International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

HARVESTING SOLAR ENERGY USING DUAL AXIS SOLAR TRACKER WITH ADDED REAL-TIME MONITORING THROUGH GSM

Danish Mushtaq Sheikh[1], Er Baljit Kaur[2]

[1]PG Scholar, Department Of Electrical Engineering, Institute of Engineering And Technology Bhaddal, Rupnagar
[2]Assistant Professor, Department Of Electrical Engineering, Institute of Engineering And Technology Bhaddal, Rupnaga

---***---

Abstract – *Solar energy has become popular due to rapid growth in use of renewable energies mainly for remote and isolated areas for electricity generation. In this paper, a sun tracking system has been proposed that aims at extracting the maximum power by converting the major part of light falling on Solar panel in to electric energy. System designed is Dual Tracking System for two directions elevation and Azimuth. Azimuth allows the panel to move left and right, while Elevation allows the panel to move up and down.*

Electric energy output of the solar panel continuously remains attached to the battery which is charged for whole day and the stored charge can be used during the night time. LCD (Liquid crystal Display) has been attached to keep a track of power generated from solar panel and battery charging level. Also the Inverter Circuit attached converts DC supply to the AC so that it can be used to drive AC appliances. GSM (Global System for Mobile Communication) has been attached to get on demand readings of battery voltage and power generated from solar panel. Current sensor (ACS712) is attached to keep a track of energy consumption and to monitor electricity theft.

Key Words: solar panel array, tracking, dual system Tracking, elevation, azimuth, LCD (Liquid Crystal Display), inverter circuit, GSM (Global System for Mobile Communication), Current Sensor ACS712.

1. INTRODUCTION

A Solar Tracking System comprises of a solar array attached on a motor mechanism to follow the direction of Sun in order to capture maximum energy for conversion in to electrical supply. Many research works on solar tracking systems may it be single axis or dual axis trackers have been conducted to facilitate the power maximization as well as efficient energy storage and utilization systems.

The solar option:

- Heat generated from sun is a never ending energy resource. Earth catches approximately $1.8*10^{11}$MW of energy from sun in the form of heat and it is much more than nearly thousand times the present consumption of all the energy sources using it.
- Due to its capability to fulfil all needs on regular basis may it be today or tomorrows till years. Thus making it the most propitious source of energy

Two factors supporting solar energy are:

- Firstly, it's the cleanest form of energy if compared with nuclear and fossil fuels.
- Secondly, where ever people reside it is available in ample quantity in each and every corner of the world. It is free of noise due to less mechanical section.

1.1 Solar Panel's Performance by Fixed Mounting

The sun rays falling on earth's surface mainly consists of three types of radiations, and the photovoltaic module solar energy from earth's surface:

First one is the rays that directly reach the surface of earth and do not disperse.

Other radiations that disperse while passing through the atmosphere of earth

Third type contains the radiations that reflect back after hitting the earth's surface.

Equation 1

Power generated (P) = Power max * Cos (j) (1)

It carries the maximum amount approx. 90% of sun's light energy if he earth's environmental conditions are stable that is if the sky is clear. And this direct beam is of at-most importance for making the PV generator work to it is maximum efficiency. And for this is it necessary to maintain the direction of solar panel towards the non-scattering bean for the most possible maximum time.

First element that is the direct beam without dispersing maximum power generated by the panel can be calculated by estimating the angle between the panel and the Non-dispersible rays of sun. Let's say the angle is j, so the Power generated can be mathematically represented as the cosine of j. equation is mentioned below.

Where Power max is the power collected with direct alignment panel towards sun rays and from equation 1 the lost power can also be calculated that we represent with letter b.

Equation 2:

$b_{\text{Power max}}$=Power max – Power max * Cos(j) = Power max(1−cos(j)) (2)

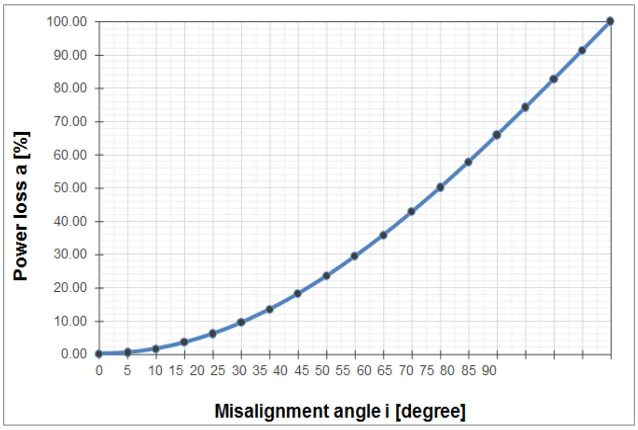


Figure1: Power loss dependency on panel misalignment [1].

The diagram appeared in figure 1 gives an illustrative assessment of what misalignment means for the yield force of PV modules. It isn't hard to see that the yield power drops basically 15% when sun based module slants 30 degrees from the sun.

1.2 Enhancement by Using Tracking Systems

Fix mount alternatives have numerous disadvantages for the presentation of a sun powered PV framework. Sun oriented trackers can take care of the center issue by limiting the skewed point between daylight's immediate shafts and the boards. With the help of motors a motorized assembly can by designed to rotate the panel to appropriate desired angle. Correlation of sun powered trackers' highlights to fixed mount is clarified in table 1.

Table1. Pros and cons of tracking PV systems in comparison to fixed one.

Advantages	Disadvantages
Higher	More
overall	complicated
efficiency	design
Higher	Higher cost
accuracy	Worse tolerance against weather
Longer active functioning time	condition Consumption of energy
Better lifetime for solar	(active trackers)
cells Applicability for	
different applications	

1.3 Active Solar Trackers

In light of revolution of sun oriented modules, dynamic sunlight based trackers can be arranged into two primary sorts: Single-pivot and Dual-hub. In single-hub trackers (SAT), sunlight based PV boards are turned about a solitary hub that typically lines up with the North meridian.

Below mentioned are the ways to arrange and build single axis trackers:

- Tilted or Inclined single-axis tracker, short is TSAT
- Tracker at right angle to the vertical, short is HSAT
- Tracker at right angle to the horizontal short is VSAT

SATs permit the sun powered modules to turn between east-west bearings as indicated by the Sun's positions. SATs give sensibly great harmony between adaptability, effortlessness and execution. Various designs of SAT are shown in figure 1.8.

Double pivot tracker (DAT) can be viewed as the redesign of SAT, where the opportunity of development is reached out to two separate headings. Figure 1.8 additionally shows three common arrangements of DAT in the base pictures.

- Tip-tilt dual-axis tracker(TTDAT)
- Horizontal dual-axis tracker(HDAT)
- Azimuth-altitude dual-axis tracker(AADAT)

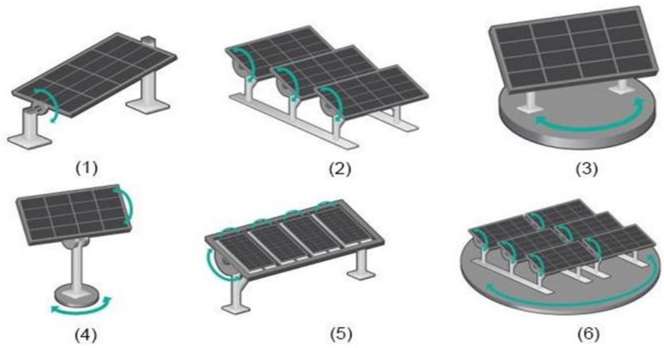


Figure 2: Various designs for PV tracking systems: (1) TSAT (2) HSAT (3) VSAT

(4) TTDAT (5) HDAT (6) AADAT. Imprinted from JUDA (2013) [2].

2. DESIGN METHODOLOGY

This project was planned and carried out with the use of Boehm-Spiral methodology. The main approach used to achieve the goal of this project was based on the iterations of work cycles, as being shown in table 2. Every single cycle in the project was based on the problems and drawbacks of the existing system and based on that the decided improvements and manipulations to be done in the existing prototype. As a result new conditions, analysis of the possibility of failures and designing of the prototype model was done.

Because of this methodology, equipment plan and usefulness programming of the sun based tracker may be changed in every form, to adjust with new destinations. Toward the finish of each cycle, an upgraded form of the framework was required to be made, with extra capacities and better execution. The interaction went through with additional cycles until the objective of the undertaking was accomplished. Boehm-Spiral procedure was applied all through the task, including both equipment and programming plans.

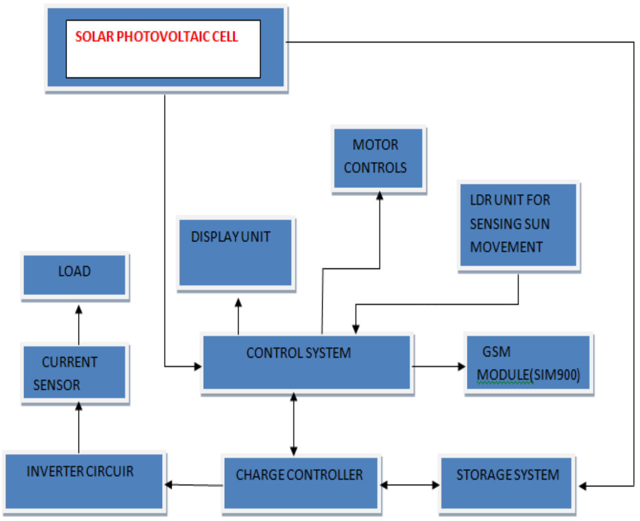
Table2. Steps in Boehm-Spiral Methodology, fax from BURBACK (1998) [3].

Cycle	Step
Cycle 1 – Early Analysis	Step 1: Objectives, Alternatives, and Constraints Step 2: Risk Analysis and Prototype Step 3: Concept of Operation Step 4: Requirement and Life Cycle Plan Step 5: Objectives, Alternatives, and Constraints Step 6: Risk Analysis and Prototype
Cycle 2 – Final Analysis	Step 7: Simulation, Models, and Benchmarks Step 8: Software Requirements and Validation Step 9: Development Plan Step 10: Objectives, Alternatives, and Constraints Step 11: Risk Analysis and Prototype
Cycle 3 – Design	Step 12: Simulation, Models, and Benchmarks Step 13: Software Product Design, Validation, and Verification Step 14: Integration and Test Plan Step 15: Objectives, Alternatives, and Constraints Step 16: Risk Analysis and Operational Prototype
Cycle 4 – Implementation and Testing	Step 17: Simulation, Models, and Benchmarks Step 18: Detailed Design Step 19: Code Step 20: Unit, Integration, and Acceptance Testing Step 21: Implementation (Deployment)

3. HARDWARE

The first step in building the solar tracker for this system was to set up the necessary hardware. Main blocks in the system includes Mounting unit, Solar panel unit, Motor unit, Photo sensor unit, Microcontroller unit, Power supply unit, Liquid Crystal Display Unit, On Demand Details through GSM Module Unit, Inverter Unit, Electricity theft detection.

BLOCK DIAGRAM:



3.1 Design for a DAT (Dual Axis Tracker) System

To built a solar tracking system Polar Mount Base

Solar Module, Solar Panel Mount, DC Geared Motor

Motor Shaft Coupler, Motor Driver, Photo-resistor

Microcontroller, Power supply Unit are required.

3.1.1 Mounting Base:

The mounting base is implemented using dc geared motors. Process Involved is to fabricate a DC motor control interfaced with driver circuit. DC geared motor that we have used is operates on 12 volt supply and the rotations per second are 10 and to drive this motor we cannot connect directly to the microcontroller because the microcontroller cannot fulfill its current and voltage requirement. So the driver IC i.e. L293D Module is used in middle to receive signals from microcontroller and sent it to motor after amplification.

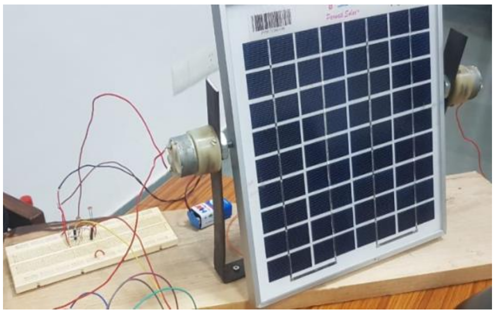


Figure 3: The mounting section look during fabrication

3.1.2 Solar Module:

Solar panel can be understood as transducer to convert sun rays captured by it in to electric supply. PV module is a collective pack of solar cells generally of 6*10. And the panel consists of solar arrays that produce and provide collected power supply for homes and industrial use. PV module used during experiment: With open circuit voltage 21.6V, Maximum power output 17.4V.

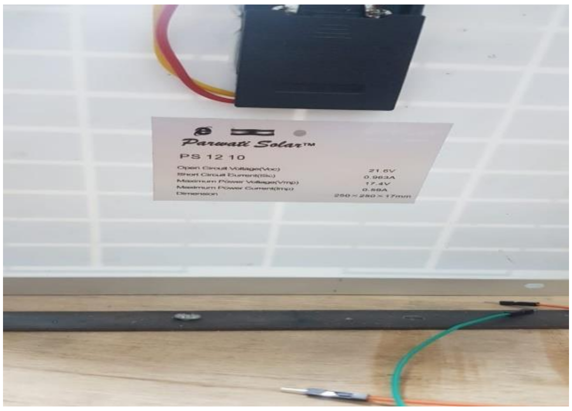


Figure 4: Solar panel used for prototyping

3.1.3 LDR (Light Dependent Resistor):

LDR's have been embedded in to the system, where two LDR's are placed on the two sides of panel work for horizontal axis and other for the side perpendicular to horizontal. LDR's work on the concept of photo-resistivity i.e. resistance goes up and down depending on the measurable amount of light.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

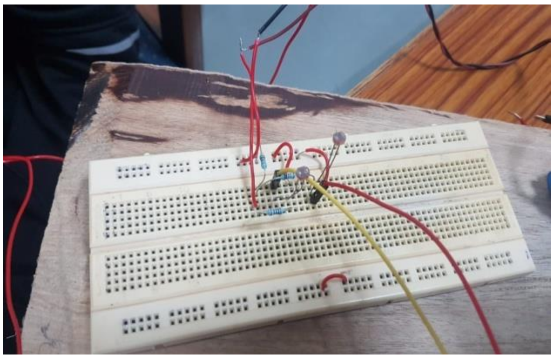


Figure 5: LDR Assembly on breadboard for testing.

3.1.4 Microcontroller chip:

The microcontroller used here is of PIC family, PIC 16F73 manufactured by Microchip. PIC 16f73 is a 28-pin microcontroller with 128 bytes RAM and 4k ROM. PIC family of microcontrollers follows the Harward Architecture and was initially brought in to market by General instruments Microelectronics Division. PIC stands for "Peripheral Interface Controller".

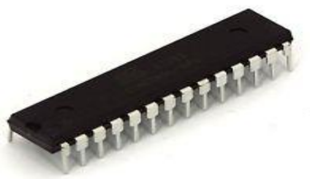


Figure 5: PIC16F73 [4]

3.2 INVERTER MODELING

Solar Inverter cum Charge Controller with Intelligent Logic Control: Inverter as the name indicates can convert the 0HZ frequency signals (DC signals) to high frequency AC signals which can be further used to operate AC devices. Charge Controller blocks are: Inverter circuit, charge controller that controls the charging of battery and checked for the overload condition using current sensor. Charge controller helps keeping the battery safe and enhances the life of the battery.

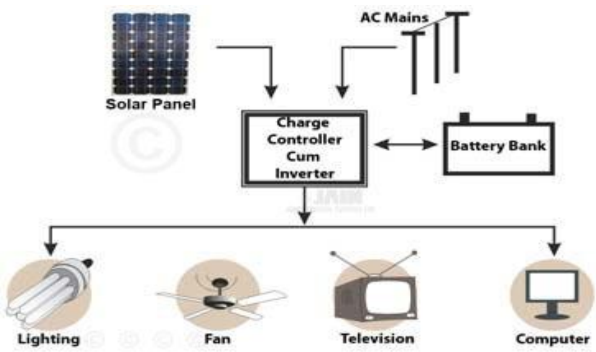


Figure 6: Inverter Blocks [5].

3.2.1 ACS712 CURRENT SENSOR:

Current sensor can identify and measure the current consumption. It works on the hall- effect concept. Current Sensor is connected to PIC micro-controller to take the current consumption reading to protect the battery from overloading.

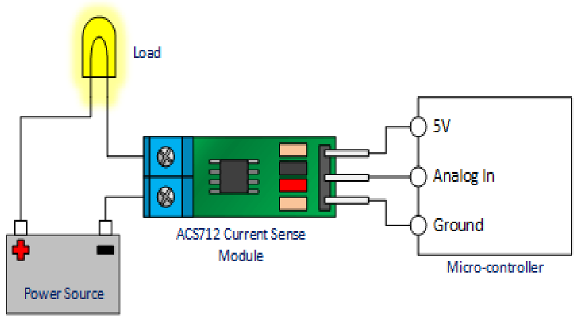


Figure 7: ACS712 connections with PIC16F73 [6].

3.3 GSM FOR REAL TIME MONITORING

GSM is used to provide all the details on Mobile device without visiting the system physically. Also GSM can be used to monitor the proper working of the system.

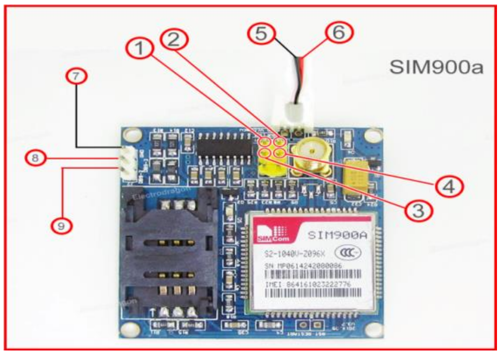


Figure 8: GSM Module (SIM900A) [7].

4. SOFTWARE

PIC16F73 microcontroller has been used to track the movement of Sun and at the same time align the panel in the direction of sun formaximum conversion of solar energy to electrical energy.

Following steps are covered under software:

Step 1: When light falls on LDRs resistance decreasesand due to which voltage drop take place. This voltage drop is received as input signal by PIC16F73.

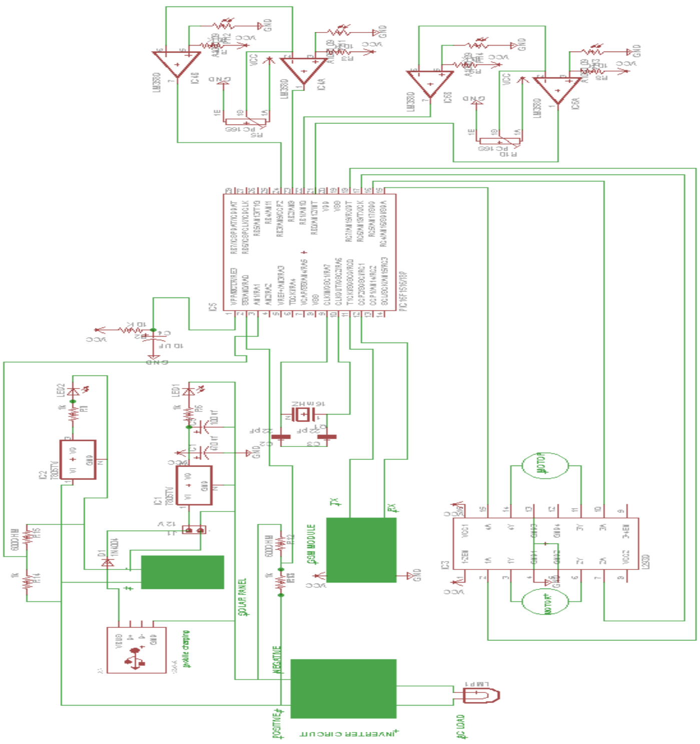
Step 2: It compare the input signal of both LDRs. If the difference between them is below 5 then it won'twork and if it is more than 5 then the LDR whose resistance is low, the motor is moved in the direction of that LDR.

Step 3: Motor IC receive signal from PIC16F73 output, accordingly motor is rotated.

Step 4: If resistance of both LDRs are same then, PIC16F73 gives signal to motor IC and it stops the motor.

Step 5: Also the system has been configured to send the battery voltage level and power generated from PV Module to user's mobile device using GSM.

4.1 CONNECTION DIAGRAM



5. RESULTS

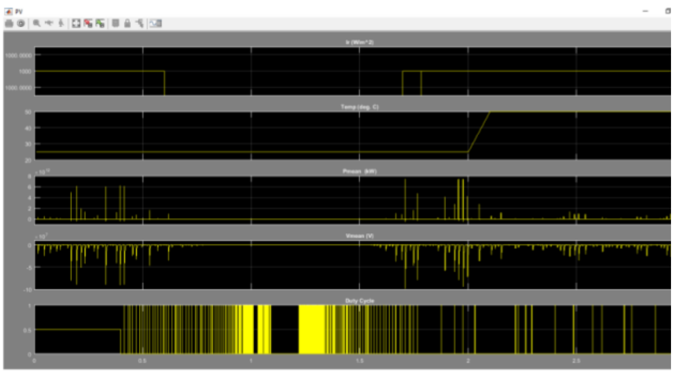


Figure 8: Photovoltaic output characteristics.

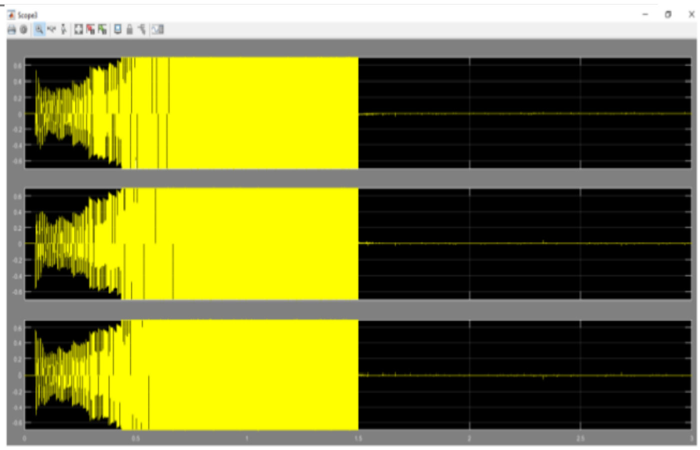


Figure 9: Output Voltage of PV System.

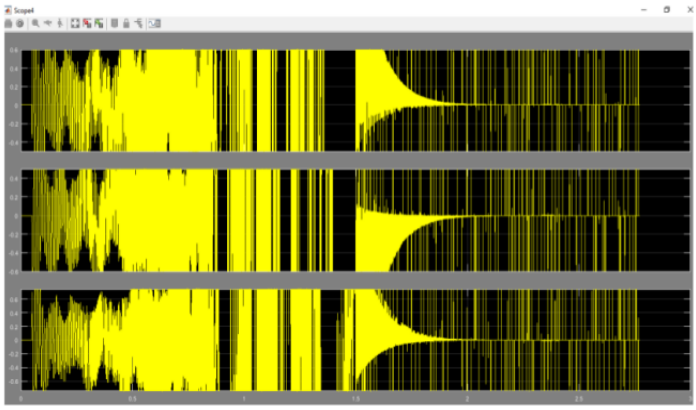


Figure 10: Output Current of PV System.

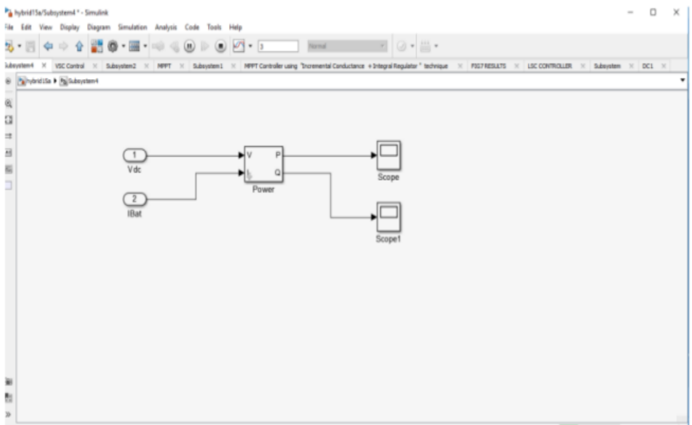


Figure 11: Internal Battery charging circuit

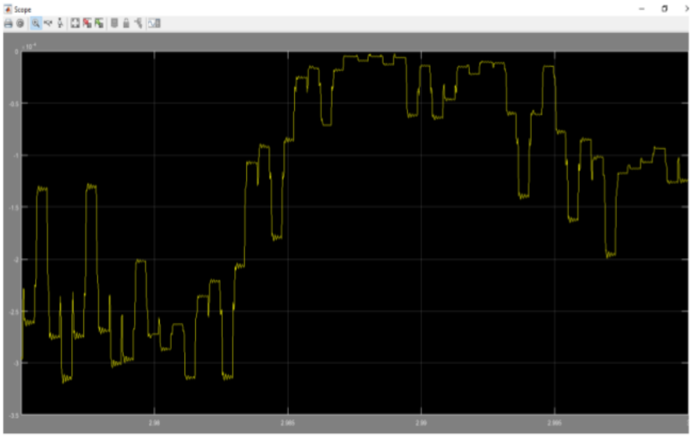


Figure 11: Output Voltage of Battery.

Table 3: Comparison of output voltage and current Measured from fixed PV module and DAT system.

Time of day	Stable Solar System		DAT System	
	Open-circuit Voltage [V]	Short-circuit Current [mA]	Open-circuit Voltage [V]	Short-circuit Current [mA]
9:30	13.28	61.3	13.52	103
11:30	13.6	79	13.86	115
13:30	13.3	77	13.5	102.5
15:30	13.28	58.5	13.6	105.5
17:30	13.01	32	13.73	87.6
19:30	12.39	9.4	13.81	46

6. CONCLUSION

Project focus was on designing a prototype for Dual axis solar tracker and accordingly the pattern was prepared to complete it successfully. The end-product was a finished plan of such a framework, with usefulness that met the plan prerequisites. While the undertaking has prevailing with regards to making a gadget with fundamental required highlights, there are as yet significant disadvantages and restrictions with the exhibition of the gadget, as talked about in the execution work of the venture. Through upgrades and enhancements the limits can be eliminated. It is a valuable reference for the individuals who need to create comparable frameworks. The information and data from this venture can likewise turn into the beginning stage for future improvement of different applications.

REFERENCES

[1] Dcruz, Hans John. (2014). Implementation of Incremental Conductance Algorithm in Dual Axis Solar Tracker for Maximum Solar Panel Output. Journal of Basic and Applied Engineering Research. 1. 39-44.

[2] C. JUDA, "5 Ways to Track Your Solar Tracker," 18 January 2013.

[3] Chaturvedi, Pratik & Thakur, Kamal & Mali, Naresh & Uday, Venkata & Kumar, Sudhakar & Yadav, Srishti & Dutt, Varun. (2018). A Low-Cost IoT Framework for Landslide Prediction and Risk Communication. 10.1002/ 9781119456735.ch21.

[4] sharvielectronics.com/product/pic16f73-microcontroller.

[5] Islam, S & Sharif, Gazi. (2010). Microcontroller based sinusoidal PWM inverter for photovoltaic application. 1 - 4. 10.1109/ICDRET.2009.5454227.

[6] Sanni, Shereefdeen & Olusuyi, Kehinde & MAhmud, Ismail. (2019). Design and Implementation of Home Appliance Energy Monitoring Device. 10.31258/ijeepse.2.2.1-6.

[7] Chaturvedi, Pratik & Thakur, Kamal & Mali, Naresh & Uday, Venkata & Kumar, Sudhakar & Yadav, Srishti & Dutt, Varun. (2018). A Low-Cost IoT Framework for Landslide Prediction and Risk Communication. 10.1002/9781119456735.ch21.