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Automated Solar Panel With Web Monitoring

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***ABSTRACT**: Automated solar panel produce more electrical energy instead of existing system. The goal of this paper is to design an automatic sun light tracking system, which can locate position of the sun. The tracking system will move the solar panel so that it is positioned perpendicular to the sun for maximum energy conversion at all time. Our system will produce up to 25% more energy than which solar panels are without tracking. Power module display battery charge percentage and notify us while charging. Main target of this paper, is to connect solar system with web site that can control and monitor the energy producing level via local or live server. System can update energy producing level by itself automatically after a time interval and also display it on the web apps local or live server. Every day system data will store into database.*

***KEYWORD :** Monitoring, power, panel, solar, web.*

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I. INTRODUCTION

Use of renewable resources for producing electricity is increasing. Solar panels arebecoming more popular day by day. May this system have already been implemented insome country. But this project some feature is new. Main reason behind thispaper is bringing some changes in old model solar, make this system more useful to userwith easy understandable feature.

Use of solar panel increasing day by day worldwide. Most of solar panel has no trackingsystem. Non tracking solar panel produce less power. To reduce the increasing demand ofelectricity, use of renewable resources such as solar panels are very popular. But solarpanels power is very less than people demand. Dual axis solar tracker can produce up to 35% more energy. Sometime need to store year round power production for furtheranalysis. Normal solar panel does not show battery capacity or any kind of warning, thisseems to be a problem for user because they cannot know battery status. This system willshow battery status and it will be helpful for user to ensure proper use of battery power. PCmonitoring system will be helpful to monitor wide area solar panels.Goal of this paper is to increase power production of solar panel.

This paper object is to replace conventional solar system with automated advance solar system with easy user friendly configuration and produce more electricity than existing solar system.This paper main target is solar panel automation and add some advanced feature with this system. Conventional solar panel does not contain solar tracker and power display module. This solar system also has database support and pc monitoring facility. Through LAN solar system will connected to PC. To ensure all time smooth connection and avoid system crash problem, such solar system can connect with more than one PC at a time. The most important thing is, to get database support solar system must be connected with a PC. LCD display always shows update status of system as battery volt, system temperature, light intensity and charging indicator. After few time interval update data will be inserted into database automatically. PC monitoring system work for showing whole system status.

II. Related Work

[1] In this paper of solar tracking system, movement controlled by of stepper motor. But servo motor movement is more accurate than stepper also require less power to move. Author also writes in paper about one axis and two axis solar panel that moved based on a time frame.

[2] Author write on their proposal *"By* using this circuit the solar array can be rotated in required direction following the sun path to get maximum energy from the sun. With the help of this Labview program the efficiency of the solar panel would be increased. Again use of this technique can capture large amount of solar energy. For these reasons the use of the non-conventional energy will increase, which is very fruitful incident of

our future power sector. It is the main contribution that once the simplicity of solar energy system design is understood, engineers and manufactures will provide new system design."

Above two[1] [2] papers one common matter is they both research on sunlight direction and intensity. In our paper we also consider this first. But both papers they clearly not describe how they built their structure based on this knowledge.First journal emphasis on stepper motor where we using servo motor. And also write solar system will move based on time frame where we propose this will totally automated and it is sure that it will work more accurately. Both papers indicate, their system has no database support, PC monitoring and Power module. In our system we add those features. Add database for year round data store.

[3]The system is designed to respond to its environment in the shortest amount of time. Any source of error at both the software and the hardware level is eliminated, or at least controlled. The system is tested for real-time responsiveness, reliability, stability, and safety.The system is designed to be stable while it is operating. It is also designed to be resistant to weather, temperature and minor mechanical stresses. Furthermore, the system is fail-safe; it can recover from failures or at least indicate that it is in that condition. But our model is fully automated.

[4]This paper studies the different types of photovoltaic systems including fixed panel, photovoltaic farms equipped to the single axis and double axis tracking systems and their effects on the performance of the solar power plants.
[5] They built a dual tracking support system. [4][5] both system only cover the concept of hardware but our model has a web monitoring service that will help user to see status of system.

III. PROPOSED MODEL

3.1 Hardware section

1. Solar tracker : Solar tracker section moves solar panels according to sun intensity. Four LDR, two servo motors connect with two solar panels. X and Y axis movements controlled by two motors.
2. Sensor section : Mainly four types of sensors used here. Voltage sensor, current sensor, gyro sensor and temperature sensor. All sensors connected to ATmega328p microcontroller.
3. LCD section : LCD shows system current status LCD connected to Arduino mega.
4. LAN module : LAN module connect whole system with PC. LAN communicate with PC through router. Need straight-through connection cable.
5. Battery section : solar panel generate power stored in battery. Battery also can charge manually through electricity.

3.2 Software section

1. Solar tracker software : A software need to operate solar tracker this code write in C language. Carefully initialize which motor is for X axis and which is for Y axis.
2. Microcontroller software : All sensors are connect with microcontroller to operate sensors, a C language software needed carefully write which part connect with which sensor.
3. LCD driver code : LCD driver operate LCD display .

3.3Admin Section

1. Admin login : This feature used by the admin to login into system. Admin is required to enter user name and password before he is allowed to enter the system .The user name and password will be verified and if invalid id is there user is allowed to not enter the system.
2. Monitor : Monitor section shows system all update information. Monitor section only for admin not all user. After login admin can monitor system.
3. Data log : Solar system data will be stored in database. Data log will shows all data from database. Date and time also show in data log.
4. Search data : Admin can search data from data log according to date.
5. Delete : Admin can delete unnecessary data from data log.
6. Print : Print option will helpful to print system data as report.

IV. METHODOLOGY

4.1 Block diagram

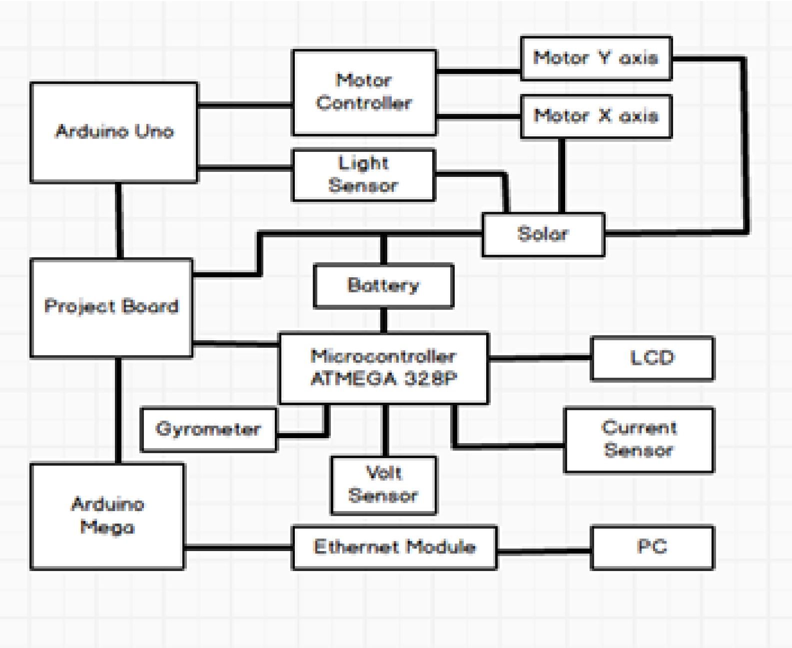

Fig 1: Block diagram of automated solar panel with web monitoring

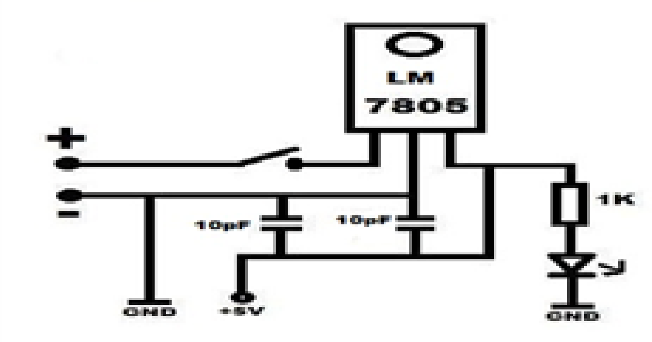

Fig 2: Main power supply circuit

This power supply circuit has two power level +12volt and +5 volt. 12volt supply is given by 12 volt adapter. Normally dc component operating voltage is +5volt. But when we connect to +5v supply it may be supply less than +5v this time component will not work properly. That why need more than +5v supply then control this. Wide range circuit design some component some time need more than +5v supply. And some component need accurate +5v supply like microcontroller it always need stand by +5v supply. LM 7805 is a +5v voltage regulator. It regulates a steady output of 5V if the input voltage is in rage of 7.2V to 35V. Hence to avoid power loss try to maintain the input to 7.2V. In some circuitry voltage fluctuation is fatal (for e.g. Microcontroller), for such situation to ensure constant voltage IC 7805 Voltage Regulator is used.

A switch is connected to this circuit that control on off state of full circuit. A decoupling capacitor is a capacitor used to decouple one part of an electrical network (circuit) from another. Noise caused by other circuit elements is shunted through the capacitor, reducing the effect it has on the rest of the circuit. In power supplies, capacitors are used to smooth (filter) the pulsating DC output after rectification so that a nearly constant DC voltage is supplied to the load. The pulsating output of the rectifiers has an average DC value and an AC portion that is called ripple voltage. Filter capacitors reduce the amount of ripple voltage to a level that is acceptable. It should be noted that resistors and inductors can be combined with the capacitors to form filter networks. A LED connected to circuit board that indicate circuit board power supply.

3.2 Solar tracker

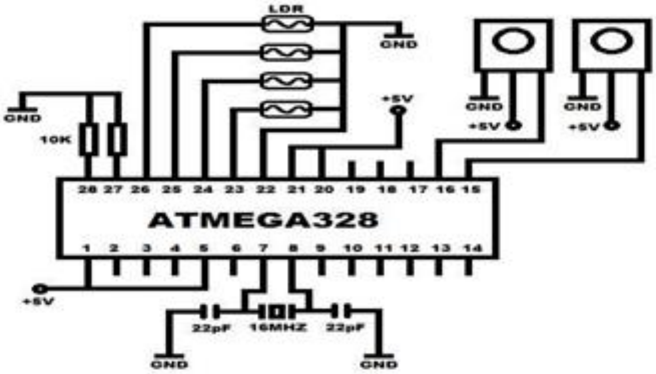

Fig3: solar tracker circuit

ATmega328p used here as programming chip. 16 MHz crystal oscillator connected with this microcontroller for better performance.

This solar tracker control system is designed to take light measurements from the east and west (left and right) side and top and down of the solar panel and determine which way to move the panel to point it directly at the source of the light. Two servo is used to actuate the panel tracker; these are available in a broad range of sizes and can be scaled according to panel size. LDR (Light Dependent Resistor) also known as photo resistor is the light sensitive device. Its resistance decrease when the light falls on it and that's why it is frequently used in Dark or Light Detector Circuit.The four LDR's are placed at the four positions of solar panel and Servo Motors are used to rotate the solar panels. The servo will move the solar panel towards the LDR whose resistance will be low, mean towards the LDR on which light is falling, that way it will keep following the light. And if there is same amount of light falling on the LDR, then servo will not rotate. The servo will try to move the solar panel in the position where LDR's will have the same resistance means where same amount of light will fall on the resistors and if resistance of one of the LDR will change then it rotates towards lower resistance LDR.

4.3 Battery section

In order to use 3.7 V lithium ion battery as a main power source of microcontroller board that require a at least +5V input voltage, an adjustable step up voltage booster DC to DC module is require. The most well-known booster module is XL6009 module. This module able to increase input voltage ranging from 3.2V to 30V dc and produce an output ranging from 5V to 35V dc.

The key principle on how booster work is the tendency of inductor to overcome the change of current and destroy the magnetic field. The buck boost converter is a type of DC-DC converter that has greater output voltage or less than the input voltage.

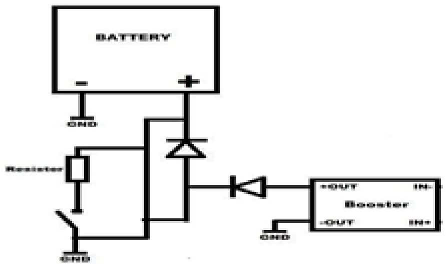

Fig4: Battery section circuit

A switch is connected to battery, those devices are operate by battery power this switch control their on off state and 1 kΩ resistor limits the current flowing into the switch.

4.4 Full system of automated solar panel

This circuit diagram is the clear representation of whole hardware system. Battery, switch, LED, solar panel, LCD, motor, Arduino, microcontroller, IC, sensors all combined shows a graphical representation. A crystal oscillator of 16MHz connect with ATmeaga328. Battery booster connected to battery section to boost up battery power. LM7804 IC connect with 12 volt power supply to maintain +4v supply. Two motors and sensors connected with microcontroller. A LED connect with power supply line than ensure whole circuit power supply. A booster connected with battery to boost up battery volt. A 20*4 LCD display connected with Arduino mega.

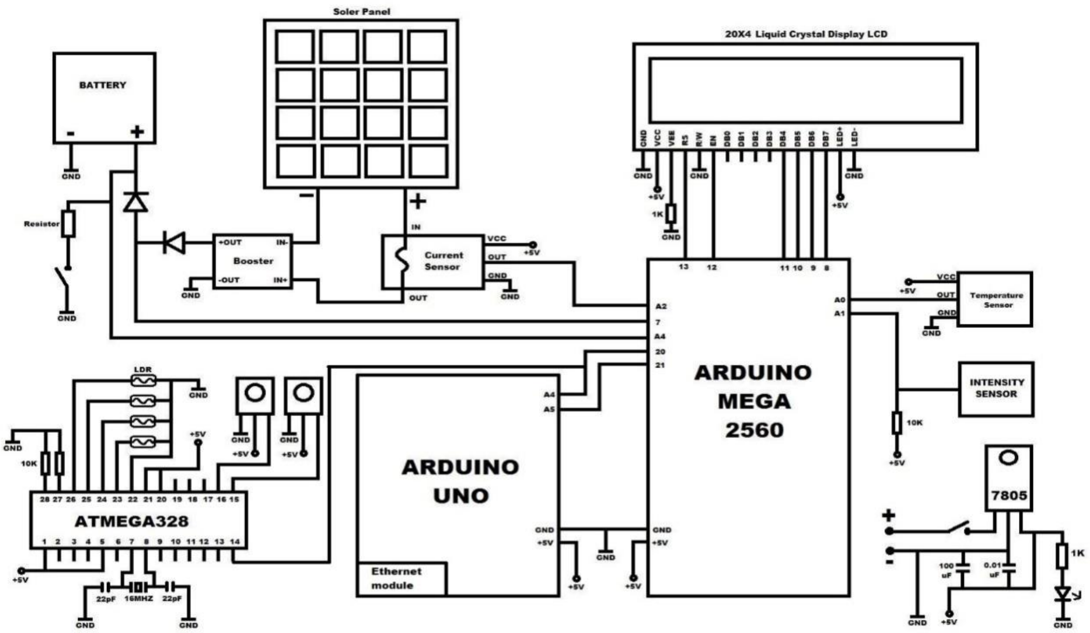

Fig 5: Circuit diagram of full system

The light intensity is monitored using an LDR sensor, voltage by voltage sensor, current by current sensor and temperature by temperature sensor. The power supply given by a 12V adapter. The ripples are removed using a capacitive filter and it is then regulated to +5V using a voltage regulator LM7805 which is required for the operation of microcontroller and other circuits.

4.5 Connect system with PC

4.5.1 Hardware and software interface

Before connecting hardware with software need to connect different chips. 3 types program burn into 3 chips. Here we use a protocol named i2c for connecting Arduino. Wire library allows you to communicate with I2C / TWI devices. Another important thig is when write program for specific Arduino chip again and again check pin used in circuit and which pins are assigned into program. When we connect hardware device with pc need two IP address one for PC another is hardware Ethernet module. Assign both IP inside code carefully and make sure configure PC and router with same IP.

4.5.2 LAN connection

An Ethernet cable is required for connecting solar system with PC. Solar system connected with PC through router.

To configure home router. There are a few things that need to understand, including, WAN, LAN, Dynamic DNS, and Port forwarding (aka Virtual Server). While all this might seem overwhelming and technical, it's quite easy if e familiar with a router's Web interface. Just make sure always back up router's settings before making any changes.

4.6 Web interface

4.6.1 Database connection

Database connection with solar system was a big challenge for us. Because data continuously updating and we need to store data automatically. By sending http request after a time interval store data.

Write an application on your web server to interface between simple GET requests and the database backend.

```
<?php
date_default_timezone_set("Asia/Dhaka");
echo date_default_timezone_get();
include("database_connection.php");
if(isset($_GET))
{
$sql="INSERT INTO`entry_log`(`anglex`,`angley`,`temp`,`bat_volt`,`intensity`,`in_time`) VALUES
 ('".$_GET['x']."','".$_GET['y']."','".$_GET['t']."','".$_GET['b']."','".$_GET['s']."','".date('Y-m-d H:i:s')."')";
$conn->query($sql);
}
?>
```

Write a sketch to tell the ethernet shield to make GET requests to the web server

Sketch code :

```
void httpRequest() {
client.stop();
  String request = "GET /Final/udp.php?" + String(message) + " HTTP/1.1";
  // if there's a successful connection:
  if (client.connect(server, 80)) {
Serial.println("connecting...");
    // send the HTTP GET request:
requestValues(2);
Serial.println(request);
client.println(request);
client.println("Host: www.arduino.cc");
client.println("User-Agent: arduino-ethernet");
client.println("Connection: close");
client.println();
    //memset(&message[0], 0, sizeof(message));
    // note the time that the connection was made:
lastConnectionTime = millis();
  } else {
Serial.println("connection failed");
  }}
```

4.6.2 PC monitoring

.

Here we design a monitoring display inside website admin can monitor system and ours monitoring system is a combo of above three types. Another http request send by Arduino and data shows in display monitor. A Javascript/Ajax code is writing for reload page and data show on monitor screen.

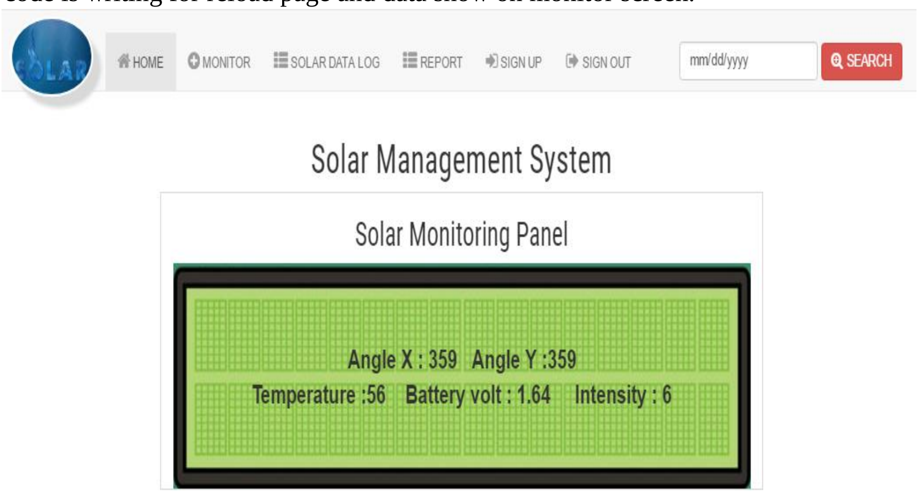

Fig 6: Solar monitoring panel

4.6.3 Log table
Log table only retrieve data from database and shows inside a table. Search option for search specific data from data base according to date. Seven attributes have in this table. This table data automatically inserted into database no user interferes needed. Here id is the foreign key. This E-R diagram indicates one to many relationship.

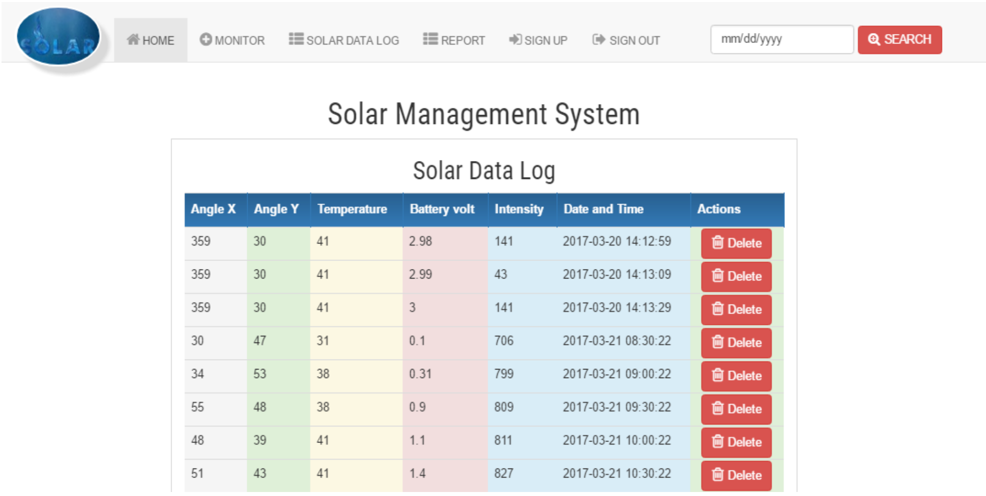

Fig 7: Solar data log

4.6.4 Report generate
In report generate part admin can select a date range for generate report. Selected data will appear another page. By print command finally those data will be print as report. A JAVASCRIPT calendar date picker use for select date range.

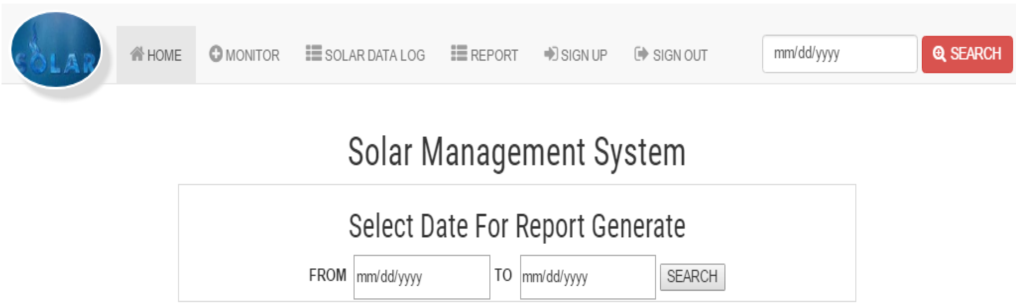

Fig 8: Select date range for report generate

V. EXPERIMENT AND RESULT ANALYSIS

5.1 Experiment

This paper goal is produce more energy than conventional solar system. This system is able to produce more energy or not to prove this statement we drive an experiment of 3 hours. We take two different solar panel and put them beside. After each 15 minutes' interval take power volt reading and put inside a data table. Advance solar panel data automatically stored in database after 15 minutes' interval. From data table data draw 2 graph according to data reading one graph for normal solar system another for advance solar system.

5.1.1 Data table

TABLE 1
Data table

Solar panel type	Date	Time and produced voltage									
		8.45 am	9.00 am	9.15 am	9.30 am	9.45 am	10.00 am	10.15 am	10.30 am	10.45 am	11.00 am
Normal	February 18,2017	.1v	.21v	.26v	.3v	.42v	.51v	.6v	.77v	.9v	1.08v
Advanced	February 20,2017	.1v	.26v	.34v	.45v	.64v	.73v	.93v	1.05v	1.2v	1.4v
Normal	March 21,2017	.18v	.3v	.56v	.7v	.82v	.9v	1.09v	1.2v	1.31v	1.44v
Advanced	March 21,2017	.18v	.31v	.68v	.9v	1.0v	1.1v	1.3v	1.45v	1.77v	1.9v
Normal	April 12,2017	.13v	.31v	.6v	.71v	.9v	1.03v	1.14v	1.23v	1.39v	1.48v
Advanced	April 12,2017	.13v	.33v	.71v	.96v	1.06v	1.21v	1.34v	1.49v	1.84v	1.97v

5.1.2 Graph

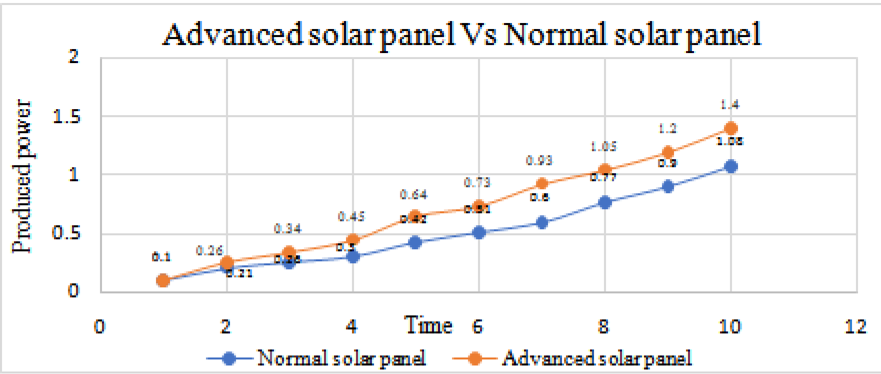

Fig 9 : February month curve

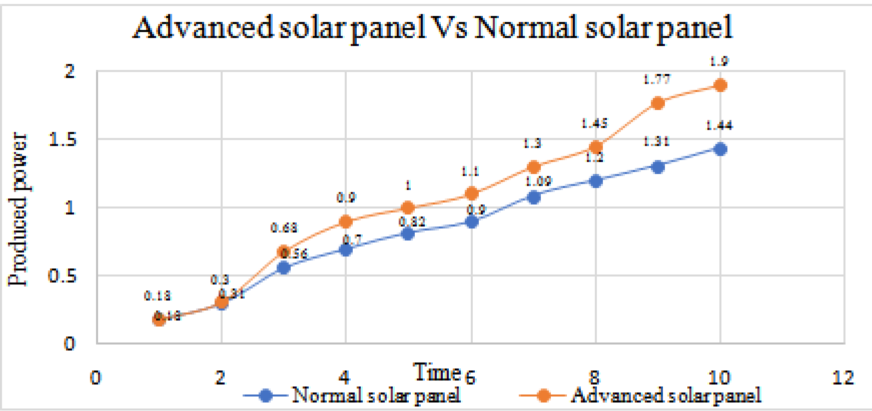

Fig 10: March month curve

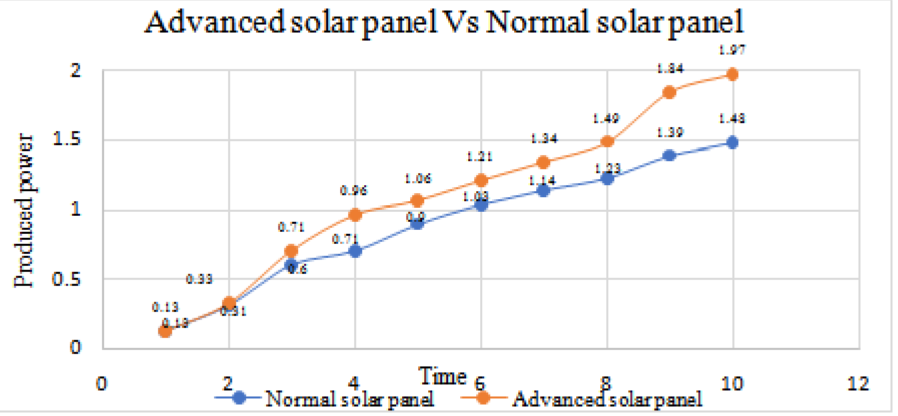

Fig 11: April month curve

5.1.3 Result calculation

February:
Normal solar panel produced power = .98 volt.
Advanced solar panel produced power = 1.4 volt.
Advance solar panel produce {((1.4-1.08)/1.08)*100%}=29.6% more energy than normal solar panel.

March :
Normal solar panel produced power = 1.4 volt.
Advanced solar panel produced power = 1.9 volt.
Advance solar panel produce {((1.9-1.44)/1.44) *100%}=31.9% more energy than normal solar panel.

April :
Normal solar panel produced power = 1.48 volt.
Advanced solar panel produced power = 1.97volt.
Advance solar panel produce {((1.97-1.48)/1.48) *100%}=33.11% more energy than normal solar panel.
7.1.4 Result analysis

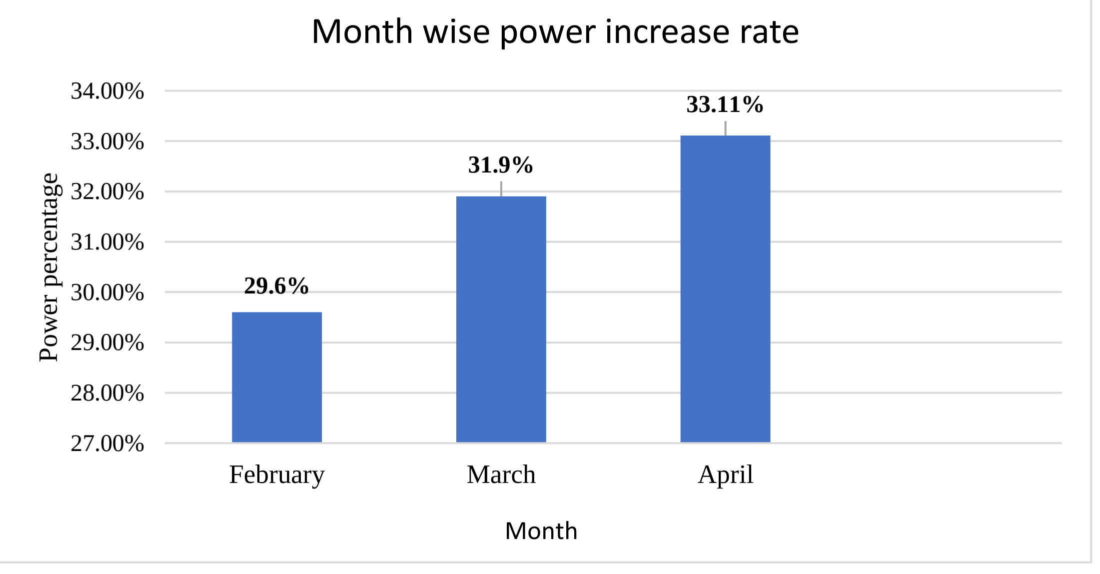

Fig 12: Month wise power increase rate

From three-month calculation result we found, output vary according to month. March output is more than February and April output is more than February and March. That means solar efficiency badly depended on season that indicates the duration of day light and light intensity.

VI. CONCLUSION

Electricity problem is a big issue in present days. Population is increasing rapidly. Beside this the demand of electricity also increasing. Our proposed system can produce 20%-35% more energy than conventional solar system.Trackers generate more electricity than their stationary counterparts due to increased direct exposure to solar rays. We want to make this happen for rural people and wide area solar panel monitoring. Rural people suffer severely in electricity problem. Another attention is make this system low cost compare with existing system of another country and also replace this system with IPS/UPS.

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