



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 6, June 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512



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An Approach to Solar Energy Monitoring System Using IoT

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ABSTRACT: solar energy is the most important energy among all the renewable energy resources use for electricity generation. Conversion from solar energy to electricity a photovoltaic system is needed. Installation of photovoltaic system can be done where sufficient energy potential which is gain needed are available easily. Performance of photovoltaic system is changing with various parameters and system component functioning. Super studying its performance a real time monitoring system is needed. This paper discussed about the performance monitoring and real-time control of PV systems with the use of internet of things using IoT and hence a better understanding of real-time operating parameters. We can access the PV system installed in a remote area that is effective and is a quick error diagnosis and generation and performance for data analysis. Photovoltaic plants significantly grow every day because most useful with low-cost plants. Sun plants are very localized and there and structured around 40% of the error of solar crops every year therefore the management of photovoltaic systems is important to improve their efficiency.

KEYWORDS: Microcontroller, GPRS module, remote monitoring, solar photovoltaic, IOT

I. INTRODUCTION

Unfriendly resources are reduced step by step. Thinking about other sustainable power assets, the energy-oriented energy is one of the most ideal energy at this time. To create a world economy, SUN-based energy significance is developing. The ongoing technology creates a photovoltaic board (PV) which is more complete and reasonable. These results have the highest conservative high energy in the economical climate. From that situation PV market will encounter a stunning development in future The number of PV plants is altogether becoming yet the present sun oriented plants are exceptionally unstructured and restricted consequently the need for the executives of these plants is gets fundamental. It is conceivable by legitimate execution checking and keeping up the vigor of PV boards. Genuine and solid valuations of PV framework introduction are significant for acceptable PV industry For study and investigation, it is important to order and perceive the future prerequisites. Maturing of boards is additionally plays significant part in estimating and ascertaining the boundaries of savvy. Web of things (IOT) based application is truly useful for checking framework at lower cost. Execution of sun powered boards is profoundly relies upon the climate conditions accordingly with the assistance of sensors we can straightforwardly gather insights regarding climate conditions like temperature and moistness of that specific area. The framework of observing continuously shows the current status of energy levels, temperature, sticky, and the ins and outs of the dead board by utilizing IOT. Then again monetary interest in the solar-powered factory is still impressive high but determines to help for better sun-based boards by reducing energy misfortune. Sunlight based energy age is the significant boundary of sun based designing issues for example, electrical or warm parts. Consequently it very well may be said that exact expectation is of significant for sun based designing considers observing of PV plants.

II. RELATED WORK

Shrihariprasath B. , Dr. vimlathithan Rathynasbapathy 2016] has developed Remote monitoring system for solar PV PCU face four main challenges, mean time to repair is tedious, inflexibility, poor manageability, and difficulty to maintain. The main objectives of this research is to design and implement a Smart Remote monitoring system using IOT that is capable of monitoring the Solar PV PCU and stores data in the cloud database through an easy manageable web interface. The proposed system has a great flexibility by using GPRS technology to interconnect the Solar PV PCU to Remote server. This will decrease the maintenance cost and will increase the efficiency of the system.



[Ankit Kekre, Suresh k. Gabre 2017] In this paper they 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.

[Saravanan.D ,Lingeshwaran.T 2019] They said for effective use of this energy solar power is used with solar tracking and monitoring. In most existing system tracking of solar energy is defined by photovoltaic cell, adruino, raspberry-pi as with IOT module which makes more cost as well as more power consumption. But in this system we defines to use low range of sensors along with stepper motor to define high throughput.

[Soham Adhya, Deepak Saha, Abhijit Das, Joydip Jana, Hiranmay Saha 2016] The discussion in this paper is based on implementation of new cost effective methodology based on IoT to remotely monitor a solar photovoltaic plant for performance evaluation. This will facilitate preventive maintenance, fault detection, historical analysis of the plant in addition to real time monitoring. Using the Internet Of Things Technology for supervising solar photovoltaic power generation can greatly enhance the performance, monitoring and maintenance of the plant. With advancement of technologies the cost of renewable energy equipments is going down globally encouraging large scale solar photovoltaic installations

.[Suprita M. Patil , Vijayalakshmi M. 2017] The proposed system refers to the online display of the power usage of solar energy as a renewable energy. This monitoring is done through raspberry pi using flask framework. Smart Monitoring displays daily usage of renewable energy. This helps the user to analysis of energy usage. Analysis impacts on the renewable energy usage and electricity issues. it extends into the real world, which incorporates everyday objects. The IoT allows objects to be sensed or controlled remotely over existing network infrastructure, creating opportunities for pure integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.

[Ambuj Gupta, Rishabh Jain, Rakshita Joshi, Dr. Ravi Saxena 2017] The following paper proposes a solar metering system which can be accessed from anywhere for monitoring and analysis of solar setups. It monitors the solar output in real time with ease and therefore any interruption in the system can be immediately monitored. This IOT (Internet of Things) based system is best suited for remote areas where solar systems are setup due to ample availability of solar energy but regular access to the areas is difficult and is not cost efficient. With the demands of renewable and solar energy escalating, this system's demand and usefulness will blatantly increase.

[Nallapaneni Manoj Kumar , Karthik Atluri , Sriteja Palaparthi 2018] The major challenge in the PV systems is to study its performance as it is varying with respect to various parameters and system components functioning. Hence real time monitoring system is needed to assess its performance. This study briefs about the use of internet of things (IoT) in performance monitoring and real time control of PV systems. Focus is made on the IoT need and its architecture for PV systems with relevant discussions. Use of IoT enhances the understanding over the real time operating parameters. This helps in accessing the control over the PV systems installed at remote areas, effective and fast fault diagnosis, maintenance, recording generation and performance data for analysis.

[Isha M. Shirbhate Dr. Sunita S. Barve 2018] The system is implemented in two phases first one is monitoring followed by prediction which helps to reduce the energy loss. The solar monitoring phase collects and analyzes several constraints being evaluated by using sensors to calculate its panel level performance. Smart Monitoring system maintains track of electricity generation contents and regional temperature. The experimental results forecast the mistake finding as well as the panel's dead state with time parameters. Phase two deals with analyzing time-series of solar energy data for prediction using Hidden Markov Model (HMM). The model decides a prediction considering probabilistic relationship of the first value to next value in series. The predicted output is then compared with real-time output to increase accuracy of prediction.

[Kyle Williams, Amer Qouneh 2017] In this paper, one such platform is used to design and build an Internet of Things solar tracker. The solar tracker predicts the sun position for maximum power output, controls servos that move the cell, monitors the output of the solar cell, collects and processes raw data to infer information that can be sent to a remote station for further analysis. Similar solar trackers can be installed at solar farms to help in energy harvesting and

management over a large geographical area. Solar trackers send processed information to a centralized location where further analysis provides energy utility companies with fine-grained energy harvesting and management capabilities; thus improving overall efficiency of energy generation and consumption.

[Zulkhairi Mohd Yusof, Md Masum Billah, Kushsairy Kadir, Abdul Malik Mohd Ali 2019] To optimize the maximum power from sunlight, the tracking system was built to get the perfect angle at the time. Lithium-ion polymer battery is responsible to supply the energy to power up the IoT device. Internet of Things (IoT) device has the ability to transfer data over a network without needing interaction by human-to-computer or human-to-human. The IoT device has been designed to detect the temperature, transmit to the cloud and the data will be collected by the MQTT lens application. This is for plant field and their workers to get the information about the temperature early and for plan ahead in the future. The paper here is presented the solar-tracking the IoT device.

[R.L.R. Lokesh Babu¹, D Rambabu², A. Rajesh Naidu³, R. D. Prasad⁴, P. Gopi Krishna⁵ 2018] This paper proposes a solution and method to monitor the dust accumulated on the solar panels to get the maximum power from for effective utilization. Always the output power of the solar panel depends on the radiation reached to the solar cell. The system also displays the malfunctioned solar panels lists and whether the electrical appliance is working directly on the solar panels or the loads is on the battery. All the panels are connected, and sensors are directly connected to the central controller which monitors the panels and loads. By incorporating the IoT technology the data received from the panels and appliance are send to the cloud from through internet for the future use as well the remote user can monitor the parameters of the connected devices.

[Mubashir Ali Mahnoor Khalid Paracha 2020] — Internet of things is an emerging technology that efficiently and effectively improving our daily life activities. It reduces the cost of living by automating the manual processes. It integrates physical objects and devices via internet for synchronized communication. Currently the cost of electricity is reaching the sky so we need some sources that can produce electricity naturally without any cost. Here, solar panels and solar plants take place for producing electricity in natural manner with sun light. Photo voltaic cells are used in these systems that converts the sun light into electricity.

[Manish Katyarmal¹, Suyash Walkunde², Arvind Sakhare³, Mrs.U.S.Rawandale⁴ 2018] Using the Internet of Things Technology for supervising solar power generation can greatly enhance the performance, monitoring and maintenance of the plant. With advancement of technologies the cost of renewable energy equipment is going down globally encouraging large scale solar plant installations. This massive scale of solar system deployment requires sophisticated systems for automation of the plant monitoring remotely using web based interfaces as majority of them are installed in inaccessible locations and thus unable to be monitored from a dedicated location. The Project is based on implementation of new cost effective methodology based on IoT to remotely monitoring a solar plant for performance evaluation. This will facilitate preventive maintenance, fault detection of the plant in addition to real time monitoring.

[K.G.Srinivasan Dr.K.Vimaladevi Dr.S.Chakravarthi 2017] The Internet of Things has a vision in which the internet extends into the real world, which incorporates everyday objects. The IoT allows objects to be sensed or controlled remotely over existing network infrastructure, creating opportunities for pure integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. This technology has many applications like Solar cities, Smart villages, Micro grids and Solar Street lights and so on. As Renewable energy grew at a rate faster than any other time in history during this period. The proposed system refers to the online display of the power usage of solar energy as a renewable energy. This monitoring is done through raspberry pi using flask framework. Smart Monitoring displays daily usage of renewable energy.

[Ravi Kishore Kodali , Jeswin John 2016] In this Paper solar monitoring system consisting of a microcontroller and various sensors that collect information and provides this information to the client using Amazon Web Services(AWS) and How we can monitor various aspects or parameters regarding the performance of a solar panel and reduced human intervention

III. PROBLEM STATEMENT

To solve management problems, maintenance and shorten the average time to improve. The system has included remote monitoring for PCU PV solar through the Internet using the host, GPRS network (Global Positioning Radio Service), the embedded system gateway and other components.

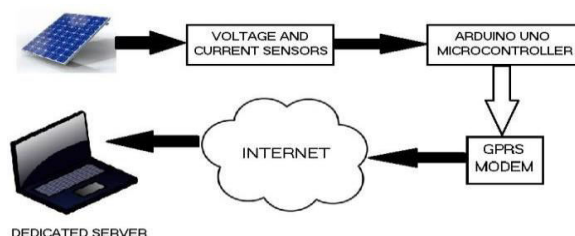


Figure1: Solar power Monitoring System using IOT

IV. COMPONENT USED

[1] Solar PV Installation

In this system we design a solar PV system on the roof top.

[2] Microcontroller.

Arduino Uno is a microcontroller board that depends on the Atmega328P processor. This tends to be encoded as needed to take advantage of Arduino's ideas in the language of C / C ++ and transferred directly to the board. This board has many uses in the hardware field entered. This is a place where it chosen whether the quality obtained with a different sensor is in the point solving point in a rational code given to the Arduino board. It measures information that is close to different sensors and sends it to GSM modules through different shared correspondence conventions on important orders for GSM module activity



Figure 2: Solar Panel Installation

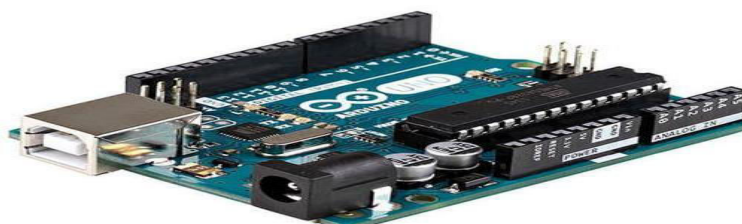


Figure 3: Arduino UNO microcontroller board

[3] GSM MODULE

The SIM 900A GSM GPRS module is used in this proposed conceptual system. This is a very reliable wireless module. The attributes are small, low cost and low power consumption. This provides GSM / GPRS 900/1800 MHz performance for sound, SMS, data, and faxes. In this system, it obtains data that will be sent to users from the Arduino board through serial communication along with what is needed on the command and sends data on the internet on the IP address that is created itself. Users can enter this IP address on the system and get real time state conditions from the Solar PV installation.

The GSM module was selected through the Zigbee module because Zigbee technology proved inefficient in large scale because it could not deal with a very large distance.



Figure 4: 900A SIM GSM Module

[4] Temperature Sensor

The LM35 integrated circuit temperature sensor is used to measure the temperature of its reach. It provides a very appropriate reading on the degree of Celsius for more than the scope of 0-100 ° C [8] while drawing a low current of around 60 amp miniature.

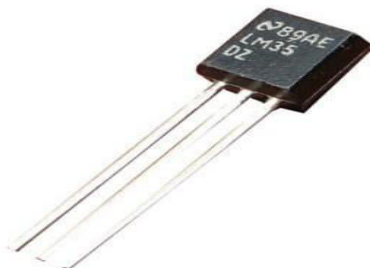


Figure 5: Temperature LM35 Sensor

[5] Voltage and Current Transducers

Solar PV voltage is detected using a voltage divider circuit. Currently detected utilizing the effect of the current effect. The lobby effect is the expected age because the current transport conductor in the opposite interesting field. The corridor effect of the sensor currently takes a shot on this guideline.

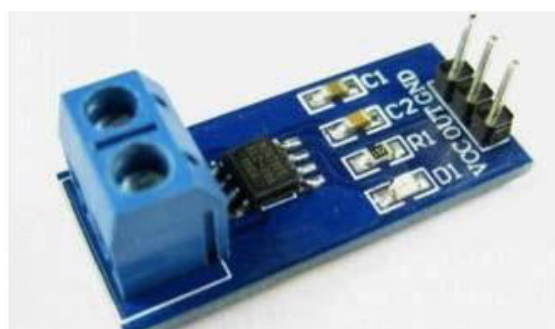


Figure 6: Hall Effect Current Sensor

V. METHODOLOGY

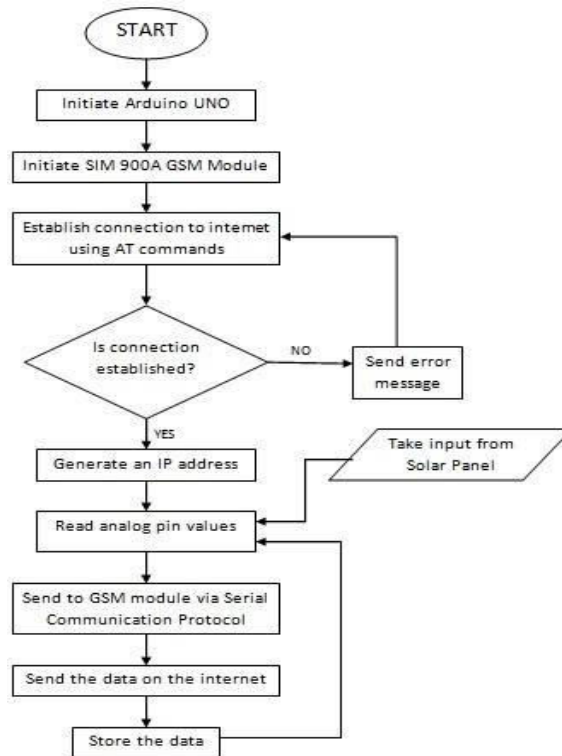


Figure 7: Flow Chart Work Solar Energy Monitoring System Using IOT

Fig. 7 shows the proposed system process from the load to the monitoring system. The work flow of the solar energy monitoring system is presented in the form of the steps below.

Step 1: Arduino displays the use of power using sensor values through current sensors and voltage dividers.

Step 2: Raspberry Pi retrieves Arduino output data through serial ports and displays on the webpage through the Python script.

Step 3: Monitored data is send to the clouds by Resberry Pi.

Step 4: Data is displayed in the form of graph and it is visible to all the users by the cloud.

4.2. Hardware Setup

Figure 8 shows the hardware settings of the proposed system. Solar energy stored in the battery with solar panels is DC at this time. So we use DC bulb as a source of power use. One Bulb Terminal is connected to the battery for the power supply. Other terminals connect to the current sensor to read at this time. Breadboard is used for complex circuits to be built. It also helps build a voltage divider



Figure 8: Hardware Configuration Settings

Arduino fetches the current value and voltage through analog pins. With the help of these values, Arduino programming calculates power and energy. Output is sent to Raspberry Pi via a USB cable. Raspberry Pi is considered server. Monitor displays web pages and cloud data.

VI. RESULTS AND DISCUSSIONS

The proposed work illustrates the results for the solar energy monitoring system.

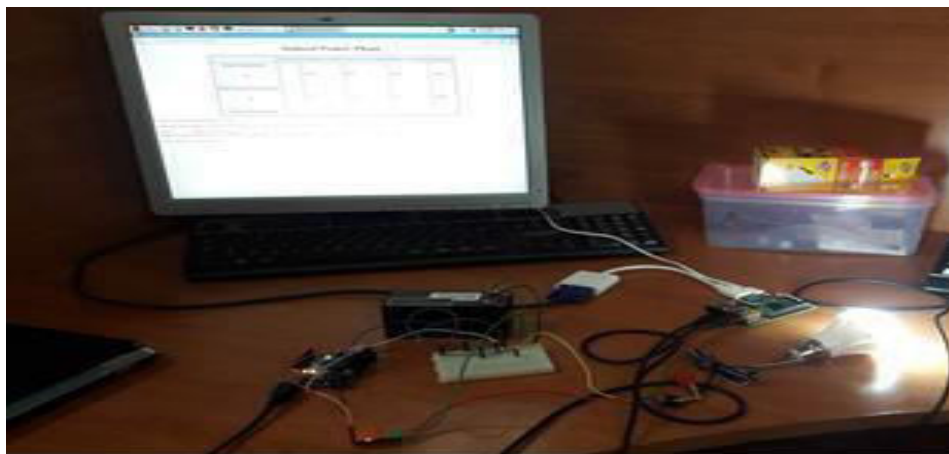


Figure. 9. Hardware configuration setup

Monitoring data sent to the Cloud is to store in a separate field. Each field displays the individual graph as shown in Figure 10. The temperature graph is shown in Fig. 11.



Figure. 10. Energy Graph of current, voltage and power

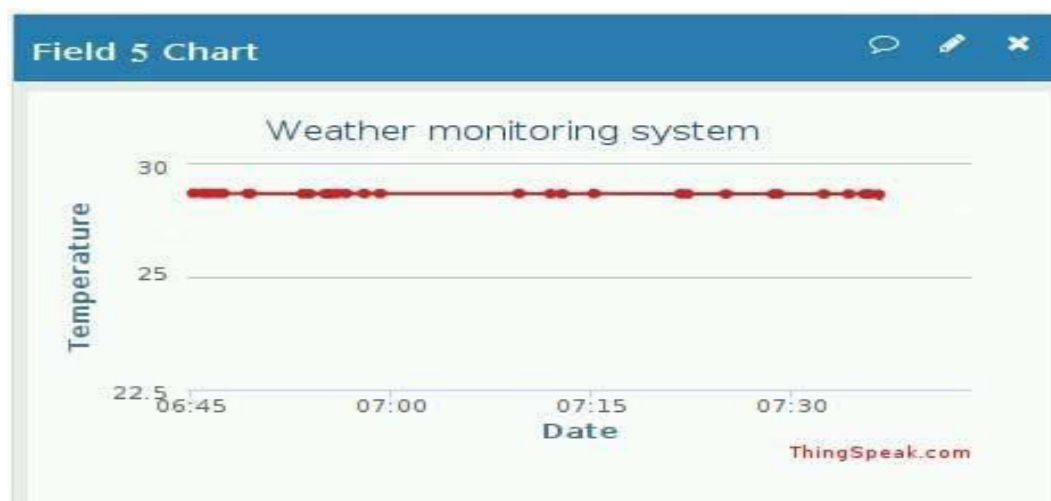


Figure. 11. Temperature Graph

The graph emphasizes the main point, making data more convincing and provides a compact way to present information to the user. The graph is a plot for current, voltage, power and energy value with respect to date. This graph is access via the internet from anywhere.

VII. CONCLUSION AND FUTURE WORK

[A] Conclusion

The sun based PV PCU observing utilizing Internet of Things has been tentatively demonstrated to work agreeably by checking the boundaries effectively through the web. The planned framework not just screens the boundary of sunlight based PV PCU , however it additionally control the information and produce the report as indicated by the prerequisite,



for instance compute unit plot and create complete units produced every month. As the traditional wellsprings of power age are exhausting, humanity needs sustainable sources, for example, sun oriented and wind energy to continue itself. With innovative progressions, cost of gadgets is diminishing with a quick rate. Consequently all we require is a decent, exceptional checking framework which can perform significant errands consequently without human intercession and can give information to the client at whatever point and any place required.

So IoT is the best solution for monitoring the PV system. It also saves energy and less labor needed in it. There is a large scope in the future because of the Internet of Things. The flexibility of this system is extraordinary and unique.

[B] Future Scope

The uniqueness of the proposed framework is that it will be simpler to filter out the plant exhibition of solar-based forces at a comprehensive level. Iot-based framework will fill the web-based information base with continuous information from plant boundaries that will increase the dynamic cycle of the position concerned. The time of observing, the introduction of defects for plants progressively will be seen in the comfort of the web. The combination of large scope networks from the Sunlight Factory will require a colossal information investigation for dynamic.

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