Solar Tracking System In Dual Axis Using LDR and Gathering of Real Time Data Using Ubidots Cloud

Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology

In

Computer Science And Engineering

by

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Under the guidance of

Prof. / Dr

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SCOPE

VIT, Vellore.

June, 2020

DECLARATION

I hereby declare that the thesis entitled "Solar Tracking System In Dual Axis Using LDR and Gathering of Real Time Data Using Ubidots Cloud" submitted by me, for the award of the degree of *Bachelor of Technology in Computer Science And Engineering* to VIT is a record of bonafide work carried out by me under the supervision of Dr. Sathiya Kumar C.

I further declare that the work reported in this thesis has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Hritwik Bhaumik

Place : Vellore

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This is to certify that the thesis entitled "Solar Tracking System In Dual Axis Using LDR and Gathering of Real Time Data Using Ubidots Cloud" submitted by Student **Hritwik Bhaumik, 17BCE0548**, **SCOPE**, VIT, for the award of the degree of *Bachelor of Technology in Computer Science And Engineering*, is a record of bonafide work carried out by him / her under my supervision during the period, 01. 12. 2018 to 30.04.2019, as per the VIT code of academic and research ethics.

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Internal Examiner **External Examiner**

Dr. Santhi V

B.Tech- CSE

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Hritwik Bhaumik

Executive Summary

The solar tracking system is the most common method of increasing the efficiency of solar photo module. This study presents the efficiencies of energy conversion of photo module with solar tracking system and fixed photo module. The proposed sun tracking system uses 4 photo resistors, which are mounted on the sides of the photo module. By these photo resistors the solar tracking system becomes more sensitive and it allows to determining a more accurate location of the sun. A comparative analysis was performed between fixed and dual-axis tracking systems. The results showed that the dual-axis solar tracking system produced 31.3% more power compared with stationary photo module.

This project aims to demonstrate the design and construction of a prototype for dual axis solar tracking system. Dual axis trackers have obvious advantages over single axis trackers. Dual axis trackers have two degrees of freedom which facilitates it to track sunlight with precision from both the axes. This improves the overall efficiency of the tracking mechanism. Dual axis trackers are also the best options for places where the position of the sun keeps changing throughout the year at different seasons.

CONTENTS

List of Figures

List of Tables

List of Abbreviations

PWM	Pulse-width Modulation
PV	Photovoltaic
DAQ	Data Acquisition
MPPT	Maximum Power Point Tracking
LDR	Light Dependent Resistor
HSAT	Horizontal single axis trackers
VSAT	Vertical single axis trackers
TSAT	Tilted single axis trackers
PSAT	Polar aligned single axis trackers
TTDAT	Tip-tilt dual axis trackers
AADAT	Azimuth-altitude dual axis trackers
ADC	Analogue To Digital Converter
EMI	Electromagnetic Interference
EMC	Electromagnetic Compatability
LPSC	Lightning Protection System Components
PVC	Polyvinyl Chloride

Symbols and Notations

&	And
/	Or
>	Greater than
<	Less than
==	Equal to
()	Function
!=	Not equal to
=	Assign

1. INTRODUCTION

1.1. OBJECTIVE

Solar tracking is the most appropriate technology to enhance the electricity production of a PV system. To achieve a high degree of tracking accuracy, several approaches have been widely investigated. Generally, they can be classified as either open-loop tracking types based on solar movement mathematical models or closed-loop tracking types using sensor-based feedback controllers. In the open-loop tracking approach, a tracking formula or control algorithm is used. Referring to the literature, the azimuth and the elevation angles of the Sun were determined by solar movement models or algorithms at the given date, time and geographical information.

1.2. MOTIVATION

With the rapid increase in population and economic development, the problems of the energy crisis and global warming effects are today a cause for increasing concern. The utilization of renewable energy resources is the key solution to these problems. Solar energy is one of the primary sources of clean, abundant and inexhaustible energy that not only provides alternative energy resources, but also improves environmental pollution.

1.3. BACKGROUND

Recently, solar energy has given more and more attention, it is a clean and renewable energy sources. The Photovoltaic (PV) cells are attained to convert solar energy from the sunlight directly to electrical energy. This energy can be utilized in many applications, like lighting, heating and performing different devices. The sun powered cell is containing semiconductor physical which utilizing the photovoltaic impact. At the point when the daylight is opposite to exterior of the PV sun powered board, can acquire higher efficient system; therefore, maximum potential electrical energy can be established. Many experimentations have been done to boost the efficiency of the solar cell. Few decades ago, solar cell modules have been created and have been invented by arranging in series to optimise the output voltage. Solar tracking system categorizes as a control system that consists of sensors to detect either the sunlight is upright to the PV panel or not, and a controller that deliver signals to one or more actuator for changing the panel to the maximum targeted position. Nowadays dual axis solar tracker mechanism gained interest in R&D field due to the evidence of gain at the efficiency of the PV panel. Presently the researchers practising the usage of dc-dc support converter to coordinate the yield voltage as well as boost the lower voltage from system of photovoltaic. The purpose of using dc-dc boost converter is to boost low output voltage to high output voltage and also avoids the reverse current flow by blocking diode. 2 Furthermore, the Pulse-width Modulation (PWM) approach is also providing by researchers to regulate the dc-dc support converter. The Extreme Power Point Tracking or MPPT method obtains maximum extreme potential force from sun oriented boards. An intelligent controller is required to support the proficiency of the control framework of PV together with mechanical model of tracking structure. One of the MPPT method is fuzzy logic controller which is very reliable for photovoltaic array because fuzzy logic technique is promoted better and rapid tracking effectiveness for different optimal operating points. It supports to record optimum power under weather surroundings changing and gain great strength plus feedback amount is big. Progressively, data acquisition (DAQ) is process of recording or storing the data of output voltage from solar panel to compare with different weather conditions.

2. PROJECT DESCRIPTION AND GOALS

A solar tracker is a perfect tool for track the path of the sun from east and west during daytime. Usually solar tracker is classified into two group i.e. i) Single axis solar and ii) dual axis tracker. For a conscientious line of longitude, every day sun moves from east to west on a fixed solar path. However, the sun moves through 460 degrees north and south throughout the seasonal revision. In our proposed model we have partiality to use micro controller based dual axis solar tracking system. The angles of occurrence of sun beam are going to be 0°. We use light dependent resistors (LDR) for trace intensity of the light of the sun. LDR incessantly monitor the solar emission and this data is transferred to the servo motor via micro-controller. Where the intensity of sunshine is highest the servo motor moves the panel that direction. Our proposed model is to calm the ability expenditure and make the highest use of solar power generation. The main plus point of our proposed model is that we use two servo motor. In order to control two motor, system desires a lot of power. Within the projected model we tend to don't use two servo motor at the same time. At the preliminary stipulation two servo motor begins running. Since the sun change its location device detects the position of the sun and it takes four minute. When the sun moves from east to west, second servo motor can stop working which situated in vertically in the solar tracker. The second servo motor will begin running if through the sun moves to the north or south position. During summer the solar path relics close to same in Bangladesh. The second servo motor won't run if there's no seasonal change. The movement of the solar panel towards in vertical and horizontal on azimuth and altitude angle is taken as a reference. The solar elevation approach is distinct for the reason that the angle located stuck between the horizontal and as a result the line linking to the sun. At nightfall or break of day distance from the ground approach is 0° and formerly the sun is at the pinnacle the height above sea level angle relics 90°.

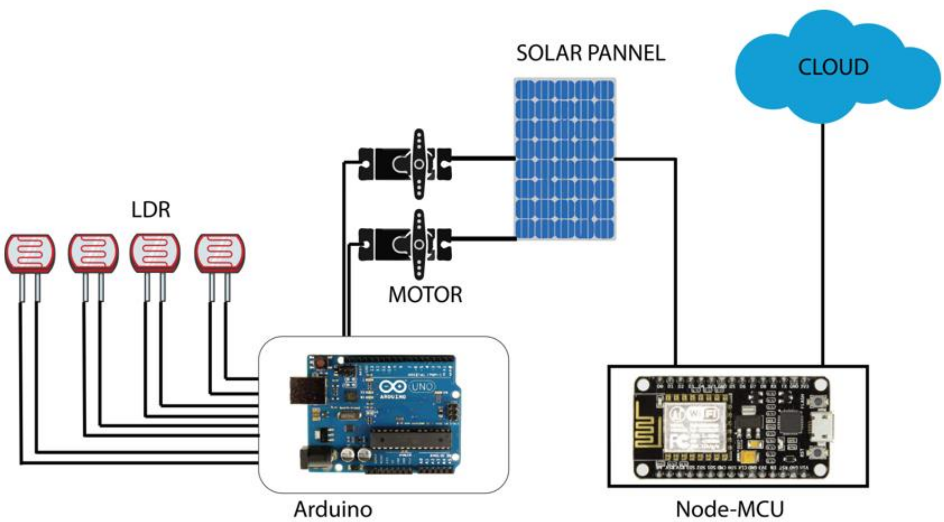


Fig 2.1 Circuit Diagram

3. TECHNICAL SPECIFICATION

3.1 Solar Tracker

Solar tracker is a gadget that keeps a track of the movement of the sun and rotates itself according to the position of the sun. The solar trackers work by keeping the solar panels, or solar collectors pointed towards the sun directly. They change their position to absorb maximum tern amount of energy from the sun. With the help of the solar trackers, the output energy can be enhanced up to 30% more. Opting for solar trackers is a wise choice if you are looking forward to increasing the amount of energy conserved from the sun.

3.2 Types of Sun tracking Solar Panel

The basic function of all the solar tracker is quite the same. They are all designed to follow the movement of the sun. They are mostly used for solar thermal technology as they use the optics for generating a high amount of heat. So, to get the maximum amount of energy, the solar panels must be oriented towards the sun the entire time. Now, there are different types of solar trackers.

3.3 Passive Trackers

These kinds of trackers use a compressed gas fluid of low boiling point so that the tracker can direct itself towards the sun in case there is an imbalance. But the major disadvantage for these solar trackers is that they aren’t precise. It works fine for the common PV panels but is not recommended for concentrating photovoltaic collectors.

3.4 Active Trackers

These trackers use a motor and gears for guiding itself towards the sun which is all controlled by a controller. These are energy consuming as the motors are powered by energy that is driven from the panels so, it is recommended to use them only if necessary.

3.5 Single Axis Trackers

These kinds of trackers have four subdivision, they are

1. Horizontal single axis trackers (HSAT)
2. Vertical single axis trackers (VSAT)
3. Tilted single axis trackers (TSAT)
4. Polar aligned single axis trackers (PSAT)

Since these trackers only work on a single axis, they can move only in a single direction. These trackers are usually aligned on a North Meridian. Thought the direction of these trackers could be changed using the advanced algorithm.

3.6 Dual Axis Solar Tracker

The Dual Axis trackers can two rotate in two degrees. It has two subdivision, they are:

1. Tip-tilt dual axis trackers(TTDAT)
2. Azimuth-altitude dual axis trackers (AADAT)

3.7 Price of Solar Trackers

Axis Type	Tracker Type	Price
Single Axis Vertical, Single Axis Tilted, Single Axis Horizontal	Active Tracker	INR 10,000
Dual Axis	Active Tracker	INR 75,000
Single Axis Horizontal, Dual Axis Tip-Tilt	Passive Tracker	INR 20/watt

4.0 DESIGN APPROACH AND DETAILS

4.1 Design Approach / Materials & Methods

The proposed tracking system can track a lot of daylight in actual fact by PV panel rotation in different axis. In dual-axis system we can track the sun in four directions as a result we can achieve more energy from the solar panel. During this emerge; we are able to incarcerate additional sun rays.

The dual-axis in service is as good as to single axis however it captures the solar energy more productively by rotating within the horizontal as well because the vertical axis the likely anticipated for dual axis tracker. 4 LDR sensors, 2 servo motor and Arduino microcontroller consists our proposed system. One rest of sensors and one motor is used to incline the tracker in sun's east – west route and the other rest of sensors and also the other motor that is mounted at the base of the tracker is used to tilt the tracker within the sun's north-south route.

The servo motor is performing operate to following the path of the sun. This two-servo motor and four LDR sensors are interfaced with a microcontroller that's scheming servo motor on the base of sensor's input. Sun light sense by LDR sensors and send a signal to Arduino microcontroller. The microcontroller received signals from LDR sensors and its deciding rotation direction of servo motors. Dual Axis tracker solar tracking system explained with the help of block diagram.

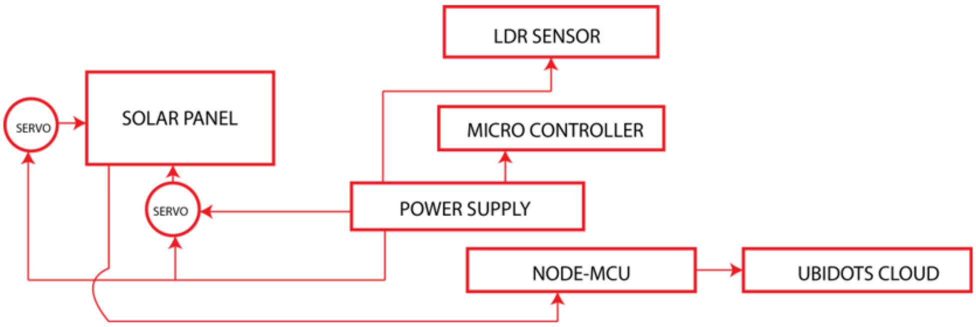


Fig 2.2 Block Diagram of Solar Tracker

The block diagram is showing that LDR sensors once sensing the sunshine forward the signal to Microcontroller. The microcontroller is a logical device that's enchanting dealings on the root of sensor put in and starting the motor driver's track consequently. Assume if the sun changes its individual locality and go from east to west, it'll cause light absorption to vary on one sensor as related to different one. On the base of light intensity feature on sensors, the controller starts driver circuits and moves servo motor to new positions wherever light falling on sensor pairs is same. The same method can maintain it up with a change in sun's locality surrounded by the sky. As a result, this proposed model is able to capture supplementary sun rays and system's solar energy conversion capability is greatly superior. How control algorithm is performing gesture assessment and is that the key deciding constituent. When it collects data from LDR sensors then main algorithm is starts. Sensors productivity is analogue that's stimulated to digital signals. This serviceable task is performed using analogue to digital converter (ADC). Digitized signals are forwarded to Arduino microcontroller. After collecting digital signals, it decides relating to the movement direction and steep angle of servo motors. Control algorithm is viewing that Arduino microcontroller drives servo motors as long as sensor light sensing is not equal to one another and if sensor signals are equal. It goes to start of the algorithm. This methodology is incessant till light falling on detector pairs is equal and PV panel is adjusted in a position for optimum power. The voltage generated by the solar panel is assorted and desires to be synchronized. A regulator is often used when the solar panel which may regulate the voltage coming back from solar panel. For this principle, supply is provided by generated solar energy. There is not any would like to give exterior power supply that makes our system economical and cost effective too. The purposed model can also use as an impartial system by introducing battery storage and proper supervision of storage system. Battery storage is controlled by the thought of generated voltage. Charging and discharging events for storage are electing the idea of generated voltage.
Appendix 1 & 2 gives typical circuit diagram and circuit operation.

4.2 Codes and Standards

Rotating Solar Panel Code – Arduino

The final code of the dual axis solar panel

```
#include <Servo.h>
//Initialize variables
int mode = 0;
int buttonState = 0;
int prevButtonState = 0;
int topLeftLight = 0;
int topRightLight = 0;
int bottomLeftLight = 0;
int bottomRightLight = 0;
int LeftLight = 0;
int RightLight = 0;
int TopLight = 0;
```

```
int BottomLight = 0;
//Declare two servos
Servo servo_9;
Servo servo_10;

void setup()
{
  pinMode(7, INPUT);    //Mode Button
  pinMode(12, OUTPUT);  //Led indicator for manual mode
  pinMode(11, OUTPUT);  //Led indicator for auto mode
  pinMode(A0, INPUT);   //Potentiometer for right-left movement
  pinMode(A1, INPUT);   //Potentiometer for up-down movement
  pinMode(A2, INPUT);   //Light sensor up - left
  pinMode(A3, INPUT);   //Light sensor up - right
  pinMode(A4, INPUT);   //Light sensor bottom - left
  pinMode(A5, INPUT);   //Light sensor bottom - right
  servo_9.attach(9);    //Servo motor right - left movement
  servo_10.attach(10);  //Servo motor up - down movement
}

void loop()
{
  buttonState = digitalRead(7);
  if (buttonState != prevButtonState) {
    if (buttonState == HIGH) {
      //Change mode and ligh up the correct indicator
      if (mode == 1) {
        mode = 0;
        digitalWrite(12, HIGH);
        digitalWrite(11, LOW);
      } else {
        mode = 1;
        digitalWrite(11, HIGH);
        digitalWrite(12, LOW);
      }
    }
  }
  prevButtonState = buttonState;
  delay(50); // Wait for 50 millisecond(s)
  if (mode == 0) {
    //If mode is manual map the pot values to degrees of rotation
    servo_9.write(map(analogRead(A0), 0, 1023, 0, 180));
    servo_10.write(map(analogRead(A1), 0, 1023, 0, 180));
  } else {
    //if mode is auto map the sensor values to 0-100 ligh intensity.
    //Every light sensor has different sensitivity and must be first tested
    //for it's high and low values
    topLeftLight = map(analogRead(A2),50,980,0,100);
    topRightLight = map(analogRead(A3),200,990,0,100);
    bottomLeftLight = map(analogRead(A4),170,970,0,100);
```

```
    bottomRightLight = map(analogRead(A5),250,1000,0,100);
    //Calculate the average light conditions
    TopLight = ((topRightLight + topLeftLight) / 2);
    BottomLight = ((bottomRightLight + bottomLeftLight) / 2);
    LeftLight = ((topLeftLight + bottomLeftLight) / 2);
    RightLight = ((topRightLight + bottomRightLight) / 2);
    //Rotate the servos if needed
    if (abs((RightLight - LeftLight)) > 4) {    //Change position only if light difference is bigger then
4%
      if (RightLight < LeftLight) {
        if (servo_9.read() < 180) {
          servo_9.write((servo_9.read() + 1));
        }
      }
      if (RightLight > LeftLight) {
        if (servo_9.read() > 0) {
          servo_9.write((servo_9.read() - 1));
        }
      }
    }
    if (abs((TopLight - BottomLight)) > 4) {  //Change position only if light difference is bigger then
4%
      if (TopLight < BottomLight) {
        if (servo_10.read() < 180) {
          servo_10.write((servo_10.read() - 1));
        }
      }
      if (TopLight > BottomLight) {
        if (servo_10.read() > 0) {
          servo_10.write((servo_10.read() + 1));
        }
      }
    }
   }
}
```

Table 4.2.1 Standards of Model

Solar PV Modules/Panels	
IEC 61215/ IS 14286	Design Qualification and Type Approval for Crystalline Silicon Terrestrial Photovoltaic (PV) Modules
IEC 61646/ IS 16077	Design Qualification and Type Approval for Thin-Film Terrestrial Photovoltaic (PV) Modules
IEC 62108	Design Qualification and Type Approval for Concentrator Photovoltaic (CPV) Modules and Assemblies
IEC 61701- As applicable	Salt Mist Corrosion Testing of Photovoltaic (PV) Modules
IEC 61853- Part 1/ IS 16170 : Part 1	Photovoltaic (PV) module performance testing and energy rating –: Irradiance and temperature performance measurements, and power rating
IEC 62716	Photovoltaic (PV) Modules – Ammonia (NH3) Corrosion Testing (**Advisory - As per the site condition like dairies, toilets)**
IEC 61730-1,2	Photovoltaic (PV) Module Safety Qualification – Part 1: Requirements for Construction, Part 2: Requirements for Testing
IEC 62804 (Draft Specifications)	Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation (PID). IEC TS 62804-1: Part 1: Crystalline silicon **(Mandatory for system voltage is more than 600 VDC and advisory for system voltage is less than 600 VDC)**
IEC 62759-1	Photovoltaic (PV) modules – Transportation testing, Part 1: Transportation and shipping of module package units

Solar PV Inverters	
IEC 62109-1, IEC 62109-2	Safety of power converters for use in photovoltaic power systems Safety compliance (Protection degree IP 65 for outdoor mounting, IP 54 for indoor mounting)
IEC/IS 61683 **(For stand Alone System)**	Photovoltaic Systems – Power conditioners: Procedure for Measuring Efficiency (10%, 25%, 50%, 75% & 90-100% Loading Conditions)
BS EN 50530 (Will become IEC 62891) **(For Grid Interactive system)**	Overall efficiency of grid-connected photovoltaic inverters: This European Standard provides a procedure for the measurement of the accuracy of the maximum power point tracking (MPPT) of inverters, which are used in grid-connected photovoltaic systems. In that case the inverter energizes a low voltage grid of stable AC voltage and constant frequency. Both the static and dynamic MPPT efficiency is considered.
IEC 62116/ UL 1741/ IEEE 1547	Utility-interconnected Photovoltaic Inverters - Test Procedure of Islanding Prevention Measures
IEC 60255-27	Measuring relays and protection equipment - Part 27: Product safety requirements
IEC 60068-2 (1, 2, 14, 27, 30 & 64)	Environmental Testing of PV System – Power Conditioners and Inverters
IEC 61000- 2,3,5	Electromagnetic Interference (EMI), and Electromagnetic Compatibility (EMC) testing of PV Inverters (as applicable)

Fuses	
IS/IEC 60947 (Part 1, 2 & 3), EN 50521	General safety requirements for connectors, switches, circuit breakers (AC/DC)
IEC 60269-6	Low-voltage fuses - Part 6: Supplementary requirements for fuse-links for the protection of
	solar photovoltaic energy systems

Surge Arrestors	
IEC 61643-11:2011 / IS 15086-5 (SPD)	Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods
Cables	
IEC 60227/IS 694, IEC 60502/IS 1554 (Part 1 & 2)	General test and measuring method for PVC (Polyvinyl chloride) insulated cables (for working voltages up to and including 1100 V, and UV resistant for outdoor installation)
BS EN 50618	Electric cables for photovoltaic systems (BT(DE/NOT)258), mainly for DC cables
Earthing /Lightning	
IEC 62561 Series(Part 1,2 & &) (Chemical earthing)	IEC 62561-1 Lightning protection system components (LPSC) - Part 1: Requirements for connection components IEC 62561-2 Lightning protection system components (LPSC) - Part 2: Requirements for conductors and earth electrodes IEC 62561-7 Lightning protection system components (LPSC) - Part 7: Requirements for earthing enhancing compounds
Junction Boxes	
IEC 60529	Junction boxes and solar panel terminal boxes shall be of the thermo plastic type with IP 65 protection for outdoor use, and IP 54 protection for indoor use
Energy Meter	
IS 16444 or as specified by the DISCOMs	a.c. Static direct connected watt-hour Smart Meter Class 1 and 2 — Specification (with Import & Export/Net energy measurements)
Solar PV Roof Mounting Structure	
IS 2062/IS 4759	Material for the structure mounting

Guidelines Best Practices

Solar PV Roof Mounting Structure

- Aluminum frames will be avoided for installations in coastal areas.

Solar Panels

- Plants installed in high dust geographies like Rajasthan and Gujrat must have the solar panels tested with relevant dust standards (Applicable standard would be IEC 60068-2-68).

Fuse:

- The fuse shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP 65 enclosures with transparent covers.

Cables:

- For the DC cabling, XLPE or, XLPO insulated and sheathed, UV-stabilized single core flexible copper cables shall be used; Multi-core cables shall not be used.
- For the AC cabling, PVC or, XLPE insulated and PVC sheathed single or, multi-core flexible copper cables shall be used; Outdoor AC cables shall have a UV-stabilized outer sheath.
- The total voltage drop on the cable segments from the solar PV modules to the solar grid inverter shall not exceed 2.0%
- The total voltage drop on the cable segments from the solar grid inverter to the building distribution board shall not exceed 2.0%
- The DC cables from the SPV module array shall run through a UV-stabilized PVC conduit pipe of adequate diameter with a minimum wall thickness of 1.5mm.
- Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers.
- All cables and conduit pipes shall be clamped to the rooftop, walls and ceilings with thermo-plastic clamps at intervals not exceeding 50 cm; the minimum DC cable size shall be 4.0 mm2 copper; the minimum AC cable size shall be 4.0 mm2 copper. In three phase systems, the size of the neutral wire size shall be equal to the size of the phase wires.

4.3 Constraints, Alternatives and Tradeoffs

Advantages:

- Solar trackers generate more electricity than their stationary counterparts due to an increased direct exposure to solar rays.
- There are many different kinds of solar tracker, such as single-axis and dual-axis trackers, which can help you find the perfect fit for your unique job site. Installation size, local weather, degree of latitude, and electrical requirements are all important considerations that can influence the type of solar tracker that’s best for you.
- Solar trackers generate more electricity in roughly the same amount of space needed for fixed tilt systems, making them ideal optimizing land usage.

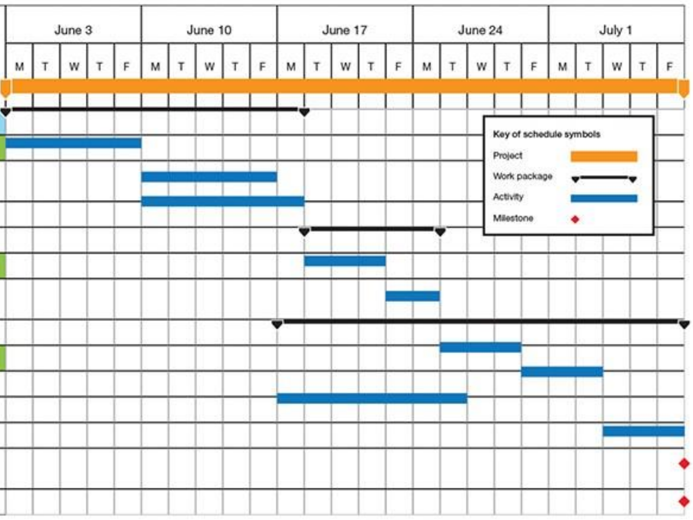
Disadvantages:

- Solar trackers are slightly more expensive than their stationary counterparts, due to the more complex technology and moving parts necessary for their operation.
- Some ongoing maintenance is generally required, though the quality of the solar tracker can play a role in how much and how often this maintenance is needed.

5.0 SCHEDULE, TASKS AND MILESTONES

Table 5.1 Grantt Chart for Schedule, Tasks and Milestones

ID	Task name	Duration (days)	Start	Finish	# Predecessors
1	100 kW rooftop PV installation	25	Mon 6/3	Fri 7/5	
2	Project management	11	Mon 6/3	Mon 6/17	
3	Design and engineer	5	Mon 6/3	Fri 6/7	
4	Obtain permits	5	Mon 6/10	Fri 6/14	3
5	Procure materials	6	Mon 6/10	Mon 6/17	3
6	Structural installation	5	Tue 6/18	Mon 6/24	
7	Install roof attachments	3	Tue 6/18	Thu 6/20	4, 5
8	Assemble racking	2	Fri 6/21	Mon 6/24	7
9	Electrical installation	15	Mon 6/17	Fri 7/5	
10	Install PV modules	3	Tue 6/25	Thu 6/27	8
11	Install dc wiring	3	Fri 6/28	Tue 7/2	10
12	Install ac system	7	Mon 6/17	Tue 6/25	4
13	Commission and inspect	3	Wed 7/3	Fri 7/5	11, 12
14	Project Complete Milestone	0	Fri 7/5	Fri 7/5	13



6.0 PROJECT DEMONSTRATION

The picture of a lab model is shown below:

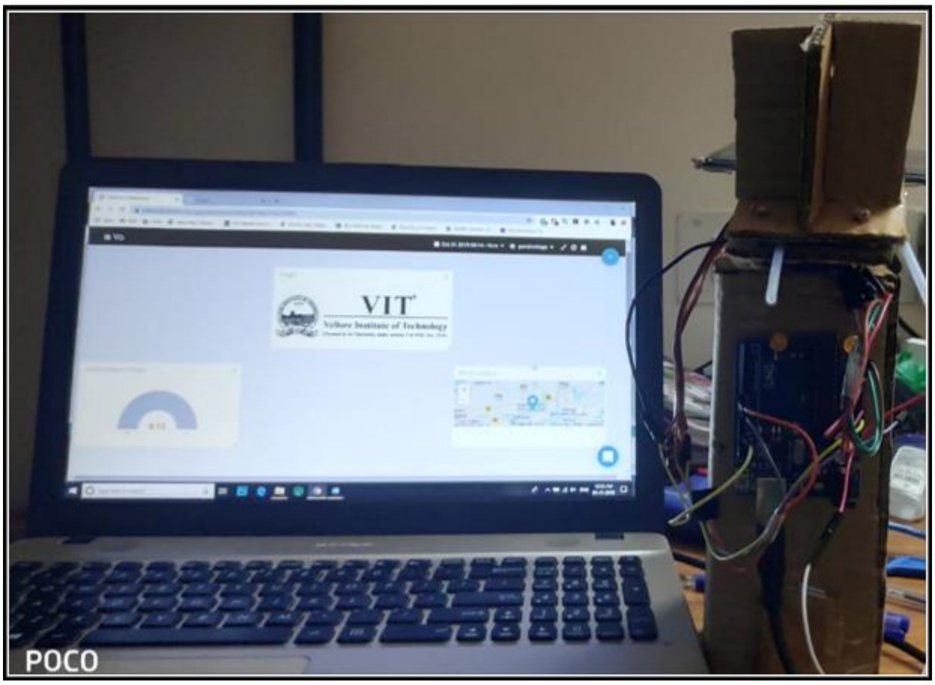


Fig 6.1 Final Project Hardware

Fig 6.2 Upwards angle

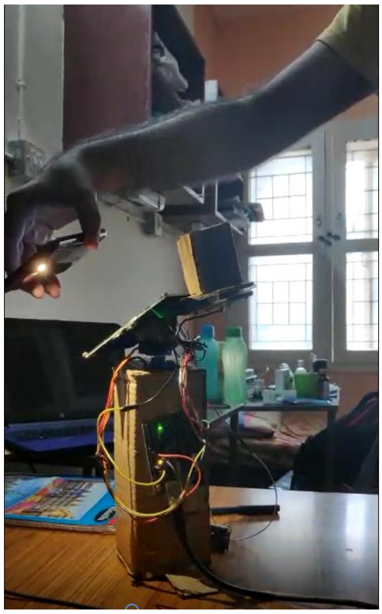


Fig 6.3 Left angle

Fig 6.3 Right angle

7.0 COST ANALYSIS / RESULT & DISCUSSION

Table 1 Left top reading for fixed and tracking panel

Angle in degrees	Left top LDR reading For fixed panel	Left top LDR reading for tracking panel
30	2.23	3.84
40	2.42	3.69
50	3.11	3.82
60	3.58	4.02
70	4.07	4.11
80	4.08	4.15
90	4.09	4.09
100	2.52	3.73
110	2.51	3.58
120	2.42	2.58
130	1.85	1.89

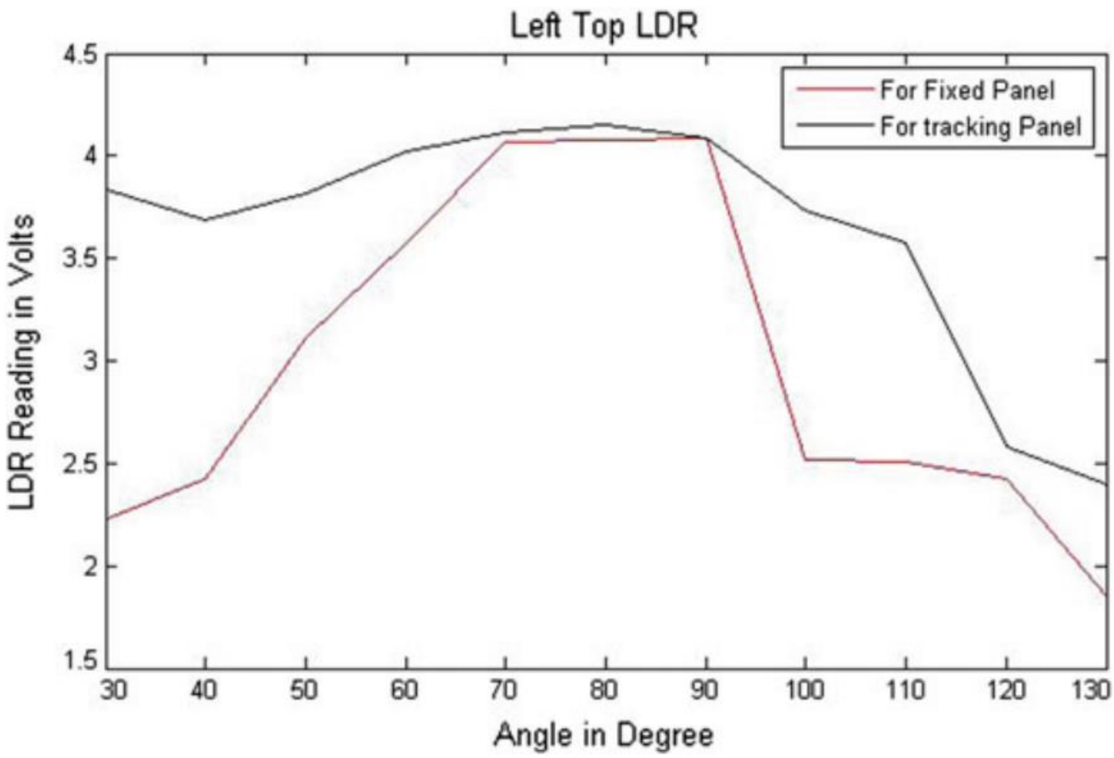


Fig 7.1 Left Top LDR reading as a function of angle light incident

Table 2 Right top reading for fixed and tracking panel

Angle in degrees	Right top LDR reading for fixed panel	Right top LDR reading for tracking panel
30	2.34	3.82
40	2.83	3.92
50	3.25	4.09
60	3.92	4.12
70	3.93	4.18
80	4.01	4.13
90	4.07	4.17
100	3.06	3.58
110	2.22	3.36
120	2.20	2.63
130	1.56	1.75

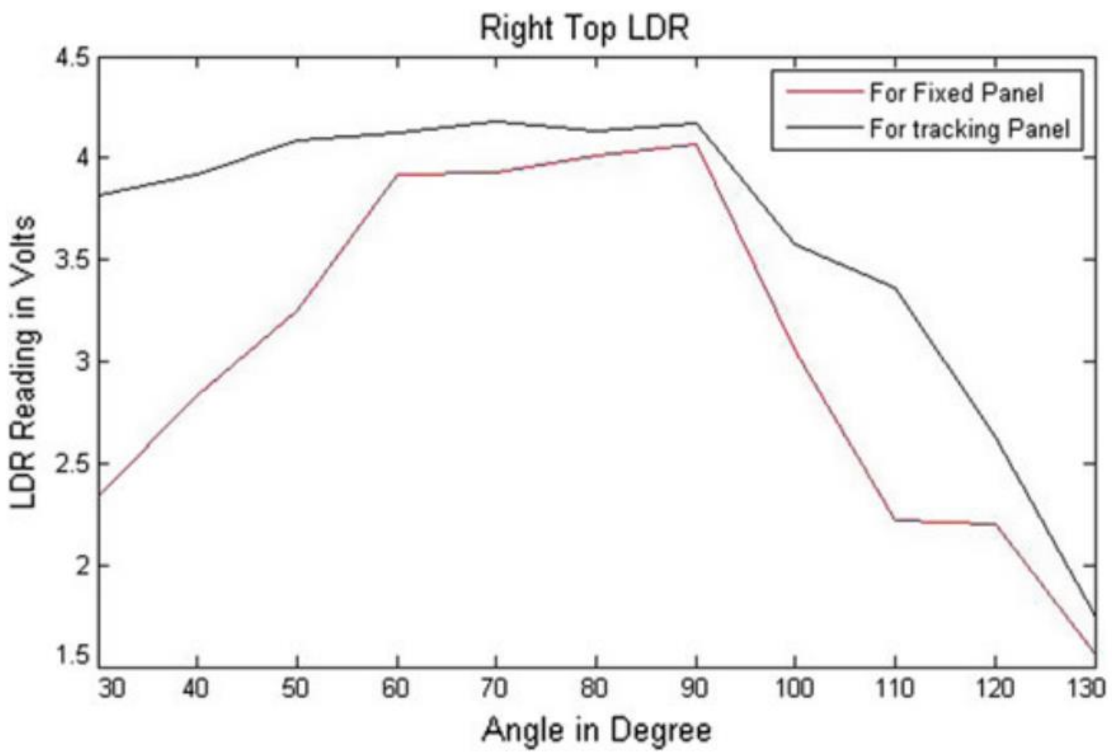


Fig 7.2 Right Top LDR reading as a function of angle light incident

Table 3 Left down reading for fixed and tracking panel

Angle in degrees	Left down LDR reading for fixed panel	Left down LDR reading for tracking panel
30	1.43	2.93
40	1.47	3.71
50	1.80	3.76
60	3.79	3.99
70	3.93	4.09
80	3.95	4.09
90	4.03	4.1
100	3.37	3.69
110	2.89	3.48
120	2.62	3.04
130	2.06	2.82

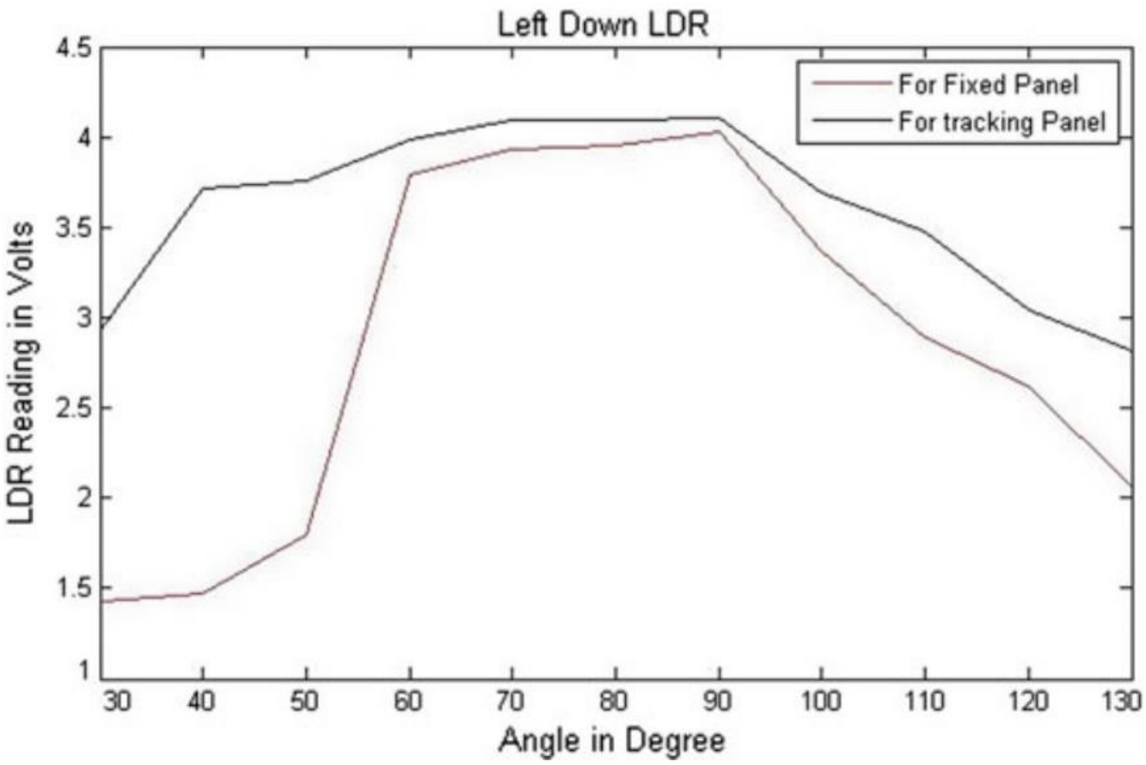


Fig 7.3 Left Down LDR reading as a function of angle light incident

Table 4 Right down LDR reading for fixed and tracking panel

Angle in degree	Right down LDR reading for fixed panel	Right down LDR reading for tracking panel
30	1.26	2.53
40	1.43	3.44
50	1.67	3.45
60	3.59	3.83
70	3.67	3.93
80	3.71	3.81
90	3.94	3.98
100	2.98	3.83
110	2.43	3.16
120	2.13	2.45
130	1.61	2.58

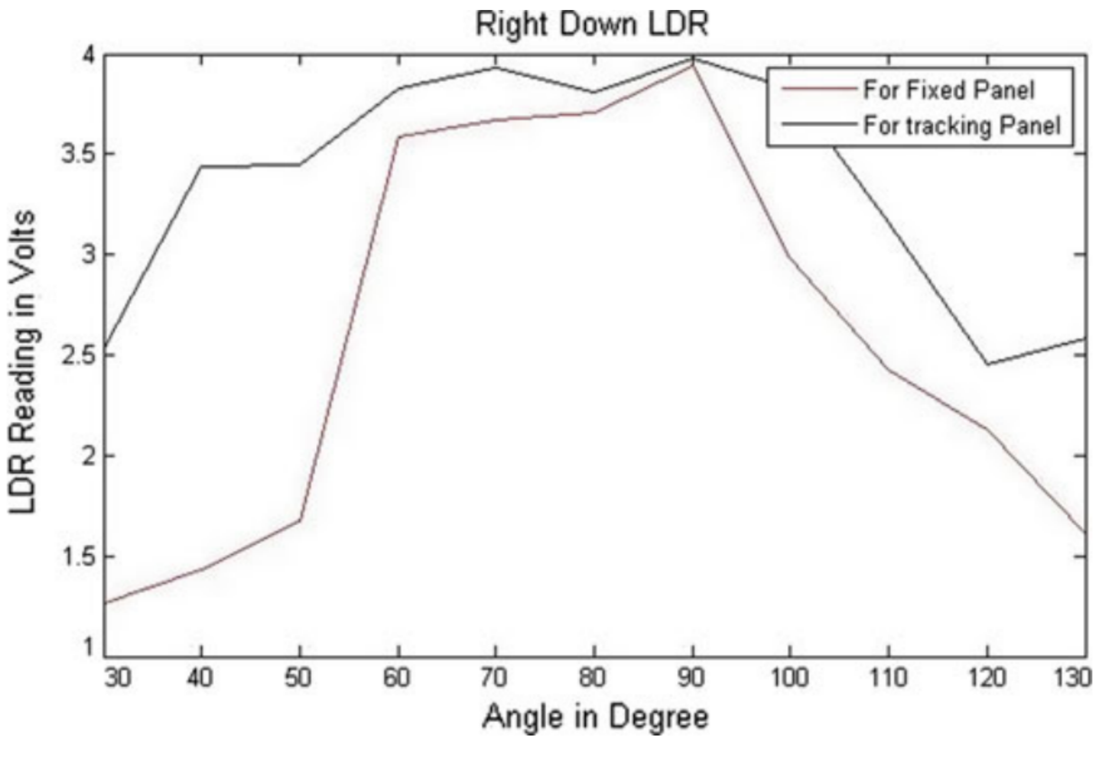


Fig 7.4 Right Down LDR reading as a function of angle light incident

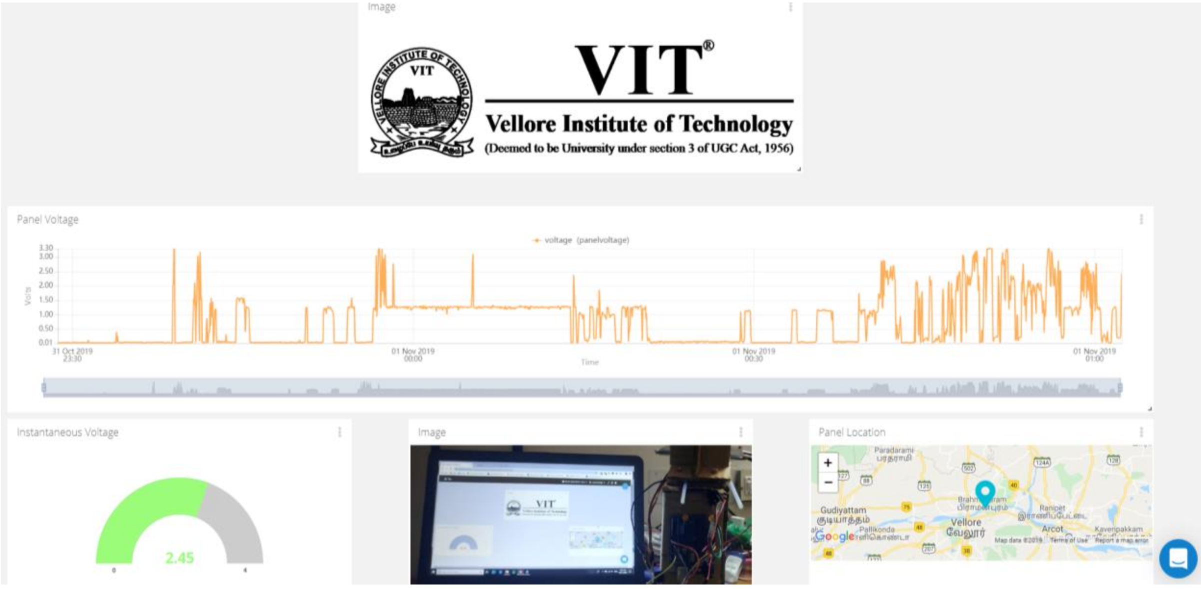


Fig 7.5 Graphical representation of Voltage Vs Time

Efficient energy from the sun is gained by the solar panels. And track the position of the sun by using the LDRs. Two geared stepper motors are used to move the solar panel so that sun's beam is able to remain aligned with the solar panel

8.0 SUMMARY

Dual axis tracker utterly aligns with the sun route and tracks the sun movement in a very a lot of cost-effective loom and includes a marvelous performance upgrading. The investigational outcomes clearly show that dual axis tracking is good enough than single and fixed solar systems. The proposed system is value effective conjointly as a stroke adjustment in single axis tracker provided notable power increase within the system. Through our experiments, we've got found that dual axis tracking will increase energy by about 40% of the fixed arrays. With a lot of works and higher systems, we tend to believe that this figure can raise more.

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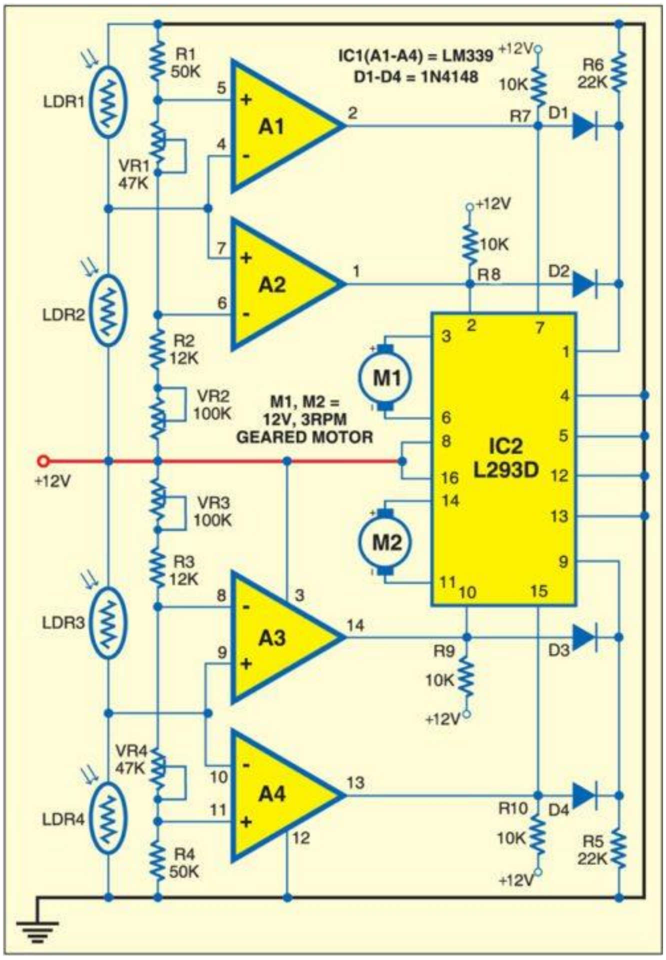
APPENDIX A

Typical Circuit Diagram



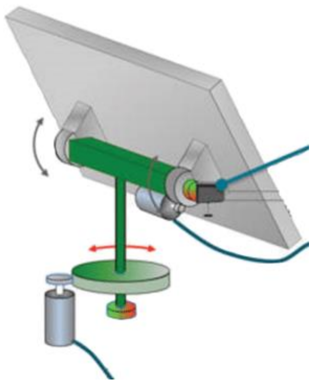
Appendix A shows the typical circuit of the solar tracking system. The solar tracker comprises comparator IC LM339, H-bridge motor driver IC L293D (IC2) and a few discrete components. Light-dependent resistors LDR1 through LDR4 are used as sensors to detect the panel's position relative to the sun. These provide the signal to motor driver IC2 to move the solar panel in the sun's direction. LDR1 and LDR2 are fixed at the edges of the solar panel along the X axis, and connected to comparators A1 and A2, respectively. Presets VR1 and VR2 are set to get low comparator output at pins 2 and 1 of comparators A1 and A2, respectively, so as to stop motor M1 when the sun's rays are perpendicular to the solar panel.

APPENDIX B

Circuit operation

When LDR2 receives more light than LDR1, it offers lower resistance than LDR1, providing a high input to comparators A1 and A2 at pins 4 and 7, respectively. As a result, output pin 1 of comparator A2 goes high to rotate motor M1 in one direction (say, anti-clockwise) and turn the solar panel.

When LDR1 receives more light than LDR2, it offers lower resistance than LDR2, giving a low input to comparators A1 and A2 at pins 4 and 7, respectively. As the voltage at pin 5 of comparator A1 is now higher than the voltage at its pin 4, its output pin 2 goes high. As a result, motor M1 rotates in the opposite direction (say, clock-wise) and the solar panel turns.



Similarly, LDR3 and LDR4 track the sun along Y axis. Fig.here shows the proposed assembly for the solar tracking system