IOT BASED SOLAR POWER MONITORING SYSTEM

Aditi Mangore,
UG Student, Department of Electrical Engineering,
Yashoda Technical Campus Satara, India

Swapnali Chougale,
UG Student, Department of Electrical Engineering,
Yashoda Technical Campus Satara, India
swapnali1550@gmail.com

Mayuri Palekar,
UG Student, Department of Electrical Engineering,
Yashoda Technical Campus Satara, India

Kunal Bhosale,
UG Student, Department of Electrical Engineering,
Yashoda Technical Campus Satara, India

Sushant Kadam,
UG Student, Department of Electrical Engineering,
Yashoda Technical Campus Satara, India

Kiran Kshirsagar
UG Student, Department of Electrical Engineering,
Yashoda Technical Campus Satara, India

Mr. S. U. Bagwan
UG Guide, Department of Electrical Engineering,
Yashoda Technical Campus Satara, India
sub_ele@yes.edu.in

ABSTRACT
Today's generation of electricity is the basic need of everyone's life. We need electricity heating, lighting and so many things. Day by day energy consumption is getting rapidly increased whereas resources is decreasing. There are two ways of electricity renewable and nonrenewable and in which solar power is renewable which get naturally. Solar power is a cheaper and free source and highly recommend for generation of electricity.
Solar energy produced by sun's light and generates the electricity. The IOT has a vision and it's allows the object to be sensed and control remotely into the computer based system and they resulting in improved accuracy. This technology has many applications like solar cities, smart villages and so on. And this technology working anywhere over the internet. In our researching we are working on a model based on IOT technology that allows for smart solar power monitoring system

Keywords: Solar Power, Renewable energy, Accuracy.

INTRODUCTION

The IoT means Internet of Things is a system of similar computing devices, digital and mechanical machines, objects, people with particular identifiers and potential transfer of information over a network without human-to-human or human-to- computer interaction. No longer disconnected from the virtual world those are Physical objects, but through Internet services it can be controlled remotely. A smart world is nothing but Smart devices, Smartphone's, Smart cars, Smart homes and Smart cities. "Smart" objects play a key role in the vision of IoT.

Solar energy is universally available all over the world and can contribute to minimize the dependence of energy imports. Solar PV leads to no greenhouse gas (GHG) emissions and other no pollutants during operation. Solar has many advantages like advanced renewable energy forecasting and enhanced scheduling of power plants, system-friendly deployment, improved operating strategies, and also investment in additional flexible resources, comprising demand-side resources, electricity storage, grid infrastructure and flexible generation.

The Rooftop Solar; Ground mounted Solar, Solar cities, Smart villages, Micro grids and Solar Street lights are the Applications of the monitoring system. 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. Solar traffic signals, solar road studs/blinkers are the Commercial Products which can also be monitored through the proposed system.

Frequent power cut is very common In India. Due to this problem, it is essential to use renewable energy and also monitoring it. By monitoring the energy forecast, households and communities who are using solar power can utilize their energy production and consumption during good weather. Here we present an automate IOT based solar power monitoring system that allow for automated solar power monitoring from any location over the internet.

In many developing countries power generation is the major factor. Due to the improvement of the industrial and commercial sector, energy demand reaches its peak. The solar photovoltaic technique is getting popular due to huge demand, availability, reduced cost, easy installation and maintenance.

PROBLEM DEFINITION

A major problem surrounding solar energy is irregularity and stability of sunlight. If cloudy weather is present in atmosphere, then the photovoltaic cells are unable to produce electricity.

This is very difficult to predict photovoltaic output of solar panel because of that big volume of solar energy is wasted so that we monitor solar energy by using IoT.

OBJECTIVE

1. The main objective is to monitor solar power by using sensors sensed by the Arduino. And display the value of current and voltage on the LCD. And calculate the power.
2. We can display the value of current, voltage and calculated power using remotely.
3. Calibrate graphical representation of current, voltage and calculated power through Wi-Fi module.
4. By using all of above methods we find the fault occurring (dust accumulated, humidity, moisture content) in the solar panels.

COMPONENT

1. Arduino Micro-Controller :-

Microcontroller board is a Arduino Uno which is an open source based on the Microchip ATmega328P microcontroller.

MCU used in Arduino UNO R3 as a main controller and this MCU is the ATmega328 microcontroller. ATmega328 from the AVR family; and it is an 8-bit device, which means that its internal registers and data bus architecture are designed to handle 8 parallel data signals.

ATmega328 micro-controller has total 28 pins which are given in below pin diagram. Arduino coverts analog signal into digital signal.

Why we use Arduino?

1. Arduino do multiple tasks simultaneously
2. No of components are easily available in it.
3. The hardware of Arduino is compact in size.
4. Cost of Arduino is less.
5. Easy to understand and easy to handle.

Pin Diagram:
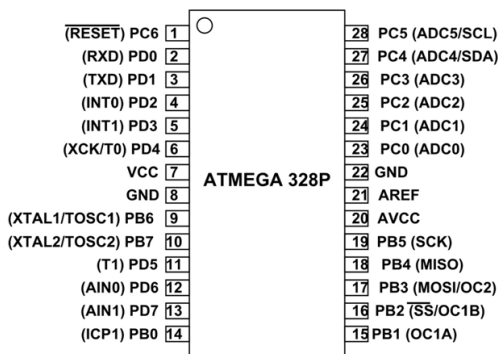

1.1 Pin Dia- ATMEGA 328P

2. Current Sensor :-

The device that finds and converts current to an output voltage is called as Current sensor. The mainly used sensor is current sensor and it is also called as current to voltage sensor.

In the current sensor, there is a current sensing resister which is used to placed into current path and therefore current is converted into the voltage.

While designing of current sensor two things are find;

1. Current flows through wire and also voltage drop occurs.
2. The current carrying conductor produces magnetic field surrounding it.

Pin Diagram:-
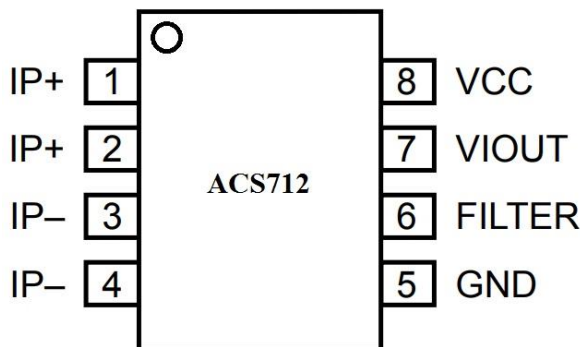
2.1 Pin Dia- Current Sensor

The following table shows the pin number, name and description:-

| Pin Number	Pin Name	Pin Description
1&2	IP+	+ve terminal for sensing current
3&4	IP+	-ve terminal for sensing current
5	GND	Signal Ground
6	FILTER	External capacitor (To set the bandwidth)
7	VIOUT	Analog output
8	VCC	Power Supply

3. Wi-Fi module :-

The Wi-Fi module is ESP8266; it gives any microcontroller access to your Wi-Fi network which is self contained SOC with integrated TCP/IP protocol stack.

Expressive Systems develop ESP8266 microcontroller in Shanghai, China and it is also called as Wi-Fi module. To perform various Wi-Fi related activities we use ESP8266 microcontroller.

Use of Wi-Fi Module

1. To provide internet connection to the electronics projects we use Wi-Fi module.
2. To allow to developing IoT (Internet of Thing) we use Wi-Fi module.
3. You can send the data over the internet by using Wi-Fi module.
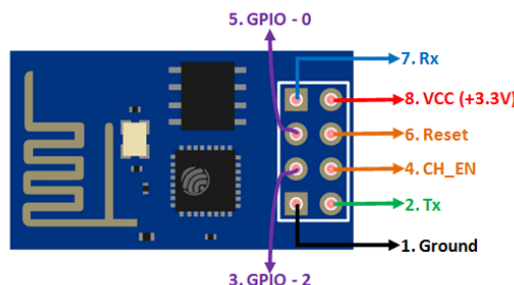
3.1 Dia- Wi-Fi Module

4. Solar Panel :-

Solar panels are also called as photovoltaic panels and it is used to converts light energy from the sun into the electricity.

Solar panels consist of Diode, Photovoltaic diode and solar cells which are active when a photovoltaic ray falls on it.

These panels absorb the photons from sunlight and assist with electrons which are present in the panels and generate electricity which is used for various purposes.

We use 4 solar panels which are connected in parallel connection. Because of parallel connection if any fault is occurring in one of the solar panel then remaining solar panels are in working.

4.1 Dia- Solar Panel

5. Voltage Sensor :-

Voltage sensor is a sensor which is used to sense or calculate and monitor the value of voltage. Voltage sensor can sense either Ac or Dc type of voltage. Voltage sensor gives 5v DC to the Arduino because Arduino works on 5v.

Applications of Voltage sensors:-
1. Detects power failure.
2. Load sensing.
3. Fault finding.
4. Safety switching.
5. Controls electricity demand.

5.1 Dia- Voltage Sensor

6. LCD:

The LCD is a Liquid Crystal Display. We use 16*2 LCD display consist of 16 characters and 2 lines. For our system we use 4 bit LCD.

LCD Pin Explanation
1. VSS – Grounded.
2. VDD – Power pin gives 5v
3. VO – Contrast select pin ,which controls the light intensity or brightness
4. RS – Register select pin, is a register mode selection process which consists of Data Mode and command Mode. These modes control the intensity and when data erase and when data display.

5. RW – Read Write pin, when we want to display the LCD data then we use Write Bar and gives zero logic. And when we want to return the data then use Read Bar but now we not required Read Bar so we grounded.

6. E – Enable pin, to active the function we use Enable pin.
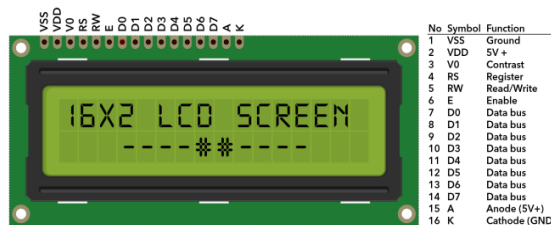
6.1 Dia- LCD

7. IOT:-

THINGSPEAK

Thingspeak is an open source software .Users communicated with internet, facilitate data access and logging data by providing API to device and social network website. Thingspeak has been subjected of articles specialized "Maker". They have integrated support from numerical computing soft MATLAB.

Thingspeak is a software which send the data to cloud and in the cloud data is stored in two channels either privet or public.

Features of IoT

- Collect data in private channels
- Share data with public channels
- RESTful and MQTT APIs
- MATLAB® analytics
- Event scheduling
- Alerts
- App integrations

RESULT

Circuit Diagram
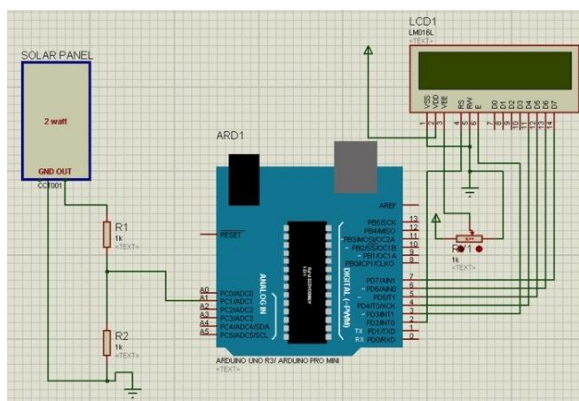
Fig 7.1 Circuit Diagram

In circuit diagram refer to figure 7.1 it is done in ThingSpeak software. It consists of solar panel, LCD display, current sensor and voltage sensors are used to IOT monitored solar. From this we have got the result

graphically which is displayed in figure 8.1 and we have got the result digitally which is displayed in figure 8.2 in the figure.

GRAPHICAL REPRESENTATION OF RESULT

Fig. Graphical Representation Of Result

DIGITAL REPRESENTATION OF RESULT

Fig. Digital Representation Of Result

REPORT ANALYSIS

Table No.1 - Day Wise Report Analysis

DAY WISE REPORT ANALYSIS

TIME 07:00AM

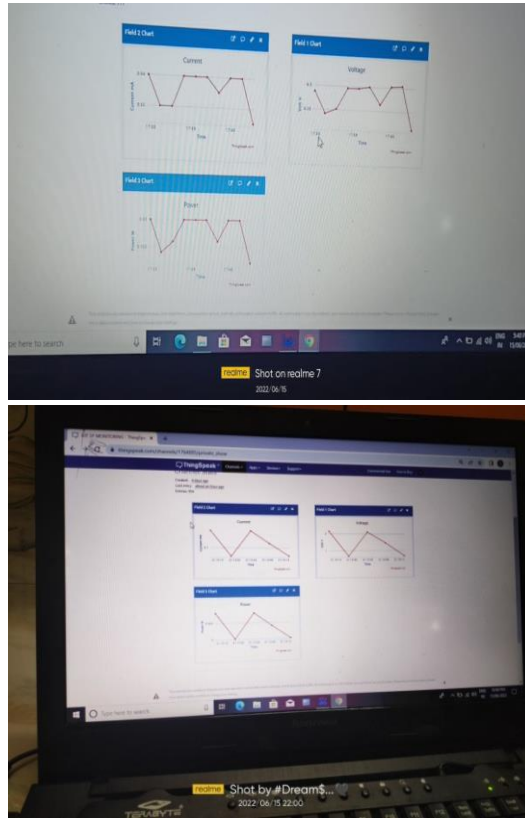| Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	7:00	1	4.05	0.6	0.24
Remove 1 solar panel	15/06/2022	7:00	2	4.05	0.6	0.24
Remove 2 solar panel	15/06/2022	7:00	3	4.04	0.58	0.23
Remove 3 solar panel	15/06/2022	7:00	4	4	0.58	0.23
All in shadow	15/06/2022	7:00	5	3.89	0.56	0.21

TIME 11:00AM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	11:00	1	7	0.62	0.42
Remove 1 solar panel	15/06/2022	11:00	2	6.85	0.6	0.41
Remove 2 solar panel	15/06/2022	11:00	3	6.66	0.61	0.4
Remove 3 solar panel	15/06/2022	11:00	4	6.4	0.61	0.39
All in shadow	15/06/2022	11:00	5	4.95	0.62	0.3

TIME 02:30PM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	2:30	1	7.2	0.6	0.43
Remove 1 solar panel	15/06/2022	2:30	2	7.2	0.6	0.43
Remove 2 solar panel	15/06/2022	2:30	3	6.86	0.61	0.42
Remove 3 solar panel	15/06/2022	2:30	4	6.46	0.61	0.39
All in shadow	15/06/2022	2:30	5	4.9	0.61	0.3

TIME 05:30PM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	5:30	1	4.3	0.61	0.26
Remove 1 solar panel	15/06/2022	5:30	2	4.16	0.61	0.25
Remove 2 solar panel	15/06/2022	5:30	3	3.47	0.61	0.21
Remove 3 solar panel	15/06/2022	5:30	4	3.3	0.61	0.19
All in shadow	15/06/2022	5:30	5	0.74	0.61	0.05

Report Analysis
sheet.xlsx

Table No.2- Night Wise Report Analysis

NIGHT WISE REPORT ANALYSIS

TIME 07:00PM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	7:00	1	0.44	0.6	0.03
Remove 1 solar panel	15/06/2022	7:00	2	0.44	0.6	0.03
Remove 2 solar panel	15/06/2022	7:00	3	0.44	0.6	0.03
Remove 3 solar panel	15/06/2022	7:00	4	0.44	0.6	0.03
All in shadow	15/06/2022	7:00	5	0.44	0.6	0.03

TIME 08:00PM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	8:00	1	0.45	0.61	0.03
Remove 1 solar panel	15/06/2022	8:00	2	0.45	0.61	0.03
Remove 2 solar panel	15/06/2022	8:00	3	0.45	0.61	0.03
Remove 3 solar panel	15/06/2022	8:00	4	0.45	0.61	0.03
All in shadow	15/06/2022	8:00	5	0.45	0.61	0.03

TIME 09:00PM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	9:00	1	0.64	0.6	0.04
Remove 1 solar panel	15/06/2022	9:00	2	0.64	0.6	0.04
Remove 2 solar panel	15/06/2022	9:00	3	0.64	0.6	0.04
Remove 3 solar panel	15/06/2022	9:00	4	0.64	0.6	0.04
All in shadow	15/06/2022	9:00	5	0.64	0.6	0.04

TIME 10:00PM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	10:00	1	0.61	0.61	0.04
Remove 1 solar panel	15/06/2022	10:00	2	0.61	0.61	0.04
Remove 2 solar panel	15/06/2022	10:00	3	0.61	0.61	0.04
Remove 3 solar panel	15/06/2022	10:00	4	0.61	0.61	0.04
All in shadow	15/06/2022	10:00	5	0.61	0.61	0.04

Table No.3- Night-Torch Wise Report Analysis

NIGHT-TORCH WISE REPORT ANALYSIS

TIME 07:00PM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	7:00	1	0.44	0.6	0.03
Remove 1 solar panel	15/06/2022	7:00	2	0.44	0.6	0.03
Remove 2 solar panel	15/06/2022	7:00	3	0.44	0.6	0.03
Remove 3 solar panel	15/06/2022	7:00	4	0.44	0.6	0.03
All in shadow	15/06/2022	7:00	5	0.44	0.6	0.03

TIME 08:00PM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	8:00	1	0.44	0.6	0.03
Remove 1 solar panel	15/06/2022	8:00	2	1.26	0.61	0.08
Remove 2 solar panel	15/06/2022	8:00	3	1.5	0.6	0.09
Remove 3 solar panel	15/06/2022	8:00	4	1.46	0.6	0.09
All in shadow	15/06/2022	8:00	5	1.37	0.61	0.08

TIME 09:00PM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	9:00	1	0.58	0.61	0.04
Remove 1 solar panel	15/06/2022	9:00	2	1.55	0.61	0.09
Remove 2 solar panel	15/06/2022	9:00	3	1.63	0.62	0.1
Remove 3 solar panel	15/06/2022	9:00	4	1.51	0.62	0.09
All in shadow	15/06/2022	9:00	5	1.45	0.6	0.09

TIME 10:00PM

Condition	Date	Time	Entry_Id	Field1(V)	Field2(mA)	Field3(W)
Full Intensity	15/06/2022	10:00	1	0.6	0.61	0.04
Remove 1 solar panel	15/06/2022	10:00	2	1.51	0.61	0.09
Remove 2 solar panel	15/06/2022	10:00	3	1.58	0.61	0.1
Remove 3 solar panel	15/06/2022	10:00	4	1.69	0.6	0.1
All in shadow	15/06/2022	10:00	5	1.47	0.6	0.09

APPLICATIONS

➢ IOT utilize computing facilities and software systems for information processing and knowledge digging.

➢ Using IOT machine to machine and Human to machine information exchange and smooth linkage of information flows can obtained.

➢ IOT real-time control is used to accurate management and intelligent decision-making of physical world can be made.

ADVANTAGES
- Unable the efficient use of renewable energy
- Environment free
- Requires the little maintenance for their application
- Cost effective

DRAWBACKS
- The batteries used to store solar power are huge sized
- The batteries need to be replaced from time to time.
- The solar energy can be directed in a limited period.

FUTURE SCOPE
1. In future need is to overcome certain problems. in solar panel related factors like repair, survey & maintenance thus enhance its efficiency.
2. Solar power plant system monitoring via IOT should be improved for better performances & maintenance.

CONCLUSION
The proposed system store the voltage and current parameters and keep updating the new values. By tracking the solar photovoltaic system continuously, the daily or monthly analysis also become simple and easy. It is also possible to detect any errors occurring in the system. If there is any uncertainty in generated data by tracking solar panels that are operated at maximum capability

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