Solar Power Monitoring System Using IOT

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Abstract— Using the web of Things Technology for supervising solar energy generation can greatly enhance the performance, monitoring and maintenance of the plant. With advancement of technologies the value of renewable energy equipment goes 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 fanatical location. The Project is predicated on implementation of latest cost effective methodology supported IOT to remotely monitoring a solar plant for performance evaluation. This will facilitate preventive maintenance, fault detection of the plant additionally to real time monitoring.

Keywords: IOT, Solar Panel, Internet, Automation of Solar System, Fall Detection, Arduino

I. INTRODUCTION

The Internet of Things (IOT) may be a system of related computing devices, digital and mechanical machines, objects, people with unique identifiers and potential transfer of knowledge over a network without human-to-human or human-to- computer interaction. Physical objects those are not any longer disconnected from the virtual world, but can be controlled remotely through Internet services. A smart world is nothing but Smart devices, Smartphones, Smart cars, Smart homes and Smart cities. "Smart" objects play a key role within the vision of IOT, since embedded communication and knowledge technology would have the potential to revolutionize. With the growing presence of WiFi and 4G-LTE wireless Internet access, the evolution towards omnipresent information and communication networks is already evident. According to the International Energy Agency (IEA), Renewable energy will be the fastest growing source of electricity, in which wind and solar PV are technologically mature and economically affordable. But still there is increase in world's demand for energy. Adopting Renewable Energy technologies is one among the advance ways of reducing the environmental impact. The latest edition of the IEA's Medium-Term Renewable Market Report specifies the renewable energy growth about 13% more between 2015 and 2021 than it was in last year's. The share of renewable energy in overall electricity generation will rise from over 23% in 2015 to almost 28% in 2021. Solar energy is universally available everywhere the planet and may contribute to attenuate the dependence of energy imports. In 90 minutes, enough sunlight strikes the world to supply the whole planet's energy needs for one year. Solar PV results in no greenhouse emission (GHG) emissions and other pollutants during operation. Solar has many benefits like system-friendly deployment, improved operating strategies, advanced renewable energy forecasting and enhanced scheduling of power plants and also investment in additional flexible resources, comprising demand-side resources, electricity storage, grid infrastructure and flexible generation. The traditional method focuses on the extent sized cost of electricity (LCOE) which may be a measure of cost for a specific generating technology at the level of an influence plant that is no longer sufficient. About a million solar panels were installed a day round the world last year. Solar PV leads providing almost 40% of global renewable electricity capacity growth over the medium-term. Finally, in analyzing the evolution of electricity and energy- consuming sectors, it explores the prime role solar energy could play within the long-term way forward for our energy system. Applications of the monitoring system are the Rooftop Solar, Ground mounted Solar, Solar cities, Smart villages, Micro grids and Solar Street lights. Consumer Products like solar water heating systems, Solar home lighting systems, solar lanterns, solar pumps, solar mobile chargers, solar cookers, LED solar torch, solar RO plant, solar fan, solar Inverters, etc. can be monitored through this project. Commercial Products like Solar traffic signals, solar road studs/blinkers also can be monitored through the proposed system. In India, frequent power cut is very common. Due to this issue, it's important to use renewable energy and monitoring it. By monitoring the energy forecast, households and communities who are using solar energy can utilize their energy production and consumption during weather. This paper is organized into five main sections: In Section I we've briefly introduced about the domain. Section II discusses the literature survey during this area. Section III discusses the proposed work done. Section IV discusses the Results and Discussions. Section V summarizes the conclusion and lastly, the references utilized in scripting this paper.

II. LITERATURE SURVEY

A. Purusothaman, SRR Dhiwaakar, et al:

Explain about the focus is on the DG agents, grid agent and Mu agents. DG agents like the distributed energy resources (DERs), load, storage and the grid agents. The Mu agent acts as the communication channel between the DG agents to the higher level agents such as the control agent. The implementation of the system has been done using an Arduino microcontroller.

B. Author Kabalci, Ersan, Alper Gorgun, and Yasin Kabalci:

Introduces An instant monitoring infrastructure of a renewable energy generation system that is constituted with a wind turbine and solar panel arrays. The monitoring platform is based on current and voltage measurements of each renewable source. The related values are measured with the

developed sensing circuits and processed by an 18F4450 microcontroller of Microchip. The processed parameters are then transmitted to a personal computer (PC) over universal serial bus (USB) to be saved in a database and to observe the system instantly. The coded visual interface of monitoring software can manage the saved data to analyze daily, weekly and monthly values of each measurement separately.

C. Jiju, K., et al:

Describes the development of an online monitoring and control system for distributed Renewable Energy Sources (RES) based on Android platform. This method utilizes the Bluetooth interface of Android Tablet or Mobile phone, as a communication link for data exchange with digital hardware of Power Conditioning Unit (PCU).

D. Goto, Yoshihiro, et al

[4] explained about an integrated system that manages and remotely monitors telecommunications power plants has been developed and has started operations. The system is used to operate and maintain more than 200,000 telecommunication power plants, which including devices such as rectifiers, inverters, and UPSs, and air-conditioning plants installed in about 8,000 telecommunication buildings. Features of the system are the integrate the management and remote monitoring functions, into one system and improved user interfaces, which use information and communication technology such as web technology.

E. Suzdalenko, Alexander, and Ilya Galkin:

Identify the problem of the non-intrusive load monitoring method of load disaggregation into separate appliances. When some local generators based on renewable energy sources are connected to the same grid, as they may be mismatched with loads variable in time.

F. Nkoloma, Mayamiko, Marco Zennaro, and Antoine Bagula:

Describes recent work on the development of a wireless based remote monitoring system for renewable energy plants in Malawi. The main goal was to develop a cost effective data acquisition system, which continuously presents remote energy yields and performance measures. The project output gives direct access, to generated electric power at the rural site through the use of wireless sensor boards and text message (SMS) transmission over cellular network. Preliminary experimental results reveal that the performance of renewable energy systems in remote rural sites can be evaluated efficiently at low cost.

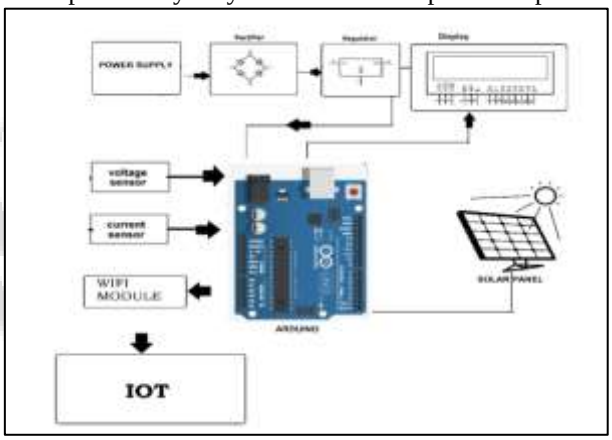
G. Nkoloma, Mayamiko, Marco Zennaro, and Antoine Bagula:

are proposes a novel monitoring, control system for achieving real time monitoring and control of a hybrid 'wind PV battery' for renewable energy system. The proposed system constitutes a supervisory control and data acquisition (SCADA) system, which employs campus network of National Cheng Kung University integrated with a programmable logic controller (PLC) and digital power meters. The proposed system is capable of performing real time measurement of electrical data that can be effectively transferred to remote monitoring center using intranet. It can be concluded from the simulated and experimental results that the proposed monitoring and control system can achieve real time supervisory control and data acquisition of remote various forms of renewable energy system.

III. METHODOLOGY

A. System Designing

Solar power plants need to be monitored for optimum power output. This helps retrieve efficient power output from power plants while monitoring for faulty solar panels, connections, and dust accumulated on panels lowering output and other such issues affecting solar performance. So here we propose an automated IOT based solar power monitoring system that allows for automated solar power monitoring from anywhere over the internet. We use arduino based system to monitor a 10 Watt solar panel parameters. Our system constantly monitors the solar panel and transmits the power output to IOT system over the internet. Here we use IOT Gecko to transmit solar power parameters over the internet to IOT Gecko server. It now displays these parameters to the user using an effective GUI and also alerts user when the output falls below specific limits. This makes remotely monitoring of solar plants very easy and ensures best power output.



. Fig. 1: Block Diagram of IOT

B. Arduino

Keeping in mind the economic constraints and the simplicity of the system, Arduino Uno has been used which abates the programming complexity. Arduino sense the current and voltage value through Analog pins. With the help of these values, Arduino programing calculates the power and energy.

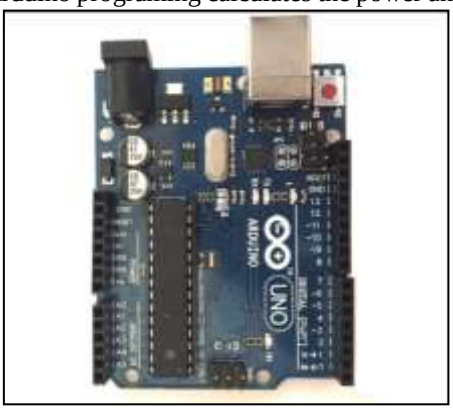


Fig. 2: ARDUINO

C. Current and Voltage Acquisition Circuit

The analog inputs of an Arduino can measure up to 5V. To protect the Arduino from short-circuits or unexpected voltage surges, we use resistor while connect to the 5V circuit. The circuit of voltage divider is shown in the Fig 3. Two resistors form a potential divider that helps to lower the voltage being measured to a level that the Arduino can read. Fig shows the voltage divider circuit. 10kohm and 100kohm register are used to reduce the voltage circuit to 5V. Analog pin of arduino gives the voltage value. Breadboard is used to build this circuit which actually extends the range that can be used. The formula for calculating values in a potential divider is:

$$Vout = [R2 / (R1 + R2)] * Vin$$

If the divider for the Arduino voltmeter is functioning correctly, then Vout will be a maximum of 5V. So we can calculate the maximum input voltage to the circuit:

$$Vmax = 5.0 / [R2 / (R1 + R2)]$$

For the measurement of current we will use a Hall Effect current sensor ACS 712 (30 A). ACS 712 measure positive and negative 30Amps, corresponding to the analog output 66mV/A. This current sensor gives the readings of the current. Those values are used in the proposed system for calculating power. In this setup DC bulb is consider as a load. Battery is considered as the power supply. Other pins of sensor is connects to the Arduino. Once the connection is done as shown in the Fig4, Arduino display the values of current flow.

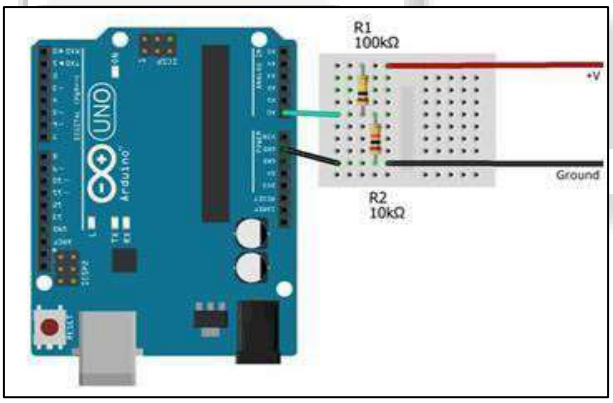


Fig 3. Voltage Divider

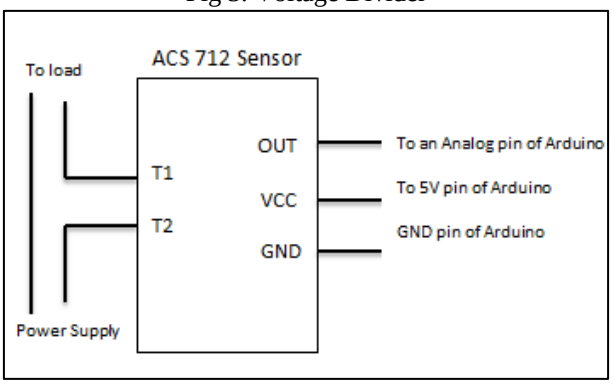


Fig. 4: Current Sensor circuit

D. Temperature sensor

Temperature sensor is used in this project to predict and monitor the solar energy storage. According to the temperature value, the energy storage modulates. Display the temperature values on the web page in the form of gauge.

E. Cloud Setup

Thing Speak is an open source IOT application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. Thing Speak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates. The user should create the account first. The account contains channels which are separate for different projects. Channel has the fields which are different for different parameter in the monitoring system. After assigning the parameter the system upload the values to it. The cloud has built-in functions in it which represent the values in the form of graphs.

F. WiFi Module

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

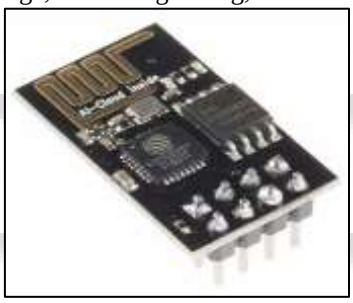


Fig. 5: WIFI module

IV. IMPLEMENTATION

A. Work Flow

Fig. 6 represents the process of proposed system from load fo the monitoring system. The work flow of the solar energy monitoring system is presented in the form of step below.

- Step 1: Arduino display the power usage using sensed values through current sensor and voltage divider.
- Step 2: Arduino send output data through serial port and display on the web page through python embedded c script.
- Step 3: Arduino with wifi module sends the monitoring data on to the cloud.
- Step 4: Cloud display the data in the form of graph, which is visible to the entire user.

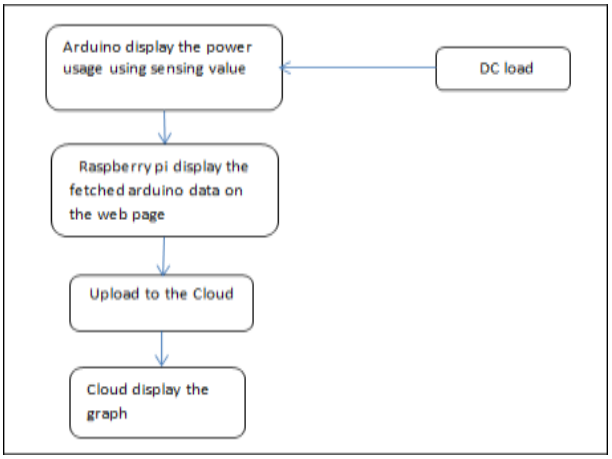


Fig. 6: Work flow of the system

V. RESULT AND DISCUSSION

The proposed work illustrates results for the Solar Energy Monitoring System.

A. Hardware configuration setup

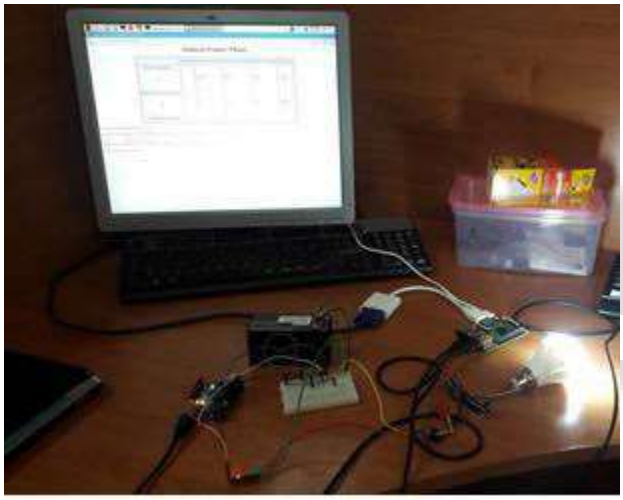


Fig. 7: Hardware configuration setup

B. Monitoring page in Intranet

We create web page of monitoring system. Flask framework code is used to create web page that can be seen in Intranet using IP address. The result of the system is displayed on the web page in the form of the table contains current in amperes, voltage in volts, power in watts and energy in watt-hours with respect to date and time.

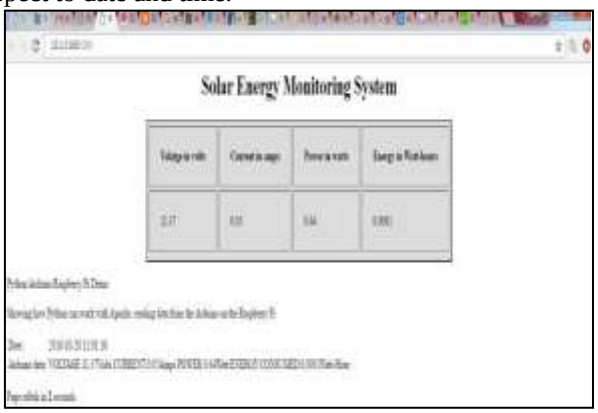


Fig. 8: Monitoring Page in Intranet

C. Graphical Representation of solar Monitoring system

The monitoring data sent to the cloud is store in separate fields. Each fields display the individual graphs.

Fig. 9: Current, Voltage, power Energy Graphs

VI. FUTURE SCOPE

The controller requires an external supply to work but using the power generated from solar panel itself the controller's input power supply can be met. For very large solar panel dual axis solar panel tracking can be done. By analyzing 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.

VII. CONCLUSION

Implementing Renewable Energy technologies is one recommended way of reducing the environmental impact. Because of frequent power cut it is important to use renewable energy and monitoring it. Monitoring guides the user in analysis of renewable energy usage. This system is cost effective. The system efficiency is about 95%.This enables the efficient use of renewable energy. The temperature sensor helps to analysis the storage of the solar energy. Thus it is reducing the electricity issues. This project can be further enhanced, by using the results of this current project, i.e. the monitored values obtained are helpful in predicting the future values of the parameters considered. Prediction of the amount of solar energy will be stored in the battery. The data stored in cloud can also be analyzed using the MatLab. The CSV file from the cloud is taken for analysis in R. The web application can be developed for interaction with the end user; the user can also predict values of the future events. In the same way we can go for android application also. During the prediction two or more models can be used for same dataset, to find the accuracy of each model.

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