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A LOW- COST MONITORING SYSTEM FOR PHOTOVOLTAIC SYSTEM USING IOT TECHNIQUE

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ABSTRACT

The main aim of this paper is to design a low-cost monitoring system for the maximum power point tracking in photovoltaic (PV) systems. The designed monitoring board consists of an embedded board (Arduino Uno based upon Atmega328), current and voltage sensors, and temperature sensor to send the temperature level, current and voltage of the photovoltaic system and to transmit the monitored data on the internet. In addition, the monitored real time data will be sending to the concerned person's mobile app through IOT. Based on the monitored data the users can check easily if the system works well or not. This paper is to develop a wireless remote monitoring system for solar photovoltaic (PV) plant. It is an Internet of Things (IOT) application implemented with an objective to offer a cost effective solution of monitoring system, which continuously presents remote energy yields and its performance monitored on a handheld gadgets such as smart phones. The main objective of this paper is to get an optimum power output from the solar panels during dust is accumulated on it. A solar panel is used that keeps monitoring the sunlight. Here different parameters like voltage, current and temperature are monitored using IOT technology. The complete operation of the dual axis tracking system wholly depends on the light dependent resistor (L.D.R) which is used as a sensor whose resistance decreases with increasing light intensity.

INTRODUCTION

Now, these days every human being needs electrical power for their quality of life. The consumption of power is increasing everyday lives, and at the same time, other energy sources are depreciating day by day. Therefore, to meet the demand for power, other sources of power is required. For the Generation of Electricity, there can be two ways first one is from Non-Renewable Sources, and another one is Renewable Sources. Nonrenewable sources are not regenerated by nature after first use such Fossil Fuels, Coal, Natural Gas, Nuclear Fuel while Renewable Sources can be utilized again and again which is not depreciating never such as sun, Geothermal, Wind Energy and Tidal Energy. Solar power is, therefore, is said to be a sustainable power source. Solar energy is clean, abundant and an easily harnessed form of energy. Solar energy, although unreliable, is becoming more and more popular with advancement in

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technology and decreasing cost. With modern monitoring and control systems, these are becoming increasingly reliable sources of energy and in some years, might even replace conventional sources completely. The Internet of Things (IoT) is a system relate the mechanical, computing devices, digital machines and objects that are provided with unique identifiers and also the potential to transmit data over a network without human interventions. The benefits are multi-fold: accuracy and efficiency improvement, reduction of human intervention, reduction of costs. The IoT can create opportunities for to new business models, enables the development of smart homes, smart grid, smart cities, and can find use in all industries, including the health care industry. Solar energy (photovoltaic) is gaining more and more importance for electricity supply around the world. Actually photovoltaics (PV) is the fastest growing renewable technology, by the end of 2017 the cumulative capacity installation of PV worldwide is about 403GWp. So there is a growing need for supervising and monitoring in real time the produced powers by PV plants. Solar Photovoltaics (PV) has emerged as one of the most promising renewable energy technologies in past few decades because of its several advantages; such as: modular nature, continuous cost reductions, efficiency improvements, no moving parts, low maintenance, inexpensive installation etc. In many parts of the world, the cost of solar PV based electricity is already equal to or lower than the electricity generated through conventional fossil fuel-based power plants. PV is also promising technology for providing cost effective electricity access to large amount of population that has either no access to conventional grid or has unreliable grid electricity.

Solar power has become more popular in the world as it is available in plenty amount with minimal impact on the environment. Though, the solar power generation becomes cheaper with advances in the conversion technology. Power generated from Solar PV installations is susceptible to changes due to changes in solar irradiance, temperature, weather conditions and many other factors. Monitoring of such installations is hence essential. IOT based wireless system is chosen in order to avoid hazards associated with wired systems, while keeping in mind the needs of near future, where every device will be smart, automated and connected via internet. To make the solar system accessible the monitoring at the customer level is the need of present. More suitable sources of energy and in few upcoming years, may overcome non- renewable energy sources completely. This system is capable of measuring voltage and current output, ambient temperature, comparing the data with previous databases and reference values and raising an alarm via a message in case of an anomaly, and sending the data over to a website which can be accessed via internet anywhere.

LITERATURE SURVEY

Sweta Priyadarshi, Sonali Bhaduri and Narendra Shiradkar2 propose a concept **"IoT Based, Inexpensive System for Large Scale, Wireless, Remote Temperature Monitoring of Photovoltaic Modules", 2018.** Large amount of high quality module temperature data in various

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end use environments is necessary for data-driven development of accelerated tests and standards for modules in hot climates such as IEC 63126. An Internet of Things (IoT) based, inexpensive system for large scale, wireless, remote monitoring of PV module temperature/hotspots is described in this paper. The proposed solution employs a temperature sensor that has an IC encapsulated in stainless steel enclosure to make it corrosion resistant, waterproof, more reliable and robust for extreme weather conditions. It is a digital thermometer that provides 9-bit to 12-bit Celsius temperature measurements and it communicates over a 1- Wire bus that by definition requires only one data line for communication with a central microcontroller. Each sensing devices has been provided with a unique 64- bit hex address which make it possible to short the data line wires of several such devices and connect them to a single data pin of the microcontroller ensuring multiple sensors to function on the same 1-Wire bus. The system employs a battery-free design and is capable of handling operating temperatures as high as 100oC, thus making it capable to record temperature data even of modules deployed in rooftop systems in hot climates. The inexpensive nature of this system and ease of retrofitting in existing PV systems would make it possible to generate large amount of module temperature datasets in various end use environments in near future.

N. Rouibah1.2, L. Barazane1 , A. Mellit2,3, and B. Hajji4 , A. Rabhi5
describe an idea **"A low-cost monitoring system for maximum power point of a photovoltaic system using IoT technique", 2019.** Integrating the Internet of Things (IoT) technology in solar photovoltaic (PV) systems is considered as an important aspect for monitoring, supervising and performances evaluation. The main aim of this work is to design a low-cost monitoring system for the maximum power point tracking (MPPT) in a PV system. Two electronics board have been developed: a data acquisition sensing and a DC-DC boost converter. The designed monitoring board consists of an embedded board (Arduino Mega 2560 based upon ATmega2560), current and voltage sensors, voltage regulator Mini BEC, LCD Display, and a WiFi module ESP8266 to transmit the monitored data (IPV, VPV, VL, IL and D) on the internet. In addition, a website has been also designed to store and display the monitored data in real time. The designed prototype has been verified experimentally at Renewable Energy Laboratory (REL) of Jijel University, Algeria. Based on the monitored data the users can check easily if the system works well or not by just comparing the measured output power with the one expected by a model.
Liu Bin1 Che Yanbo1 Zhao Lihua develop a concept **"The Design of Photovoltaic Monitoring System"2017,** In this paper, the photovoltaic monitoring system is designed as principle of environmental protection, energy conservation and stability. It provides general calculation of all parameters of the solar energy monitoring system and selects parameters for the photovoltaic cells and controller. The results of different algorithms are compared to make the maximum efficiency of the system. Taking Tianjin area as an example, the parameters of photovoltaic cells, the battery, the controller and other important devices are selected for the system. The result shows that when the monitoring equipment is out of grid, solar energy will be

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used to effectively monitor the target. In this paper, it provides general calculation of all parameters of the solar energy monitoring system and selects parameters for the photovoltaic cells and controller. Taking Tianjin area as an example, the parameters of photovoltaic cells, the battery, the controller and other important devices are selected for the system. However, solar modules and batteries are affected by temperature, humidity and equipment points, it is priority for the use of solar power when environmental considerations in the paper.

Ankit Kekre propose an idea **"Solar Photovoltaic Remote Monitoring System Using IOT",2017** —As technology is advancing, cost of renewable energy equipments is decreasing which has resulted in a massive increase in solar photovoltaic installations. Most of these installations act as auxiliary power source. A majority of these are installed in inaccessible locations – as close as a rooftop to as far away as a dessert. Hence they require sophisticated systems for remote monitoring of these installations using wide area networks. In this paper we will discuss a low cost IOT based embedded Solar PV Monitoring system which will make use of GPRS module and a low cost microcontroller to send the data measured at the production end on the internet, which can then be accessed anywhere on the globe. This will provide us real time information of the installation which will help us in its maintenance, fault detection and will give us a record of all the data at fixed intervals. To cope up with rapidly changing technology, IOT is the best solution for monitoring of solar installations. IOT based remote monitoring of the Solar PV installation will also save energy [14] and man-labour. Because of the use of IOT in this proposed system, there is a large scope for future work. can add modern devices and sensors without the fear of compatibility. Flexibility of this system is its uniqueness. Adding more sensors, it can measure AC voltage and current output, power consumption of load, solar irradiance and corresponding output of the solar panels and a lot more.

A.MEZOUARI, K. MATEUR, M. ALAREQI, L. HLOU propose a
concept "Development of an integrated data-acquisition system for Photovoltaic blocks mutualization monitoring using labview", 2017**.** The photovoltaic blocks mutualization (PVBM) is a system for recovering and using the excess of photovoltaic power produced from homes or consumers. This system is based on the Automatic control of interconnections of different photovoltaic blocks. In this paper, the development of a computer- based system for PVBM system monitoring is described. The proposed system is used to oversight the switching matrix and control the allocation of each photovoltaic block. The purpose of this work is to implement into a FPGA Xilinx circuit, an algorithm for PVBM system integrated with UART (Universal Asynchronous Receiver Transmitter) serial communication protocol for monitoring the system. The LABVIEW program is used to further process and display collected data in the PC screen. The proposed architecture permits the rapid system development and has the advantage of flexibility in the case of changes, while it can be easily extended for controlling the PVBM system operation for any number of homes and PV blocks. In this paper, the development of an integrated dataacquisition system for the photovoltaic blocks mutualization monitoring is described. The proposed system is based on the implementation into a FPGA Xilinx circuit an UART serial communication protocol using VHDL, for monitoring the PVBM system. The

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LABVIEW program is used to further process and display collected data in the PC screen. The design is successfully tested using an experimental set up. The results are stable and reliable and show the correct functionality. This circuit can be also used in many data acquisition applications for digital processing.

EXISTING METHOD

Large amount of high quality module temperature data in various end use environments is necessary for data-driven development of accelerated tests and standards for modules in hot climates such as IEC 63126. A GSM based, inexpensive system for large scale, wireless, remote monitoring of PV module temperature/hotspots is described in this paper. Integrating the GSM technology in solar photovoltaic (PV) systems is considered as an important aspect for monitoring, supervising and performances evaluation. The main aim of this work is to design a low-cost monitoring system for the maximum power point tracking (MPPT) in a PV system. Two electronics board have been developed: a data acquisition sensing and a DC-DC boost converter. The designed monitoring board consists of an embedded board (Arduino Mega 2560 based upon ATmega2560), current and voltage sensors, voltage regulator Mini BEC, LCD Display, transmit the monitored data (IPV, VPV, VL, IL and D) on the internet. The designed prototype has been verified experimentally at Renewable Energy Laboratory (REL) of Jijel University, Algeria. Based on the monitored data the users can check easily if the system works well or not by just comparing the measured output power with the one expected by a model. The solution employs a temperature sensor that has an IC encapsulated in stainless steel enclosure to make it corrosion resistant, waterproof, more reliable and robust for extreme weather conditions. It is a digital thermometer that provides 9-bit to 12-bit Celsius temperature measurements and it communicates over a 1- Wire bus that by definition requires only one data line for communication with a central microcontroller. Each sensing devices has been provided with a unique 64- bit hex address which make it possible to short the data line wires of several such devices and connect them to a single data pin of the microcontroller ensuring multiple sensors to function on the same 1-Wire bus. The system employs a battery-free design and is capable of handling operating temperatures as high as 100 oC, thus making it capable to record temperature data even of modules deployed in rooftop systems in hot climates. Establishment of the Solar Parks have the potential of reducing the cost of electricity from solar power. The sensors are used to monitor and collect the information about the climatic condition of the farm like temperature, humidity, day/night mode and also to check the power generated on the field. GSM-based Wireless Sensor Network (WSN) has the features of high bandwidth and rate, non-linetransmission ability, large- scale data collection and high cost effective, realized with Zigbee. For the wireless section, GSM type network has been used because it is modern wireless sensor networks. Development of RealTime atomization of solar power system with various parameters being controlled by a microcontroller and maintained using the low power by adaption of wireless technology. The status of the load is monitored and data is stored at EEPROM, depending on the requirement of load application adequate facilities is chosen by the controller.

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Things get interesting when smart devices combines with smart services to create compound applications.

3.1 DEMERITS:

• Human intervention is very high.

• The existing system uses GSM and Zigbee which will not helpful to use monitoring from a long range.

PROPOSED METHOD

The photovoltaic monitoring system is designed as principle of environmental protection, energy conservation and stability. It provides general calculation of all parameters of the solar energy monitoring system and selects parameters for the photovoltaic cells and controller. The results of different algorithms are compared to make the maximum efficiency of the system. However, solar modules and batteries are affected by temperature, humidity and equipment points, it is priority for the use of solar power when environmental considerations in the paper.

Most of these installations act as auxiliary power source. A majority of these are installed in inaccessible locations – as close as a rooftop to as far away as a dessert. Hence they require sophisticated systems for remote monitoring of these installations using wide area networks. In this paper we will discuss a low cost IOT based embedded Solar PV Monitoring system which will make use of sensors and a low cost microcontroller to send the data measured at the production end on the internet, which can then be accessed anywhere on the globe. This will provide us real time information of the installation which will help us in its maintenance, fault detection and will give us a record of all the data at fixed intervals. To cope up with rapidly changing technology, IOT is the best solution for monitoring of solar installations. IOT based remote monitoring of the Solar PV installation will also save energy and man-labour. Because of the use of IOT in this proposed system, there is a large scope for future work. We can add modern devices and sensors without the fear of compatibility. Flexibility of this system is its uniqueness. Adding more sensors, it can measure AC voltage and current output, and corresponding output of the solar panels and a lot more.

In the Proposed system, Arduino uno microcontroller is used here to interfacing with solar panel and sensors. Panel voltage is obtained by applying in voltage sensor in voltage divider circuit. The current is sensed by current sensing circuit and temperature by temperature sensor. All the data is then transmitted to remote server with the help of microcontroller which transfers the data to cloud through Internet of Things. The cloud data is retrieved by user using mobile application called Blynk.

The proposed system for monitoring the solar module using IoT, helps to implement a low cost monitoring system. The parameters voltage, current and temperature are monitored by using the sensor mounted on PV panel and Power Conditioning Units (PCU). For sensing the voltage,

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voltage sensor is used in the methodology, we can see that the power flow of the model is explained in that the solar radiance energy. This electrical energy is then sensed by various sensors such as voltage generated by solar panel is sensed by voltage sensor for measuring voltage with the help of voltage divider principle and current produced by solar panel is measured by current sensor module and temperature or heat energy available or fall on solar panel is tracked by the temperature sensor. All collected data of voltage, current and temperature sensor is then fed to Arduino Uno microcontroller which converts the signals into digital using serial interface and microcontroller unit acts as a gateway and sends this data over the cloud server and then this data is accessed via user over the Blynk mobile application. The real time location will also be tracked and displayed on the mobile application. In case if any sensor value varied then an alarm system will also turned ON. Solar tracking can be done with the help of LDR. 2 LDR sensors will be connected with the system. The servo motor will make the photovoltaic cell to track solar light based on the high light intensity. When LDR 1 has intensity then the cell will tilt to one direction. In case if the LDR2 has high intensity then the photovoltaic cell will be tilted to another direction.

3.2 BLOCK DIAGRAM:

3.2.1 TRASMITTER UNIT:

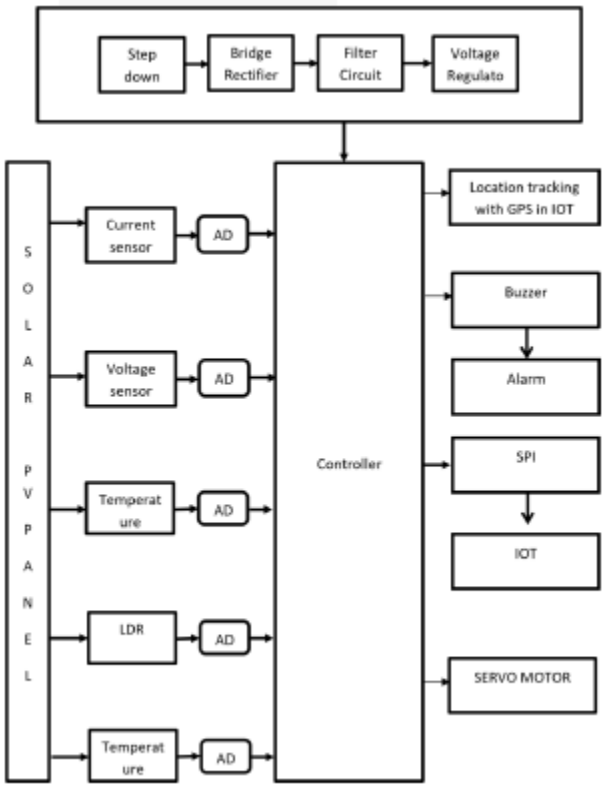

Fig no. 3.2.1 Transmitter Unit

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3.2.2 RECEIVER UNIT:

Fig no. 3.2.2 Receiver unit block diagram

3.3 MERITS:

• Real time monitoring of voltage, current and temperature can be monitored.

• The proposed system is very useful for regular monitoring of field status without visiting manually, and saves time

RESULT AND DISCUSSION

The hardware setup of the photovoltaic system monitoring will be attached in the following figure.

Fig. 5.1 Hardware setup

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CONCLUSION

In this paper a low-cost monitoring system for maximum power tracking in a photovoltaic module is designed. The IoT technique is used in order to monitor data such as voltage, current and temperature level of solar photovoltaic system. The proposed system stores the data from the solar photovoltaic system continuously, so it keeps track of the solar photovoltaic system analysis becomes easy and efficient. Using the analysis it is possible to detect any fault occurring in the system as there would be inconsistency in the data generated by the system. By solar tracking the solar panel is operated at its maximum efficiency all day. This has been done with the light dependent resister and servo motor. This technology makes it possible in particular to improve the monitoring, the performance and the maintenance of the photovoltaic system. The designed system can analyses and /or check the status of parameters being measured in a photovoltaic system.

6.2 FUTURE SCOPE

For very large solar panel dual axis solar panel tracking can be done. By analysing the data it is possible to predict the future values of parameters. Artificial intelligence can be implemented using various machine learning algorithms so that the system can become smart enough to take decisions about data and performance.

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