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A Study of Solar Power Monitoring System Using Internet of Things (IOT)

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Abstract:- Renewable energy sources are a practical solution for addressing the ongoing supply gap in the power industry. Because of the availability of solar energy throughout the world, unlike other geographically restricted resources, solar energy is most beneficial of all renewable energy resources. Sophisticated frameworks for remote monitoring of the plant using web-based interface is required for this massive scale of solar system deployment. Since the greater part of them are set in areas that are inaccessible and therefore monitoring them is not possible from a specific location. Internet of Things (IoT) enables the objects to be detected and remotely controlled by an established infrastructure of a network, creating possibilities for the pure physical-environment integration into frameworks that are based on computers. Application of IoT is proving beneficial for monitoring renewable energy generation. This application of IoT uses system based on Arduino to monitor parameters of the solar panel. The solar panel is monitored by the system continuously and the power output is transmitted over the internet to the IoT Network. It now uses an effective Interface to display these solar panel parameters to the user and it also alerts user when the outcome falls underneath the cut-off points specified. This makes, distantly monitoring of solar power plants more convenient and the best output of power is guaranteed.

Keywords:- *Internet of Things (IOT), Power Output, Renewable Energy, Solar Energy, Solar Panel*

I. INTRODUCTION

Electricity is the most essential needs in the lives of everyone in this modern world. The energy consumption graph is rising from day to day, while energy resources are diminishing in parallel. For the generation of electricity, many number of sources are used to balance the lack of electricity. There are two prime sources to generate electricity: one is the conventional sources of energy and the another one is non-conventional sources of energy. Several carriers of the energy like nuclear fuels and fossil fuels too are utilized, yet they are not the renewable resources and these are said to be the non-conventional resources. In it's broadest sense, solar power source plays a vital role in achieving the sustainable power source. Sun's rays serves as a significant source for the electricity generation by converting it into electric power and this application is conventional, which is known as the Solar Thermal Energy.

Despite the fact that different sustainable sources, for example, wind, tides, geothermal, rain, etc., are available solar power has enormous benefits.

In comparison to other resources that have geographical limitations, solar photovoltaic among all renewable energy sources, the availability of solar energy across the country proves to be the most beneficial and it will also have minimal effect on the environment. The solar energy that the earth receives is, 430 Quintillion Joules per hour, which is all that could possibly be needed to supply power to the entire world for a year. However, the issue here is, it is difficult to use this amount of energy effectively. Now-a-days the solar panels are installed everywhere but they are not monitored, by doing this, we don't know the amount that they produce and also the solar panels work at its most extreme effectiveness for an hour or for 2 hours, however, by using IoT, the monitoring and control of the solar panel will solve these problems. For ideal power yield, solar power plants should be monitored. This assists in retrieving effective output of power from the power plants while monitoring for defective panels, connections and the dust collected on the panels, bringing down the output and other such issues affecting the solar performance.

The Internet of Things (IoT) is a cutting edge innovation by which an object could be detected, observed and controlled distantly using the Cloud Server Network. By using this IoT technology machines can communicate without the requirement of humans.

An IoT based solar power monitoring framework monitors the parameters of thepanel, such as voltage, current and power, displayedover a web-server by using the internet, Now, the solar panel uses LDR to detect sunlight, with the goal that it can get positioned where it gets most extreme sunlight, because of this solar panel can work at its greatest productivity the entire day.

A. Abbreviations and Acronyms

IOT-Internet of Things
LCD-Liquid Crystal Display
LDR-Light Dependent Resistor

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II. HARDWARE REQUIREMENTS

A. Arduino Uno

The Arduino Uno is an open-source microcontroller board, which is based on the ATmega328 (datasheet). Arduino Uno has 16MHz crystal oscillator, 6 analog inputs, a USB connection, an ICSP header, a power jack, 14 digital input or output pins and a reset button. It comprises of all which is needed to aid the microcontroller; power it with a battery or AC-to-DC adapter or just associate it to a PC with a USB link to get started. It is powered for its operations by a 5-volt dc supply. High functionality with familiarity and simplicity is the purpose of the Arduino UNO. It serves as a link between the solar panel and the Internet of Things (IoT).

Fig.1 Arduino Uno

B. Wi-Fi Module ESP8266

The ESP8266 is a Wi-Fi microchip, built by Espressif systems with a complete TCP/IP protocol stack and MCU (Micro Controller Unit) capability. It is inexpensive. This is mainly used for the IOT embedded applications development. ESP8266 is used to interface the cloud server with the microcontroller. Arduino's measured data is processed by the ESP8266 module for data storage in the IOT or Cloud.

Fig.2 Wi-Fi Module ESP8266

C. Liquid Crystal Display (LCD)

The LCD screen is a flat panel electronic display technology, commonly used in various devices and circuits. LCD is a basic (16x2) display, that is, it can display 16 characters per line and there are 2 such lines. 16x2 LCD display will have a black text on Green background. The LCD is used to view the different parameter values sensed by the sensors, such as the voltage, current and power of the solar grid. Over any other multi segment LEDs, these modules are mostly preferred because, LCDs are cost-effective; can be programmed easily; there is no constraint on displaying custom characters (unlike in seven segments) and special characters, etc.

Fig.3 Liquid Crystal Display (LCD)

D. DC Motor

Generally, motors are composed of a permanent magnetic field stator and a rotor and are used to convert the electrical signal into mechanical rotation. By using either permanent magnets or electromagnetic windings, the magnetic field is maintained. DC motors are of many types and sizes, which also includes brushless, gear, and servo motor types. The main applications for these motors are variable speed and torque. Here, a dc servomotor (10 rpm) is used, which are also called as control motors. It operates on the basis of the concept of PWM (Pulse Width Modulation), meaning that the duration of pulses applied to the specific control pin controls the angle of rotation of the motor. With the help of a resistor, for the rotation of solar panel, the gears that are required are connected to the motor.

Fig.4 DC Motor

E. Power Supply Unit

A step-down transformer(230/15V), a filter, a rectifier and a voltage regulator are part of the unit. The transformer remains associated with the AC supply and it steps down the voltage from 230V to 15V, at that point the rectifier changes over the AC into DC, the filter circuit consists of a bypass capacitor which eliminates the ripples that are not required in the DC voltage. Now, voltage regulator is used to maintain the voltage given to the Arduino between +12 to-12.

F. Relay

Relay is an electrically operated switch, which controls the equipment with the help of electric signals. Controller generates the 3 digital signals based on the signals provided to the Arduino by the 3 LDRs and now, it directs only the largest digital signal to the relay. Now, the relay serves as a dc motor driver circuit, it drives the dc motor to the position where the light intensity is maximum.

Fig.5 Relay

G. Light Dependent Resistor (LDR)

A light-dependent resistor (LDR), also called as photo-resistor is a variable resistor which will be controlled by light. The fundamental working principle of an LDR is photo conductivity. The photo-resistor functions as a variable resistor, and the resistance value of the LDR varies depending on the intensity of light. So, we are connecting this LDR by providing constant voltage through Arduino pins to understand the level of light intensity at the solar power plant.

Fig.6 Light Dependent Resistor (LDR)

H. Solar Panel

The solar panel, otherwise called as photovoltaic module is a device which is utilized to transfer the solar energy into electrical energy by absorbing the sunlight. A solar panel is made of multiple cells, and multiple panels that are wired together forms a solar array; the greater number of panels we can deploy, the more will be the power generated. Silicon like semiconductor material is used to make the PV photovoltaic solar panels. Solar panels generate Direct Current.

Fig.7 Solar Panel

III. SOFTWARE REQUIREMENTS

A. ThingsSpeak Cloud Setup

ThingsSpeak is an open-source IOT platform application, which offers different services, that are only focused on building IOT applications. It is an API that stores and retrieves the information from the sensor or the objects/things associated with the system through the internet that utilizes Hypertext Transfer Protocol (HTTP) from the local network to the cloud. All the information logs that are received from the sensors will get updated by ThingsSpeak cloud platform application, tracking the location applications, and the status application providing to the clients(users) and taken from the clients. To use the ThingsSpeak application, the client needs to create an account which contains various channels aimed at observing the various parameters in the framework or in monitoring the parameters in a remote device. This cloud allows the administrator(user) to envision the information in graphical representation. Energy yield information is transferred to a router with internet-based monitoring, making it accessible through the online interface. Your solar panel output information can be accessed from anywhere you can get an internet connection, which is the primary benefit of frameworks like these.

Fig.8 ThingsSpeak Cloud Setup

B. Arduino Integrated Development Environment (IDE)

Arduino IDE is the open-source development platform compatible for Mac OS X, windows and Linux (both 32 and 64bits) operating system. This software is mainly used for editing, compiling and uploading the code into the Arduino device. Both C and C++ programming languages are supported in this environment. It is easy to install. You can easily add libraries according to the hardware module. And also, software update will be available from time to time.

IV. WORKING PROCESS

For the current status of the solar panel to be sensed, the sensors are used, that is the current is sensed, using the current sensor. The solar panel is rotated by the DC Motor, using the DC Servo Motor relying on the LDR, with the goal that the panel gets the maximum sunlight at every moment. To the motor, relay serves as the driver. To the sensor, LDR and the relay, the controller is wired. LDR and the analog signal from the sensor acts as controller's input and the relay is supplied with the output signal, on the basis of the input from LDR and parameters of the solar panel like power and voltage generated which are calculated from the sensor's current signal are displayed on the LCD.

An interface is shared across the controller and the cloud server utilizing the Wi-Fi module, subsequently the panel parameters like voltage, current and power generated are transferred to the server. Along these lines, the ongoing status of the panel can be viewed remotely. It can be compared and analysed, as the parameters of the panel are stored in the server every hour and every day.

Data from the different solar panels is integrated by Internet of Things platform and applies analytics to share the most significant data with applications made to address specific requirements.

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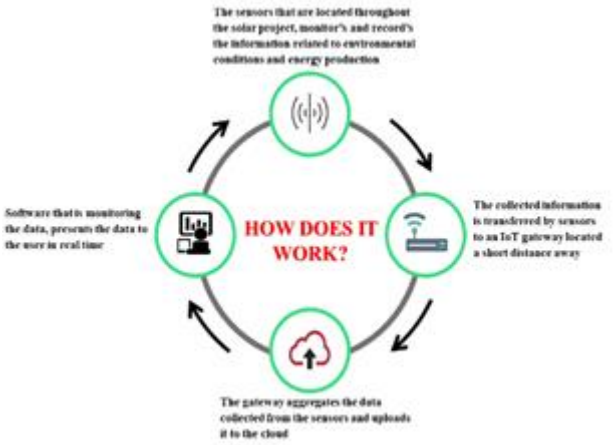

Fig.9 Working Process of Solar power Monitoring Using IoT

Powerful IoT platforms like Things speak, Microsoft Azure and Google cloud platforms, etc., can distinguish precisely what data is valuable and what can be securely disregarded. This information can be utilized to make recommendations, detect faults, and recognize potential issues before they happen. Data collected by the associated sensors enables to make smart decisions based on real-time information, which helps in saving money and also time.

V. CONCLUSION

Internet of Things (IoT) driven framework is aimed at getting an ideal power output from the solar panels, in this project. The different solar panel parameters like voltage, current and temperature are displayed on the LCD by using this IOT technology. The daily, weekly and monthly analysis becomes simple and efficient, as this system keeps continues track of the solar power plant. With the help of this analysis, it is possible to identify any issue occurred within power plant as there would be discrepancy in the information produced by the framework. Solar panel is worked at its maximum efficiency the entire day, by the solar tracking.

VI. FUTURE SCOPE OF WORK

The controller needs an external source to work, however, by means of the power generated by the solar module itself, the controller's input supply of the power can be met. Dual axis solar panel tracking can be done, for very large solar panel. It is possible to foresee the future predictions of parameters, by analysing the information. Using various machine learning algorithms, Artificial intelligence this can be implemented, so that the system can turn out to be smart enough to take decisions about information and performance.

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