and industrial applications.

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