IoT Based Solar Power Monitoring System

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Abstract. Presently we are invading in a new period of modernisms i.e., Internet of Things (IoT). By using the IoT supervising solar energy can greatly enhance the performance, monitoring of the plant. It is a technique to keep track of the dust assembled on the solar panels to induce the maximum power for active utilization. The amount of output power of the solar panels depends on the radiation hit to the solar cell. All the panels are attached and the sensors are precisely connected to the central controller which supervise the panels and loads. Thus, user can view the current, voltage and sunlight.

1. Introduction

The Internet of Things (IoT) is one of the most important technologies of everyday life, which helps people live and smarter. An IoT is a device, which is used to enable the connection between machine and the cloud [9]. This technology helps to exchange the data between the connected devices on the available network [7]. Through the internet, the user can acquire the data and control the devices from any place all over the world [8], [10]. It is an ecosystem which consists of web enabled gadgets that use processors, sensors and other communication hardware devices to fetch and send the data. By using IoT we can set up machine to machine connection or device to device connection without human interference. It also utilizes computing facilities and software systems for information processing. The need for using IoT technology in this solar power monitoring system is as the range of sun's radiation is not fixed and may vary according to the location, time and climatic conditions, the solar panels which are exposed to the sun always need to be monitored. The solar panels can be monitored from any location by using IoT technology [1], [6].

In today's world, electricity is one of the most basic needs in everyone's life. We need electricity for heating, lighting, refrigeration, transportation systems and all the home appliances [2], [12]. Day by day the energy consumption is getting rapidly increased whereas the energy resources are decreasing in parallel. So, in order to balance the deficiency of electricity, various sources are used to generate electricity. There are two ways available for the generation of electricity one is by using renewable sources and the other one is by using non-renewable sources. Non-renewable sources are such as coal, natural gas, fossil fuels while the renewable sources can be utilized again and again such

as sun, wind energy, tidal energy [3], [5], [11]. Hence, solar power is said to be an imperishable power source. Therefore, to overcome the issues related to scarcity of electricity an IoT based solar power monitoring system is being proposed.

Solar power has become very trendy as it is available in abundance and solar power generation is also cheaper in the conversion technology. In this technology the light energy is converted into electrical energy which is known as photovoltaic effect and this is called solar energy. By using solar power, the pollution will be reduced and by monitoring it the energy forecasting, households and communities, the productivity can also be enlarged [4], [2]. By monitoring this system, we can know the status of it and also shows when there is a problem which is so helpful.

The proposed system describes an IoT based solar power monitoring system. In this system the sunlight is converted into electricity by solar cells which are present in solar panels. We use an Arduino. Current voltage parameters are measured by using sensors. The values of current and voltage are shown on the LCD display. An IoT device is also connected to the sensors through which the parameters are displayed on the display can be monitored from anywhere by using an available network.

2. Proposed System

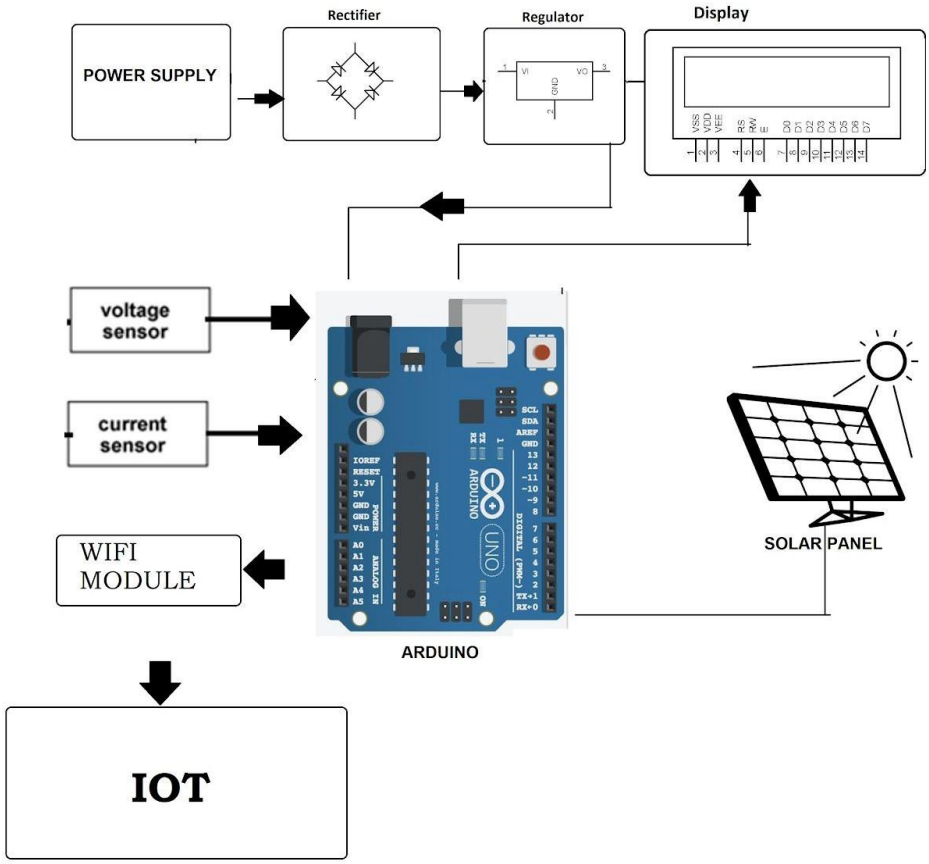


Figure 1. Block diagram of proposed System.

The main intention of this proposed project is to get maximum power output from the solar panels. Additionally, if there is any improper functioning of the solar panels will be shown and also the parameters like voltage and current are monitored by using the sensors and displayed by using the IoT technology. This model is explained by using the solar radiation i.e., sunlight from the sun is trapped by the solar panels and then these solar panels capture sunlight and turn into useful energy forms of energy such as heat and electricity. Then the obtained electrical energy is sensed by the sensors such as voltage sensor sense the voltage generated by the solar panel with the help of voltage

divider principle and current is obtained by using mathematical formulation. The designed structure of the proposed monitoring system is shown in figure 1. The experimental arrangement of the introduced system consists of solar panels, Regulator power supply, Wi-Fi module-ESP8266, Voltage sensor, Current sensor, LCD (Liquid Crystal Display) and Arduino Uno microcontroller. Programming codes are developed on Arduino IDE, Embedded C.

3. Hardware description

3.1. Arduino Uno

It is a microcontroller board which is built on ATmega328P microchip. The word Uno means 'one'. It consists of 14 digital input/output pins that can be associated with various types of other circuits and Arduino Uno also has 6 analog I/O pins that are supported by Arduino IDE (Integrated Development Environment), with the help of a USB cable. Apart from these Arduino Uno shown in figure 2 also consists of a Power Jack, a 16MHz crystal oscillator and a reset button. It operates at a voltage of 5v. It has all the features required to support the microcontroller.

Figure 2. Arduino UNO.

Figure 3. Solar Panels.

3.2. Solar Panels

Solar Panels are also called as PV (Photovoltaic) panels shown in figure 3 are used to convert the light energy from the sun. Solar panels are made up of many independent solar cells which are formed by combining the elements like silicon, phosphorus and boron layers. These panels absorb the photons from sunlight and collaborate with the electrons which are present in the panels and generate electricity which can then be used for various purposes.

3.3. Regulated Power Supply

It is an embedded circuit, shown in figure 4; it consists of a rectifier circuit that converts alternating current (AC) supply into direct current (DC). It supplies a stable voltage to a device which works with definite power supply. The output which is gained from the regulated power supply is always near DC but may be alternating or unidirectional. The other name for regulated DC power supply is linear power supply. This has various blocks like step down a transformer, rectifier, DC filter, and regulator.

Figure 4. Regulated Power Supply.

3.4. WI-FI Module

We are using WI-FI Module-ESP8266 in this system, which is shown in figure 5. This is a self-contained SoC microchip which consists of a TCP/IP protocol stack that permits access to any microcontroller to a Wi-Fi network. It has enough storage capability and on-board processing that allows it to interact with the other sensors and gadgets. This module requires an external logic level converter as it is not capable of 5V-3V logic shifting.

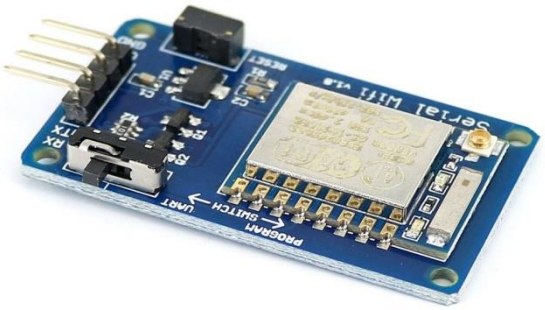


Figure 5. Wi-Fi Module.

3.5. Voltage Sensor

Voltage Sensor is a device which is capable of sensing or identifying the type of electrical or optical signals. The voltage sensor is shown in figure 6. This sensor is used to calculate the amount of voltage obtained in an object and also used to monitor it. It is primarily used to detect and measure AC or DC

voltage levels. Voltage itself is given as input to this sensor and the output may be switches, analog voltage signal, a current signal etc.

Figure 6. Voltage Sensor.

3.6. LCD Display

An LCD (Liquid Crystal Display) is an electronic display module which is commonly used in various devices and circuits to display the data. The LCD display used in this system is shown in figure 7. Generally, an LCD works by blocking the light. We are using a 16x2 LCD display in this system. A 16x2 display consists of 16 characters and 2 lines. LCD is a formation of both solid and liquid. It uses liquid crystals to produce a visible image on the screen.

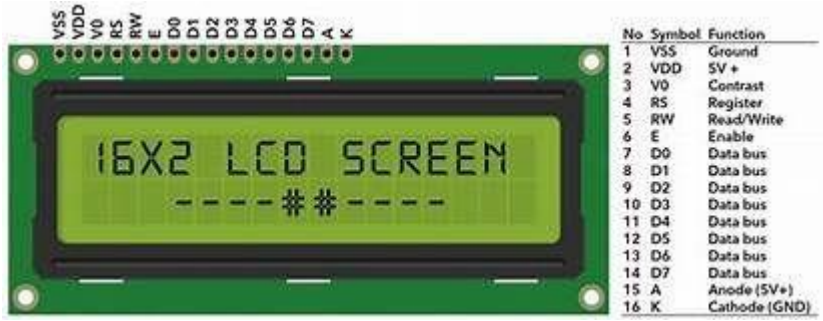
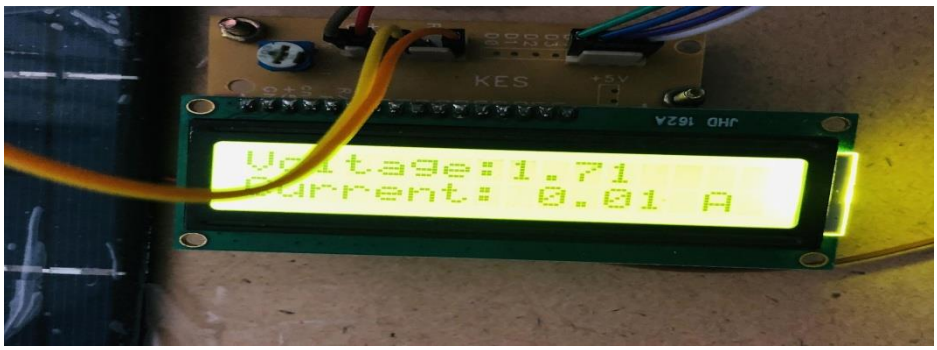


Figure 7. LCD Display.

4. Result

The working model of the proposed system is shown in figure 8. In this project an IoT based Solar power monitoring system is designed to obtain the maximum output power from the solar panels. After the conversion of light energy into electricity through solar panels, the current and voltage parameters are recorded using sensors. The amount of voltage and current received are shown on the LCD display with the help of IoT technology. As there is a Wi-Fi module connected to the sensors, we can view the readings in our mobile device by connecting to the Wi-Fi network. Whenever the readings or data changes it is automatically updated in our mobile. By using IoT technology we can monitor the working of solar panels and there may be a chance to detect the problem when anything goes wrong.



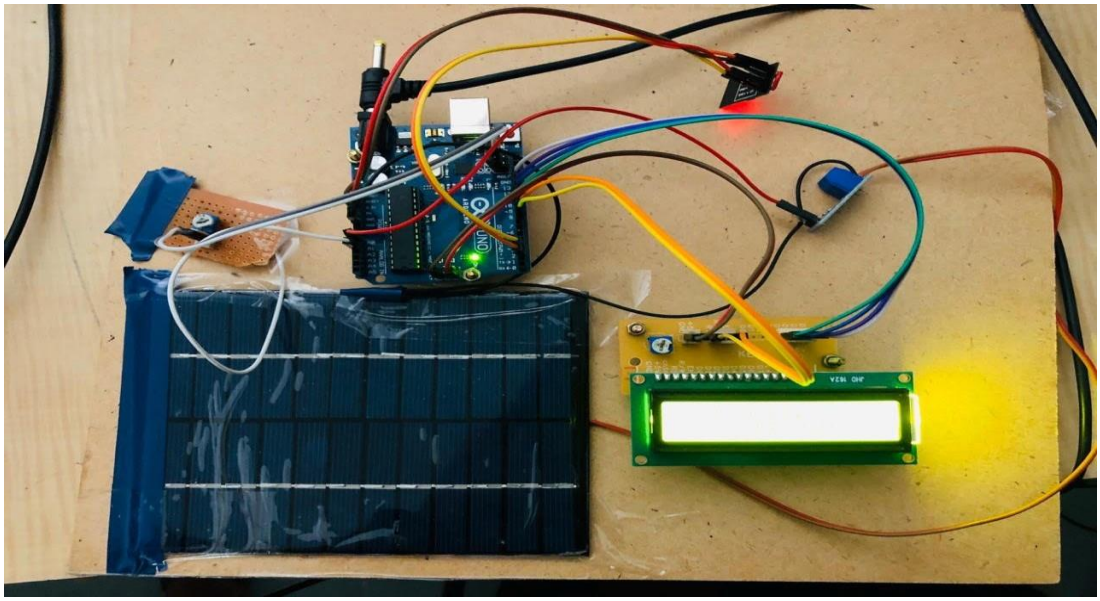


Figure 8. Demonstration of the proposed System.

5. Conclusion

The proposed system stores the voltage and current parameters and keeps updating the new values. By tracking the solar photovoltaic system continuously, the daily or monthly analysis also becomes simple and easy. It is also possible to detect any errors occurring in the system if there is any uncertainty in the generated data by tracking the solar panels that are operated at the maximum capability.

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