

Smart Solar Grid Monitoring System

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Abstract- Energy is key to all advancements and way of utilizing it efficiently helps the mankind to explore unsolved mysteries in the universe. The sun is the major natural source of energy for its solar family. If we can properly drain energy from this vast resource, we can attain the state of saturation in energy. But way to achieve it is complicated and our scientists are working in tremendous number of ways. One of the best ways is usage of solar panel at a large scale and monitoring it with the help of advancements in Internet of Things (IoT). Our project primarily serves the above purpose in most efficient way. This paper depicts the continuous monitoring of data acquired such as voltage, current and power from each constituent of the solar grid block. Main objective of this system is to display graphical representation of parameters instantaneously in a cost- effective way.

Keywords- Cloud, Renewable energy, smart grid, Thing Speak,

I. INTRODUCTION

India is facing acute shortage of power. The continuous power availability can be attained with the help of renewable energy. It is Eco friendly, safe and clean renewable energy. Coal and oil are the major energy offering resources. They are imported at high cost. Therefore, it is necessary to take a look at alternate energy source. Within short period of time the solar light produces sufficient amount of energy. Thus our dependence on solar energy has become inevitable. This solar energy can be harnessed by many ways and using solar panels is one of them. This solar energy is converted into electrical energy and then sent to an inverter and later to the end appliances. During this process, significant data has to be monitored like voltage, current, power at different stages of the process. For full time live monitoring, we join hands with IoT technology.

The Internet of Things (IoT) is one among the leading technological vogue. It is a Machine to Machine communication which refers to a network comprises of physical objects which gather and share electronic information to the heterogeneous end systems. It is equipped with a wide variety of smart devices that enables objects to send data to web. This data can be easily managed and accessed anywhere.

IoT offers distributors to collect, exchange, manipulate and interpret data in real time. It provides robust access to data and it results further enhancements and improved operations. Solar energy and IoT together play a very vital role in current trend.

Cloud computing is an IT paradigm that accredits endless access to shared resources with minimal effort. Cloud storage is a versatile expertise has a significant purpose in managing database. The data which is stored in cloud can be indubitably maintained, configured and backed up. The cloud provider makes them available to the user to access from any location via internet. One of the major advantage of cloud is server virtualization which provides scaling and multi-tenancy at reduced cost. Due to the enormous bandwidth and flexible network connections users can attain prominent services in secluded data centers. It permits us to construct, analyze and manipulate applications online. The key applications of cloud computing are big data analytics, disaster recovery and file storage.

Since renewable energy is applied extensively, monitoring it is also essential. Analyzing and monitoring abrupt changes in the unit is very much required to detect and correct the misconceptions. This proposed work gives the graphical representation of voltage and current values of individual blocks of the solar grid system. Solar panel consists of large number of energy consuming cells called solar PV cells. The occurrence of fault in these cells tends to entire system to be futile. While scrutinizing the total system there is no chance of fallacy and massive energy can be attained. Ground mounted solar, smart villages, solar street lights, micro grids, rooftop solar are the widespread applications of monitoring systems.

II. LITERATURE SURVEY

[9] SRR Dhiwakar, Purushothaman et al describe about two major agents of solar grid system. They are DG agents and Mu agents. DG agents are recognized as the distributed energy resources like load, storage and grid agents. Grid agent comprises of solar photovoltaic cell and battery. The second agent is Mu agent that carryout the communication progress between DG agents and higher level control agents. The implementation process of the system has

been handled using Arduino microcontroller. The parameters are measured and passed to the controller unit. Controller unit will process and display the values. Database is not maintained in this research.

[4] Author Ersan, Alper Gorgun, Kbalci and Yasin Kbalci, launched an instantaneous scrutinizing system. This project uses wind pump and solar panel. The related values are obtained from the sensing circuits which are well developed. The 18F4450 microcontroller of Microchip is selected to process the observed entities. Universal Serial Bus (USB) is used to transfer the data to the computer. The visual interface is coded for the monitoring software and it can be useful for managing and storing data. Each measurement is separately analyzed daily, weekly and monthly.

[8] Jiju, K., et al focus on the online control and monitoring development system, specially made for distributed Renewable Energy Sources (RES). The construction of this system is based on android platform. It is a user friendly podium can be accessed by all kind of clients. This project exploits Bluetooth as an interface. This acts as a communication path for exchanging the data. In this prototype the hardware system is circuited and separated from the software. There is no detached software is made for controlling but the normal mobile devices are used. Tablets, mobile phones are enabled with Bluetooth and attached with hardware setup. The measured arguments are switched over to android devices and managed. Power Controlling Unit (PCU) is the chief element of this research.

[3] Yoshiro, Goto, et al talks about a system that monitors power plants of telecommunication has been germinated. The system can maintain about two lakh communication units which includes components like inverters, UPSs, air-conditioning plants and rectifiers. Integrating the management, distant monitoring functions are the chief features of this research. User interfaces are also applicable for the smooth operation. These applications uses web technology.

[5] Alexander, Ilya Galkin and Suzdalenko illustrated the problem of non-intrusive load controlling technique of load disaggregation into detached applications. When some local generators based on reproducible energy sources are attached to same grid, as they may be incompatible with loads variable in time.

III. OBJECTIVE

The main intention of this research is to sense and monitor the parameters like current and voltage values from

the individual blocks of solar grid system. The idea of this process is to depict the graphical representation of instantaneous electrical entities which are sensed using diverse voltage divider circuits. The system facilitates to employ this in smart grid for effectual usage and to reduce misconceptions.

IV. METHODOLOGY

In this section we exhibit the system design of Smart Solar Grid Monitoring System.

System Design

The proposed system is for scrutinizing of solar energy using Internet of Things (IoT). Solar panel helps to stock the energy in the battery. Electrical appliances can exploit the energy saved in the battery.

Battery is connected with Arduino. Arduino is a microcontroller which is having the application of reading the sensor values. Current sensing circuits and voltage divider circuits are the two circuits implemented in this project.

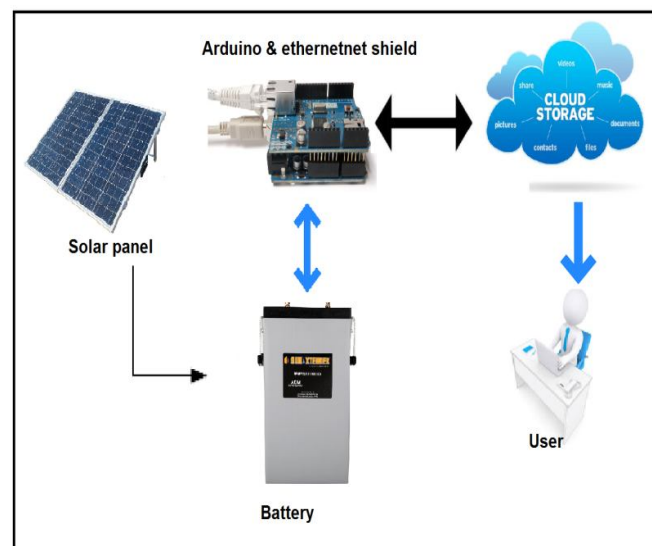


Figure-1 System Design

Arduino is attached with Ethernet shield. Ethernet shield is used to provide internet access to the microcontroller. The network connection is taken through modem. Ethernet shield and modem are connected together through the cable. The monitoring data will be uploaded to the cloud using this set up. Then the entities which present in cloud storage will be displayed in a graph using Thing speak.

Arduino

Arduino is an open resource electronics platform based on hardware and software. It is a cross platform device and very simple and clear to program. The boards of Arduino are able to read inputs of various sensors as well as simple circuits. Hardware part is given with external sensor inputs and software part is utilized by Arduino programming language and the Arduino Software (IDE). Programming language is based on wiring and IDE is based on processing. In our proposal arduino measure the voltage and current values through analog pins.

Current and Voltage sensing Circuit

The analog inputs of an Arduino can measure up to 5 volts. We should prefer the circuit with resistors even connecting with 5V circuit. Resistors have the purpose of protecting arduino from short circuits or unexpected voltage surges. An example for voltage divider circuit is shown in Fig.2.

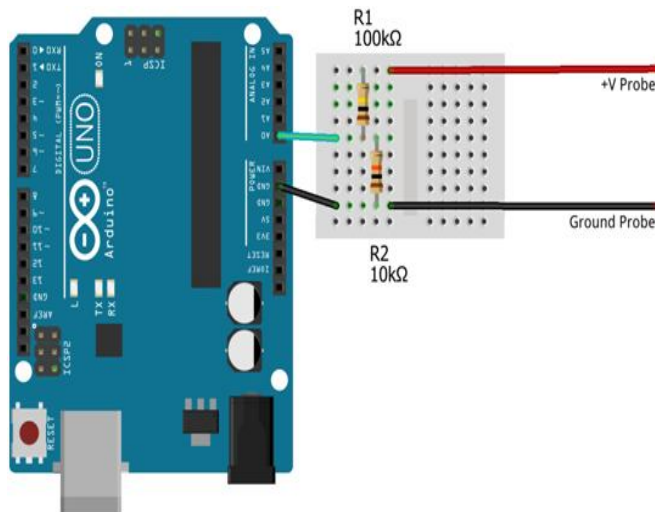


Fig-2 Voltage Divider Circuit

Cloud setup

Thing Speak is an open source IoT application which is used to stock and regain the user's data. It is an Application Program Interface (API) having some set of subroutines and protocols, referred from [1] [2]. Thing speak works under HTTP protocol. HTTP can be abbreviated as Hyper Text Transfer Protocol; this is applied in collaborative and hypermedia information systems.

Thing speak facilitates the design of location tracking applications and sensor logging applications. MATLAB is the computing software from MathWorks which provides an integrated support to Thing Speak. All of the documentations of thing speak is incorporated with MathWorks.

The account should be created first by the user. Thing Speak account encloses channels which are separated for different kinds of projects. Channel itself have loads of fields in which various parameters can be demonstrated.

After assigning the parameter the system uploads the values in cloud and exhibits the values in the site. The record of history is kept for all entities. The values are graphically represented using some built-in behaviors in the cloud platform.

V. IMPLEMENTATION

Work Flow

The below flow chart describes about the process of our anticipated work of project. The work flow given here is from the solar panel to cloud database.

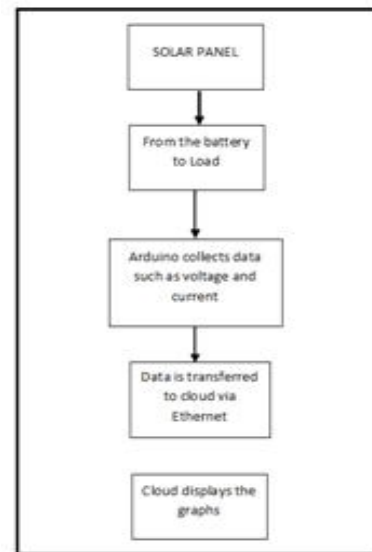


Figure-3 Workflow

- The energy from the solar panel is DC voltage. And this voltage is given to the battery and inverter
- The energy from the battery is distributed to a load
- Arduino microcontroller will collect data such as current and voltage that is to be displayed in graphs
- Collected data will be stored in cloud using the Ethernet shield form Arduino
- The results are displayed in graph in Thingspeak webpage

HARDWARE SETUP

The below diagram shows the hardware setup of our proposed work of project. The type of energy coming from solar panel is Direct Current (DC) [4]. Hence the power from

panel is connected to battery. Battery acts as the source for a load. One end of load is associated with battery and the other end is connected to sensor circuit. The work of sensor circuit is to find the current values which will be collected by Arduino MC. The voltage is found using voltage divider circuit and those readings are collected by Arduino. Both the circuits are placed in the dot matrix board. A Buck-Booster converter circuit is also used for the purpose of maintaining a constant range of voltage. The buck inverter acts as step-down converter and booster inverter acts as step-up converter.

The analog pins of Arduino helps to gather voltage and current readings. Appropriate program for the Arduino is used to get those readings. The data has to be stored in cloud and the values have to be displayed in graph. So Ethernet shield is used to transfer the data from Arduino to the webpage via internet.

SOFTWARE SETUP

The Arduino software is chosen as development software. Arduino IDE is an open-source platform for compiling and uploading the program to Arduino controller. Arduino program acts as the communication link between those sensor circuits and the microcontroller.

The program includes libraries for both Ethernet connection and Thingspeak platform. Using the program, collected values is transferred to internet from Ethernet shield using Ethernet cable. The program includes appropriate protocols that are needed to connect to the Thingspeak.

With the help of Arduino programming the monitored data is uploaded to cloud. Thingspeak is a cloud platform used in our project. It is an open-source Internet of Things (IoT) API and application for storing and retrieving data in cloud. This platform helps us to display the data as graphs with constant updates.

VI. RESULTS AND DISCUSSION

The below is given a picture of hardware setup and the webpage displaying graphs of our proposed work. The program used here helps to connect to internet and display the monitored data in webpage using a laptop. The data is constantly uploaded at certain interval.

Graphs

The observed data that is sent to the cloud and it is displayed in separate fields with respect to date and time. Each field represents the individual graphs.



Figure-4 Battery Current



Figure-5 solar panel voltage

Graphs accentuate the important points, which makes the data more considerable and deliver a compact way of providing data to the users. Here the graphs are plotted for current, voltage and power values with respect to date and time. These graphs can be retrieved over internet from anywhere.

VII. CONCLUSION

Renewable energy is one of the way to reduce the environmental impact to maintain an efficient power consumption. Frequent power cut is an important issue and so we use renewable energy which needs monitoring the energy. Monitoring directs the user in analyzing usage of renewable energy. Our project is a cost effective system. The system efficiency is about 95%. This enables the efficient use of renewable energy. Hence it reduces the electricity issues occurring in our world.

This project can be further enriched, by using the monitored values which are very much helpful in forecasting the future readings of the parameters measured. Another

enhancement will be of analyzing the monitored data using the MatLab. The CSV file can be downloaded from the cloud platform i.e. Thing speak and is taken for analysis in R. Along with the webpage, an android application can be developed for interacting with the end user. The accuracy of the model can be determined by using same data with different model.

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