Monitoring of Solar Power Plant and Load Control

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ABSTRACT:The solar energy is lots available in world so we will utilize this for solar power generating purpose. The currently used energy sources are not renewable. In this project renewable energy sources used because they cannot damage natural surroundings, renewable and free of cost. If these natural resources is solar power and there are several ways to use it. The work of remote data monitoring is highly useful, thereby decreasing the manual work and the errors in reading. In this system we used Ethernet module as trans receiving system.

The objective of this work is to develop a power management system for optimum utilization of generated power from Solar PV power plants. So this increase efficiency of solar power plant as well as monitoring the system. The features of the proposed scheme are automatic load switching, advanced remote metering & control, and priority based switching.

KEYWORDS:*Renewable energy, IoT, Cloud, monitoring, load control, solar power optimization.*

I. INTRODUCTION

Today's industry works with conventional energy sources like coal, oil, natural gases or uranium. Meanwhile, we will have two big problems with them; they produce several kinds of pollutions. If we do not care atmospheric pollution, climate change or nuclear waste can endanger our living condition on the earth.

On the other side, the renewable energy sources use natural flows. These renewable energy sources only use a small part of the flow due to which they cannot damage natural surroundings. One of these natural resources is solar power and there are several ways to use it. This will produce electricity, how the photovoltaic technologies work, and then will show an implementation of the hardware developed for collecting the data (voltage, currents etc.). The solar power pack is long lasting, cost effective and trouble free power solution. As a result of proven technology, they are highly efficient with low maintenance. With just one time investment, solar power packs eradicate non-availability of grid power, unpredictable power Cuts & rising electricity bills worries. They are eco-friendly too.

The term "Photovoltaic" (PV) is a combination of two words- "photo", meaning light, and "voltaic", meaning electricity. Thus PV technology is the scientific term that used to describe the solar power and the generation of electricity from light. Here, solar cells arrays convert light from the sun directly into electricity. Solar power systems are like any other power generating systems. In solar power systems, different equipment is used than the conventional electromechanical power generating systems.

To overcome these problems we design the system to distribute the load on non-renewable resources to renewable resources (solar). With this data acquisition through the internet of things, control the system or load. This proposes system is for monitoring of solar power and load control using internet of things.

II. LITERATURE REVIEW

R. Nagalakshmi, B. Kishore Babu, D. Prashanth have suggested Solar arrays can also have a higher level of sophistication, in terms of optimizing their performance, extending their active life and increasing their residual value. Unfortunately, the technology to do this doesn't come with the basic package [1].

Haider-e-Karar l, Aziz AltafKhuwaja, Abdul Sattar have proposed Using Arduino boards for data acquisition is considered as one of cost effective solution and easily available. In this paper our aim is to monitor and control DC power produced by solar panels and consumed by load through computers locally and remotely using simple and cost effective hardware like Arduino board [2].

Alvin O. Converse presented the solar power pack is long lasting, cost effective and trouble free power solution. As a result of proven technology, they are highly efficient with low maintenance. With just one time investment, solar power packs eradicate non-availability of grid power, unpredictable power Cuts & rising electricity bills worries [3].

Hong Insung, Kang Byeongkwan, and Park Sehyun were proposed Non-availability of grid power, unpredictable power cuts, rising power bills and maintenance worries are the major concerns for today's consumers [4].

Kabalci, Ersan, AlperGorgun, and YasinKabalci introduce 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 [7].

Yoshihiro, et al 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[8].

III. PROPOSED WORK

The main objective of this proposed work is to monitor by using data of solar current, solar voltage, solar power generation and controlling the load automatic way. This system will be helpful for industries as well as organizations.

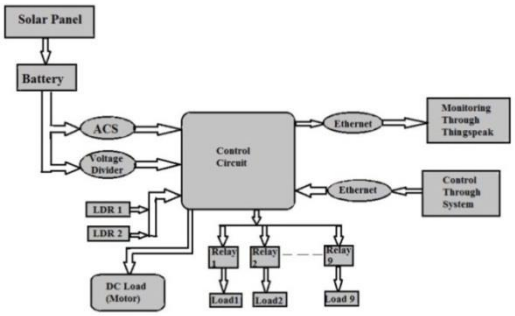


Fig.1 Block diagram of proposed system

In the figure 1 shows the block diagram of proposed system. In which control circuits is the heart of this system as a flow of circuit, this proposes system is for monitoring of solar power and load control using Internet of Things. Solar panel helps to store the energy in the battery. Battery has the energy which is useful for the electrical appliances. Battery is connected to the Arduino. Arduino is a micro controller which is used to read the sensor values. Current sensor and voltage divider are connecting to the Arduino.

Arduino is connected to Ethernet shield through USB cable. Ethernet shield is working as a server. The data from the arduino is display on the web page through Ethernet. The monitoring data upload to the cloud through Ethernet systematic data to drive the loads in automatic way. According to these reading control circuits send data to the thingspeak through Ethernet. At the end of thingspeak, it calculates and create graph to monitor [2].

According to monitored graphs, we will decide to control loads. At control module, our controllingunit shows numbers of load on grid supply and solar power supply [1]. When we will gives command through control system to switch the power supply, this command received by control circuit through Ethernet shield. And according to received command control circuit switch respective relay through relay driver circuit, which are connected to load and switch the power supply. On the other hand control circuit track the sun position for solar panel, for that we are using two LDR to calibrate the intensity of sun light and get the position of sun [1]. Both LDR gives input to the control circuit and according to that input control circuit track the sun position with Johnson gear motor which is connected to solar panel to rotate it. With this flow of system monitoring and controlling solar power plant and load.

We divided this proposed system in three modules based on their working:

A) Monitoring of load module.

B) Controlling of load module.

C) Sun tracking module.

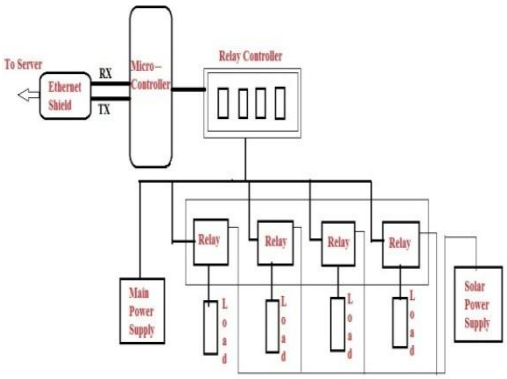
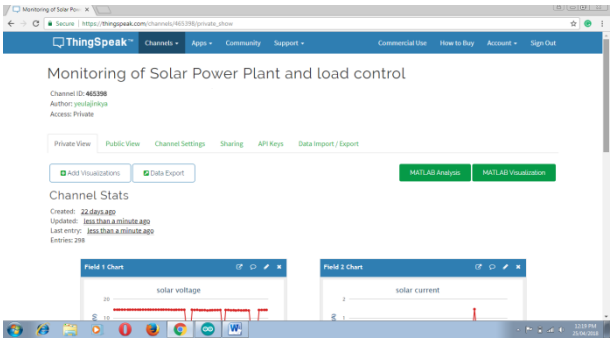


Fig.2 For Load Control

3.1. Cloud Setup (Server)

ThingSpeak is an open source internet of things application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak 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.



3.2. Microcontroller

A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems.

3.3. ArduinoMega

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 16 analog inputs, 54 digital input/output pins (of which 15 can be used as PWM outputs), 4 Universal Asynchronous Receiver/Transmitter (UARTs), a 16MHz crystal oscillator. The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of Static Random Access Memory (SRAM) and 4 KB of Electrically Erasable Programmable Read-Only Memory (EEPROM) (which can be read and written with the EEPROM library). Other Arduino boards like UNO can be used depending upon number of inputs needed.

Each of the 54 digital pins on the Mega can be used as an input or output, using pinmode(), digitalwrite(), and digitalread() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50 k ohm. A maximum of 40mA is the value that must not be exceeded to avoid permanent damage to the microcontroller.

Fig.3 Arduino mega

3.4 Solar Panel

Solar panels are devices that convert light energy into electricity. A solar panel is a packaged, connected assembly of photovoltaic cells. Several types of solar cells available in the market are:

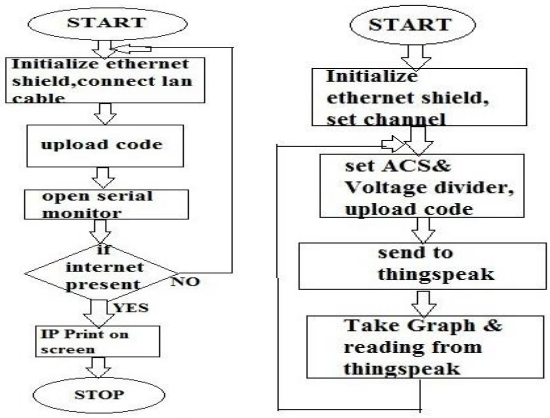
- Monocrystalline silicon (mono-silicon or single silicon)
- Polycrystalline silicon (multi-crystalline, multi-silicon, ribbon)

We used 24W (12V and 1.5A) polycrystalline solar panel for our experiment.

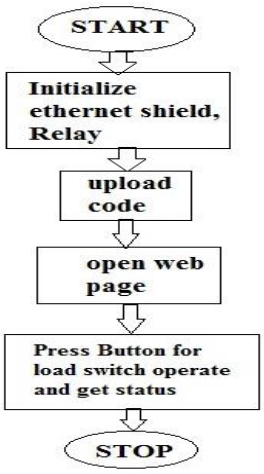
IV. IMPLEMENTATION

4.1 Work Flow

Fig.5 represents the process of proposed system for monitoring system and controlling system of load. The work flow of the monitoring of solar power plant and load control is presented in the form of flowchart as below:



(a)(b)



(c)

(a) For finding IP address (b) for monitoring system (c) for controlling load system

Fig.4 Shows work flow of system

4.2 Experimental Setup

Fig.5 shows the Experimental Setup of theproposed system. The solar energy stored in battery bysolar panel is DC current. So we use DC bulb as thesource of power usage. One terminal of the bulb isconnected to the battery for power supply. Secondterminal is connecting to the current sensor for provide currentreading. zero PCB is used for the complex circuit tobuild. It also helps to build voltage divider.

Sensor sense the current and voltage value sends to arduino through Analog pins. With the help of these values, Arduino programing calculates the power. Output is send to the Ethernet shield through USB cable. Ethernet shield is considered as the server. The monitor displays the web page and cloud data with the help controlling the load by iot.

Fig.5 Experimental Configuration Setup

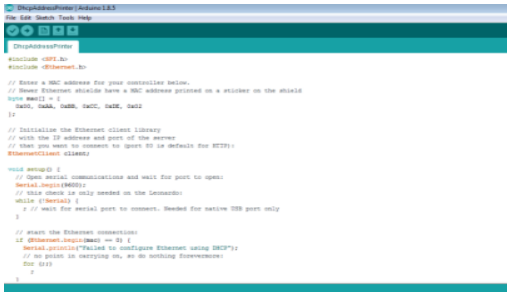
Table 1: Experimental setup for monitoring and controlling of load

Component	Specification
Microcontroller	Atmega 2560
Relay	DPDT 12V, 10A
Transistor	BC547B
DC Motor	12V, 60rpm.
Solar Panel	24W, 17.5V, 1.5A.
LED Light	load
Power Supply	12V,2A output
Ethernet module	W5100
Resistors	10kohm, 100kohm.
Current Sensor	ACS712
Crystal Oscillator	16MHz
Capacitor	100nF
LDR	Sun Sensor
Diode	1N4007
DC power jack	12V
USB port	5V

4.3 Software Setup

The open-source Arduino Integrated Development Environment or Arduino Software (IDE) – is used in system for upload the code on to board. The sensor and circuit are connect to the Arduino for communicate with them to sense current and voltage. We write the code in c for the sensing and calculating the power and energy.

With the help of python program monitoring data is upload to the cloud. ThingSpeak cloud is used in this project. It is an open source Internet of Things (IoT) application and API to store and retrieve data. In this cloud we creation the social network of things with status updates.



V. RESULTS AND DISCUSSION

The proposed work illustrates results for the Monitoring System of solar power plant and load control.

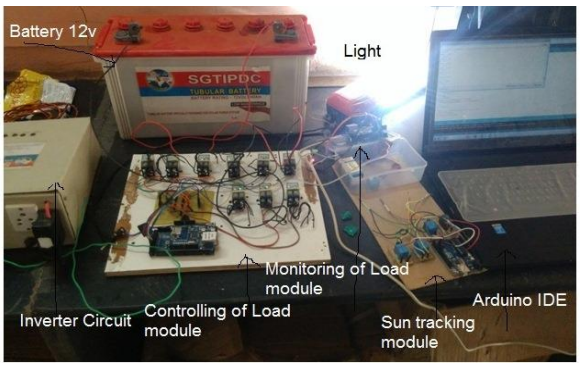


Fig.6 Monitoring and Controlling Circuits for Load Control

Used of Without Sun Tracking System

Table 2: Voltage, Current and Power for System without Tracker

SR. No.	TIME	VOLTAGE (V)	CURRENT (I)	POWER (W)
1.	12.15pm	14.29 V	1.47 A	20 W

Used of With Sun Tracking System

Table 3: Voltage, Current and Power for System without Tracker

SR. No.	TIME	VOLTAGE (V)	CURRENT (I)	POWER (W)
1.	3.45pm	17.41 V	0.17 A	2.95 W

5.1 Controlling Load System Panel

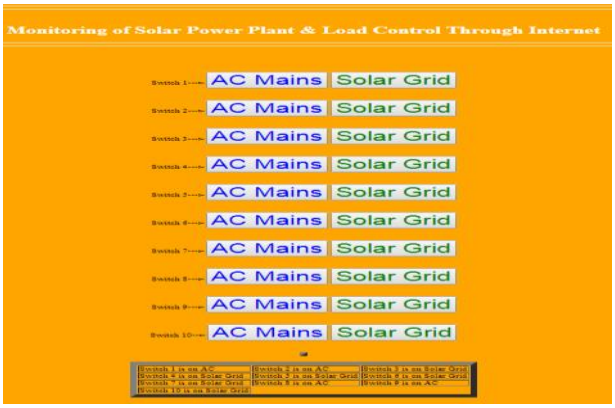
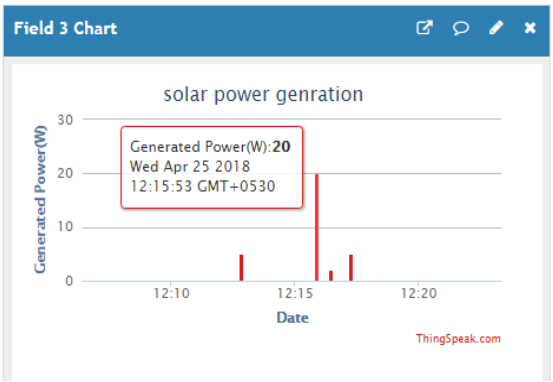
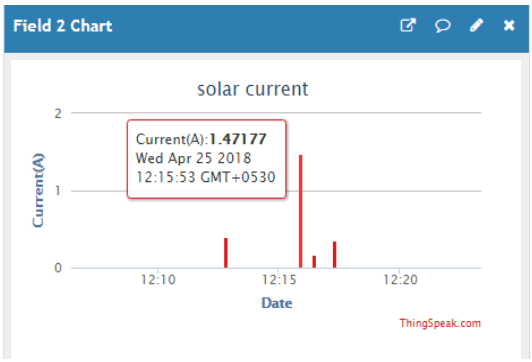


Fig.7 Control panel for user interference

5.2 Graphs

The monitoring data sent to the cloud is store in separate fields. Each fields display the individual graphs as shown in the Fig.8





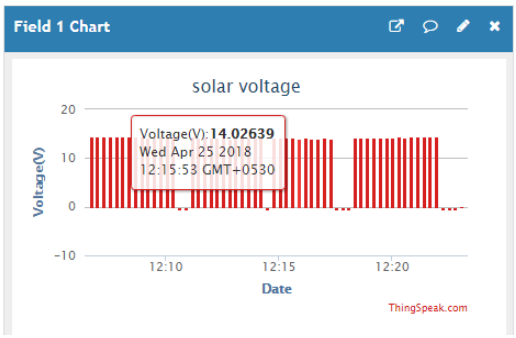


Fig.8 Current, Voltage, and Power Generation Graphs

Graphs emphasize the main point, make the data more convincing and provide a compact way of presenting information to the users. Graphs are plot for current, voltage, power and energy value with respect to date. These graphs are access through internet from anywhere and also available on mobile app.

VI. CONCLUSION AND FUTURE SCOPE

From the Design and Experimental Setup with Arduino, Ethernet and Iot was Monitoring and Controlling Solar power plant with automatic load control, which decreases power consumption of grid supply and increases the use of renewable resources. This is profitable for organization or industries and beneficial for environment. This monitoring system provides a systematic graphical representation monitor the load and control system used to manage the load.

For the future scope we can implement the system to control load in automatic, according to monitoring system with an artificial intelligence. That will able to decide load switching according to ACS and Voltage divider inputs.

It helpful in predicting the future values of the parameters considered. The data stored in cloud can also be analyzed using the Matrix laboratory. The CSV file from the cloud is taken for analysis in Renewable sources. 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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