ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 6, Issue 12, December 2019

Design and Implementation of IOT Enabled Smart Solar Power Monitoring System

K.Tamilselvi[1], E.Jananandhini[2], N.Vijayakumar[3]

Assistant Professor(s), Department of Computer Science and Engineering[1, 2]

P.A.College of Engineering and Technology, Pollachi, India

Assistant Professor, Department of Computer Science and Engineering[3]

Pollachi Institute of Engineering and Technology, Pollachi, India

tamilslevipacet@gmail.com, jananandhinie.pacet@gmail.com, vijayqps@gmail.com

Abstract: The solar energy has a wide scope in the future. Solar power plants must need to be monitored for best possible 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. Therefore here we propose an IOT based solar power monitoring system that allows solar power monitoring automatically from anywhere over the internet. We use Arduino based intelligent system to monitor a 10Watt solar panel parameters. In this system frequently monitors the solar panel parameters and transmits the power output to IOT system over the internet automatically. In this project few solar energy parameters are calculated with help of various sensors. This project includes controller Arduino Uno; the software used will be Arduino IDE. We will calculate various parameters like Current, Voltage. For calculation of intensity we will see LDR sensor for current measurement the current sensor, for voltage we will use voltage divider representing the whole result of the calculated parameters the whole result of the calculated parameters will be displayed on 16×2 LCD. Which is interfaced with Arduino Uno for running the whole circuit we will use a 230/12 V step down transformer which reduce the A.C voltage to 12 volt. After that bridge rectifier is used to convert 12 V A.C. to12V D.C. The D.C voltage have some ripple contents which will be filtered through the filter circuit which is capacitive filter and for the microcontroller operation the whole 12V D.C supply will be reduce to +5V. The solar energy is huge source of energy in the globe. It is renewable energy resources thus there is no matter about its consumption This makes remotely monitoring of solar plants very easy and ensure best power output.[9]

Keywords: IOT, Smart Solar System, Power Monitoring, Intelligent solar system

I. Introduction

An intelligent solar PV system can use both electrical as well as solar energy to charge the system storage battery. This can further be used to generate electricity in the absence of either or both of energy sources. In General during day time only electricity is generated from solar panels, with a peak production during noontime. This electricity is variable and not matched with the consumption of the domestic. To overcome this gap between what is produced and what is required during the absence of solar electricity production. It is essential to store energy for further use and control energy storage and consumption in an intelligent way. Final objective is to monitor the PV system via Internet of Things (IoT).

Solar power system is designed to supply usable solar power by means of photovoltaic energy. It consists of a number of components, including solar panels to absorb and convert sunlight into electricity, a solar inverter to change the electric current from DC to AC, as well as mounting, cabling and other electrical accessories to set up a system. A solar array of a typical residential PV system is rack-mounted on the roof, rather than integrated into the roof of the building, as this is significantly more expensive. [2-3]

The objective is to develop a dual axis tracking system for rotating the solar panel in two different axes or use the

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 6, Issue 12, December 2019

existing one. MPPT mechanism is applied to improve the power gain by accurate tracking of the sun.

Fig.1 Solar PV Developed with Sun Tracking

A smart hybrid inverter or smart grid inverter is a trending production of inverter for solar applications using renewable energy for domestic consumption, particularly for solar photovoltaic installations. Electricity from solar panels is generated only during the day, with peak generation around noontime.

This electricity is fluctuating and not synchronized with the household's electricity consumption. To overcome this gap between what is produced and what is consumed during the evening when there is no solar electricity production, it is necessary to store energy for subsequent utilization and control energy storage and consumption in an intelligent hybrid (smart grid) inverter. [4]

II. Proposed Work

The objective of the proposed system is to monitor the power of the system using the current and voltage value sensed by the Arduino. The display of the solar energy system shows the power and energy usage. In this system setup helps to implement in smart grid for efficient usage

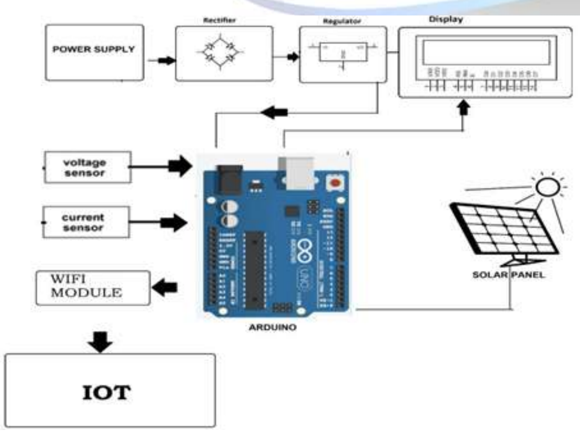

Fig.2 Block Diagram

A. System Design

The proposed system is for monitoring of solar energy using IoT. 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 working as a server. The data from the Arduino is display on the LCD. The monitoring data will uploaded as a message in mobile. [5]

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 programming calculates the power and energy.

Fig.3 System Design

C. Current and Voltage Acquisition Circuit

The analog inputs of an Arduino can measure up to 5V. Even when connect to a 5V circuit, you should use the resistors to help protect the Arduino from short-circuits or unexpected voltage surges. The circuit of voltage divider as shown in the fig.4

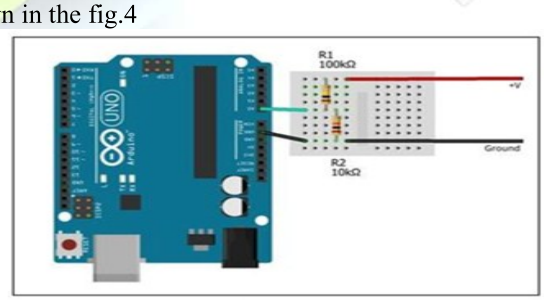

Fig.4 Voltage Divider

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 6, Issue 12, December 2019

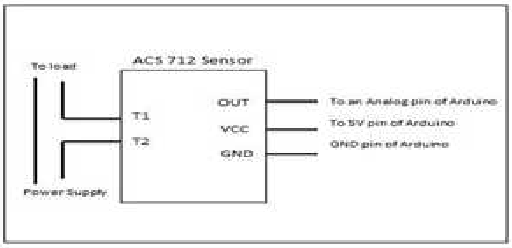

Fig.5 Current Sensor Circuit

Those two resistors form a potential divider that is used 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. Breadboard is used to build this circuit. The Analog pin of Arduino gives the voltage value. This 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, and so you can calculate the maximum input voltage to the circuit:

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

For current measurement 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 Fig.1, Arduino display the values of current flow. [7]

D. 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.

III. Implementation and Result

A. Work Flow

The Arduino compiler requires that two functions be implemented for any program to be uploaded to aboard. These are fairly intuitive and straightforward: there is a setup method and a loop method. The function of setup in this case is straightforward with one exception. This is the action required to turn on and allow the cell phone to reach a state where it is ready to receive messages. Once inside the main control loop, the logic of the program is also fairly straight forward. 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: Raspberry pi fetch the Arduino output data through serial port and display on the web page through python script.

Step 3: Raspberry 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. [6-8]

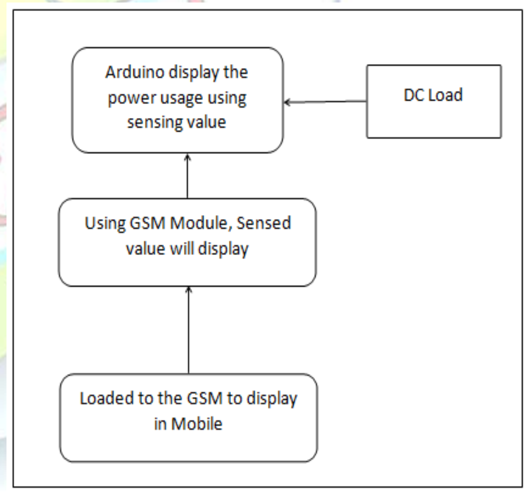

Fig.6 work flow process

B. Hardware Setup

Fig, 6 shows the Hardware setup of the proposed system. In this system was designed with the Arduino Uno, Solar panel, Voltage sensor, LCD Display and Current sensor . The solar energy stored in battery by solar panel is DC current. So we use DC bulb as the source of power usage. One terminal of the bulb is connected to the battery for

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 6, Issue 12, December 2019

power supply. Other terminal is connecting to the current sensor for current reading. Breadboard is used for the complex circuit to build. It also helps to build voltage divider. [9]

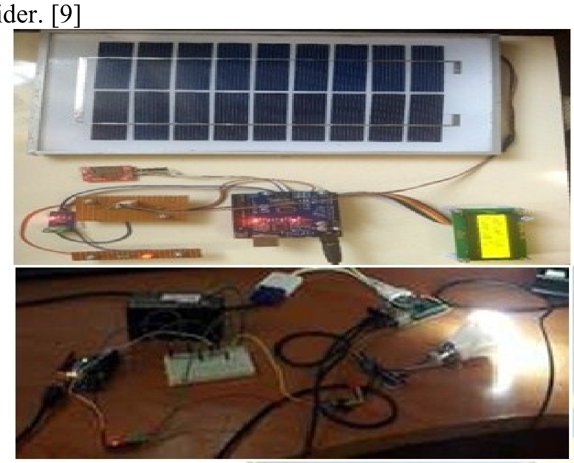

Fig.7 Hardware setup of the proposed system

Arduino sense the current and voltage value through Analog pins. With the help of these values, Arduino programming calculates the power and energy.

The result of the system is displayed on the LCD &SMS 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.[10]

C. Source Code

```
#define NUM_SAMPLES 10
#include <LiquidCrystal.h>
LiquidCrystal lcd(4,5,6,7,8,9);
int sum = 0;
unsigned char sample_count = 0;
float voltage = 0.0;
double IVoltage = 0;
double Current = 0;
float v = 0.0;
long previousMillis1 = 0;
long interval1 = 30000;
int count=0;
int count1=0;
void setup()
{
Serial.begin(9600);
lcd.begin(16, 2);
}
void loop()
{
for(int i = 0; i < 1000; i++) {
IVoltage = (IVoltage + (.0049 * analogRead(A0)));   // (5 V / 1024 (Analog) = 0.0049) which converter Measured analog input voltage to 5 V Range
delay(1);
}
IVoltage = IVoltage /1000;
Current = (IVoltage -2.5)/ 0.185;
String a=String(Current,2);
while (sample_count < NUM_SAMPLES) {
sum += analogRead(A2);
sample_count++;
delay(10);
}}
v = voltage * 11.132;
sample_count = 0;
sum = 0;
lcd.clear();
lcd.setCursor(0,0);
lcd.print("Voltage: ");
lcd.print(v);
lcd.setCursor(0,1);
lcd.print("Current:");
lcd.print(a);
delay(2000);
if(voltage<3)
{
if(count==0)
{
Serial.println("AT+CMGF=1");    //Sets the GSM Module in Text Mode
delay(1000);  // Delay of 1000 milli seconds or 1 second
Serial.println("AT+CMGS=\"+918940265919\"\r");           //
8056416951Replace x with mobile number //
delay(1000);
Serial.print("VOLTAGE LOW");// The SMS text you want to send
delay(2000);
count++;
}}
else
{
count=0;
}
}
if(voltage>6)
{
if(count1==0)
{
```

```
Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
delay(1000);  // Delay of 1000 milli seconds or 1 second
Serial.println("AT+CMGS=\"+918940265919\"\r");          // 8056416951Replace x with mobile number //
delay(1000);
Serial.print("VOLTAGE HIGH");// The SMS text you want to send
delay(2000);
count1++;
}
}
else
{
count1=0;
}
unsigned long currentMillis1 = millis();
if(currentMillis1 - previousMillis1 > interval1) {
stosms(v,a);
}
}
void stosms(int v,String a)
{
Serial.println("AT+CMGF=1");    //Sets the GSM Module in Text Mode
delay(1000);  // Delay of 1000 milli seconds or 1 second
Serial.println("AT+CMGS=\"+918940265919\"\r");//8056416951Replace x with mobile number //
delay(1000);
Serial.print("SOLAR PANEL PARAMETERS ");
delay(2000);
Serial.print("V: ");// The SMS text you want to send
delay(2000);
Serial.print(v);// The SMS text you want to send
delay(2000);
Serial.print("V   I: ");// The SMS text you want to send
delay(2000);
Serial.print(a);// The SMS text you want to send
delay(2000);
Serial.println(" A");// The SMS text you want to send
delay(1000);
}
```

IV. CONCLUSION

This project has some significant claims to success as well as some admitted failures. The greatest success was the completion of the hardware component of this project. The accomplishment of the hardware side of this project represents the critical proof of concept for this system because not only is the hardware the most significant initial cost in any remote monitoring system, it also represents the source of most after-installation costs. Thus, the ability to show that this implementation accomplishes the requirements of this project is much more contingent on the success of the hardware side than the software side. It is conceivable that a simplified gradient of this project could actually operate independent of this logging software altogether. This project has some obvious areas that remain to be implemented. The first and most obvious of these is of course the software application on the server-side of this monitoring system. This software system is for most practical purposes independent of the hardware side of this system, which is completely unaware of what party is calling it for information. The general purpose of system is to store historical data about a solar power system, and present it in such a way that allows for long term system analysis to be conducted. Such a system will accomplish this task by periodically calling the monitoring device, collecting the data received in the form of DTMF, decoding these tones, and storing them in a database.

This database can then be queried in order to produce graphs and other output representing such things as charge curves, solar insolation data, average power output over time, and so on.

REFERENCES

[1]. Purusothaman S.R.R. and Dhiwaakar et al., 2013. "Implementation of Arduino-based multi- agent system for rural Indian microgrids." IEEE Innovative Smart Grid Technologies-Asia (ISGT Asia). IEEE, 2013.

[2]. Kabalci, Ersan, Gorgun A. and Kabalci Y., 2013. "Design and implementation of a renewable energy monitoring system." Power Engineering, Energy and Electrical Drives (POWERENG), Fourth International Conference on. IEEE, 2013.

[3]. Jiju K. et. al., 2014. "Development of Android based on-line monitoring and control system for Renewable Energy Sources." Computer, Communications, and Control Technology (I4CT), International Conference on. IEEE, 2014.

[4]. Jayavardhana G. et. al., 2013. "Internet of Things (IoT): A vision, architectural elements, and future directions." Future generation computer systems, 29 (7):1645-1660.

[5]. Mayamiko N., Zennaro M. and Bagula A., 2011. "SM 2: Solar monitoring system in Malawi." Kaleidoscope: The Fully Networked Human?-Innovations for Future Networks and Services (K-2011), Proceedings of ITU. IEEE, 2011.

[6]. Alexander S. and Galkin I., 2013. "Case study on using non-intrusive load monitoring system with renewable energy sources in intelligent

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 6, Issue 12, December 2019

grid applications." International Conference- Workshop Compatibility and Power Electronics.

[7]. P. Gopi Krishna et. al. "Design and development of bi-directional smart IoT gateway with interoperability for heterogeneous devices" International Journal of Engineering & Technology, 7 (2.8) (2018) 109-114

[8]. Nordrum, Amy (18 August 2016). "Popular Internet of Things Forecast of 50 Billion Devices by 2020 Is Outdated". IEEE

[9]. P. Gopi Krishna et. al. "Design and development of smart energy meter for effective use of electricity in IoT applications" International Journal of Engineering & Technology, 7 (2.8) (2018) 115-119

[10]. P. Prakash et. al. "Maximum Power Point Tracking Using Fuzzy Logic Controller Based Cuk Converte" International Journal of Engineering Trends and Technology, Volume 67 Issue 11- Nov 2019

BIOGRAPHY

Mrs.K.Tamilselvi is currently working as an Assistant Professor in the Department of Computer Science and Engineering at P.A. College of Engineering and Technology. She completed her undergraduate program in BE CSE from Anna university in the year of 2011. She further did her Master of Engineering in CSE from Anna University in the year of 2013. She has 6 years of teaching experience. Her area of research includes Embedded Systems,IOT, Data Structures and Data Mining.

Mrs.E.Jananandhini is currently working as an Assistant Professor in the Department of Computer Science and Engineering at P.A. College of Engineering and Technology. She completed her undergraduate program in BE CSE from Anna university in the year of 2011. She further did her Master of Engineering in CSE from Anna University in the year of 2013. She has 6 years of teaching experience. Her area of research includes Embedded Systems, IOT and Computer Networs.

Mr.N.Vijayakumar is currently working as an Assistant Professor in the Department of Computer Science and Engineering at Pollachi Instituite of Engineering and Technology. He completed his undergraduate program in BE CSE from Anna university in the year of 2011. He further did his Master of Engineering in CSE from Anna University in the year of 2013. He has 6 years of teaching experience. His area of research includes Embedded Systems, IOT and Cloud Computing.

