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FABRICATION OF DUAL AXIS SOLAR TRACKING SYSTEM WITHOUT USING SENSORS

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Abstract— In the view of effective use of solar energy, more specifically solar photovoltaic cells major research is going on. This paper explains, independent solar tracking system based on individual independent panels to track the main central panel according to the sun position using motors which are individually operated via particular compact panels. The direction of main central panel is controlled by this individual independent panels to drive the motors and then to rotate the pulley by the belt transmission to achieve the exact position for the main central panel. This paper deals with the performance of solar panels energy conversion is dependent on sunlight it receives. Therefore, it is necessary to design a tracker device that can set the direction of the solar panel always follow the sun position. The two-axis sensor less trackers have developed in this research to maximize energy conversion. Position of solar panel move based on sun position using sunrise and sunset database. By using linear interpolation, the sun position in latitude and longitude direction for other time can be obtained during a day. Based on these values the solar panel set its position using two DC motors. This technique independent from weather conditions, although cloudy, panel position remains consistent with the maximum illumination when the weather is sunny back later. By this way, the solar panel absorbs maximum sunlight as well as generate maximum electricity. In this study, a dual axis solar tracker system is newly designed and tested at several times to track the sun position. A new approach to solar panel systems has been investigated and designed in this study via motivation of no sensor and less mechanical construction. Since a fixed solar panel will not work with the highest solar radiation at every moment of a day; a system which has solar tracker can consider..

Index Terms—solar tracking, sensor les, dual axis, main solar panel, Guide panels, DC motors, solar radiations.

1 Introduction

Sun is an abundant source of energy and this solar energy can be harnesses successfully using solar photovoltaic cells and photovoltaic effect to convert energy into electrical energy. In the United States, the top three energy sources of electricity are coal at 37%, natural gas at 30%, and nuclear at 19%. These forms of energy are non-renewable meaning they will eventually be depleted. For this reason, it is important to seek renewable sources of energy for they are cleaner, easier to use, require less maintenance, and will always be available. This project focuses on solar energy, which is a renewable form of energy.[1]

On average the earth surface receives about 600 W/m2 of solar energy. This value depends on several factors such as the time of the day and the atmospheric conditions. In 2012, only 0.11% of solar energy was used to generate electricity. It is estimated that solar energy will become the largest source of electricity by the year 2050. For this reason, there should be a larger investment in harnessing solar energy. People who live in secluded areas have limited access to efficient power because it is unavailable or too expensive. Also, with the rising cost of fossil fuel most people who live in standard-sized homes are interested in finding alternative. But the conversion efficiency of a normal PV cell is low. One of the main reason for this is that the output of PV cell is dependent directly on the light intensity and with the position of sun in the sky changing continuously from time to time, the absorption efficiency of an immobile solar panel would be significantly less at certain time day and year, for the solar photovoltaic cells are maximum productive when they are perpendicular to the sun and less productive otherwise. So, to maximize the energy generation and improve the efficiency solar trackers are required. Using double-axis solar tracking systems, the position of the sun is followed in East-West direction during a day and North-South direction during seasons. Therefore, in several studies, many different methods such as a Light Dependent Resistor (LDR), phototransistors, and other sensors have been proposed and used to track the position of the sun. The current technology on market can be categorized as active tracer and passive tracer. A common solution for the Sun tracking is that a central pivoting PV cell is carried around this pivot by one or more motors connected to an electronic sensor. The

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sensors are used for measuring and/or detecting the Sun light and generating a corresponding analog voltage signal into the input of the comparator circuit. On the other hand, the problem with such a design with any sensors is that the sensors have a narrow sensitivity range, troubleshooting difficulties, much more cost and weight when they are built in a circuit. In this respect, the aim of this study is to design a dual axis solar tracking system without any sensor in order to eliminate efficiency limits of PV panel to produce electrical energy from solar energy. [5]

Solar power in India is a fast-developing industry. The country's solar installed capacity reached 31.696 GW as of 31 October 2019. India has the lowest capital cost per MW globally to install the solar power plants. The Indian government had an initial target of 20 GW capacity for 2022, which was achieved four years ahead of schedule.[8]

2 Methodology

1) To design a 3D model of the system we used Catia v5 software to design basic model of the system and working simulation of the system.
2) To eliminate the electronic appliances, we thought a new idea to track the sun whole day in dual axis which we have to implement.
3) To reduce the cost of the system we have eliminated nearly many electronic appliances which were used in previous all the system to track the sun position.
4) To eliminate the use of stored energy to the motors we connected the motor supply directly to the small plates which are used for tracking the sun position.
5) To fabricate the system, we made a model design which we have to fabricate.

2.2. Mechanical calculations of torque required

1] pulley: -

D = range 40mm-112mm

Assumed diameter of pulley is 60mm

FOR CAST IRON:

2] Hollow shaft: -

Assumed Length = 640mm *3=1920 mm

Diameter = 20mm

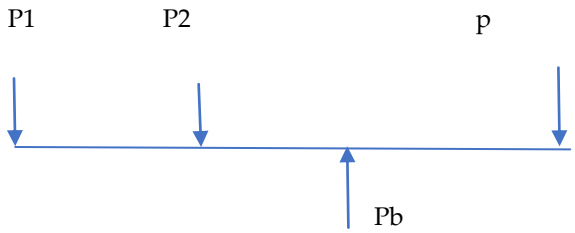
Density of C I = 7300 kg/m^3

V = A * L= 3.14/4 * ((0.02) ^2-(0.015) ^2) *1.920

= 0.000175m^3

Mass = 7300*0.000175 = 1.925 kg

3] Total weight on pulley: -



Pw = P1+P2+Pb+Ps

= 10.986*9.81

122.625 N

Torque = load * radius

= 122.625*0.03

= 3.233 Nm

Hence motor torque = 3.233Nm

Power = (2*3.14*N*T) / 60

Assume – (N = 10RPM, V = 12V, Torque = 12Kg -cm

4] Weight on 2nd pulley: -

Consider mass of pulley = 1Kg

Total weight on pulley = 10.986+1

= 11.9861Kg

Torque = 11.986*9.81*0.03

= 3.527 Nm

Hence torque on motor is 3.527 Nm

FOR WOODEN SHAFT:

Density of hard wood = 700Kg/m^3

Volume= (3.14/4) *0.02^2*1.920

= 0.00060288 m^3

Mass = density * volume

= 0.00060288*700

= 0.422016 Kg

Total mass on pulley: - P1+P2+Pb+Ps

= 2.7+1.836+4.5+0.422016

= 9.45806 Kg

Torque on pulley = load * radius

= 9.45806*9.81*0.03

= 2.7834 Nm

Weight on 2nd pulley:

Assume weight = 1Kg

Total weight =: - P1+P2+Pb+Ps

= 2.7+1.836+4.5+0.422016 +1

= 10.45806 Kg

Torque = load * radius

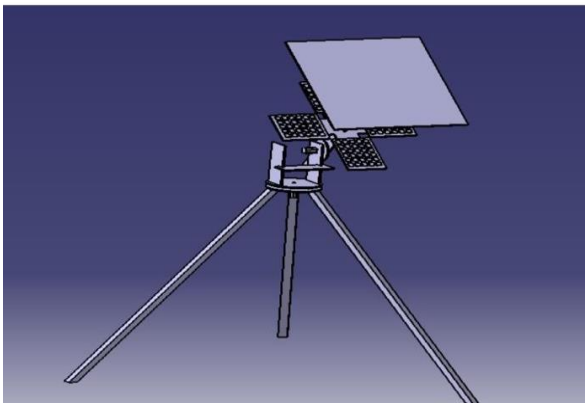
= 10.45806*9.81*0.03

= 3.077 Nm

Hence torque on motor = 3.077 Nm

3. DESIGN and EXPERIMENTAL SETUP

The solar panel has been designed and the prototype of the system produced related to the motion type of the model. As it is mentioned before, the system has binary motion in order to get the solar radiation perpendicular to the panel's surface every time. The solar panel makes its rotation around its vertical axis in monthly basis. The orientation of the panel in vertical is related to the azimuth angle of the sun that has been described in geometry of the sun part. In addition to that, the solar panel has its rotation around its horizontal axis in daily basis depending on sunrise and sunset times.



3.1MAIN COMPONANTS USED IN MECHANISM:

1. Solar Panel

Photovoltaic solar panels absorb sunlight as a source of energy to generate direct current electricity. A photovoltaic (PV) module main plate of 10W and four control plates of 1W each are used to sense the direction of sun and turn the main plate towards sun.

3.Motor

6 Volts, 1-Watt DC Motor is used for tracking the central panel. The power fromcontrol panels receive to dc motor and depending on which controlpanel is receiving the sunlight, main panel gets turned in that direction.

4.Belt and Pulley

The set of belt and pulleys are used to transmit power from the DC motor to shaft on which main plate is mounted.

4.WORKING: -

At starting the main plate of the system which covers all the four small plates behind it, will be pointing exact towards the sun .As the sun changes its position towards right the right side small plate will be exposed to the sun, as soon as the sun rays falls on the plate the energy conversion will start and it will supply the electric power to the motor, then the motor will rotates in clockwise direction. By this motion of motor will be transferred to the pulley using flat belt drive and

whole setup move towards the right. When the system will come in exact pointing towards the sun the small plate will be comes in shadow then the power supply will stop towards motor. Same these mechanisms will be happening in case of the left side plate when it exposes to the sun. When the upward small plate expose to the sun after the change of the position of the sun the energy conversion will start and it will supply the electric power to the motor, then the motor will rotate in clockwise direction. By this motion of motor will be transferred to the pulley using flat belt drive and whole setup move upward. Same these mechanisms will be happening in case of the lower side plate when it exposes to the sun.

5.Results and Discussion

We have taken readings for 10 W solar panel of Spark solar company of model SS-10-18-P which has open circuit voltage of 21.96 V and current of 0.59 A. we didn't connected any load and measured the voltage and current after every 10 min from which we calculated the power and plotted the different graphs of Power VS Time they are as follows

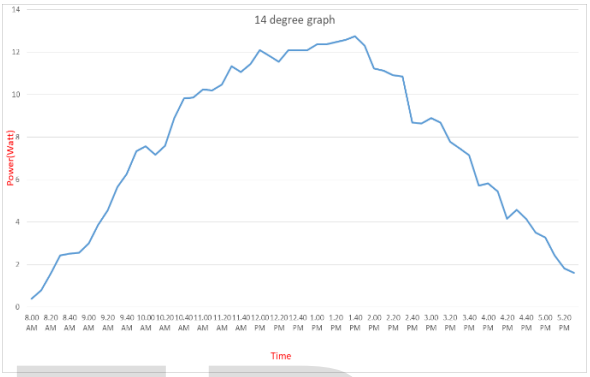
5.1Graph for 12-degree fixed angle: -

We have fixed the plate at 12-degree inclination from surface facing towards the south and inclined to north and taken the reading for whole day from that the below graph is plotted.

From this graph we can see that the power output in the morning from 8 AM to 10 AM is below 8 watt which is 60% output of total capacity of the solar plate.it is increasing as time increases after 10 AM the power output is fast increasing. Between the time 11 to 2 PM the output is between 10 to 12 Watt which is 100% and highest power output during a day after 2 PM it is decreasing as time passes and the power output after 3 PM is below 8 watts as it is in the morning. The power output at the end of the day is nearly 1 Watt. When we calculate the energy output for whole day from this graph, we get the 4495-watt min energy.

5.2. Graph for 14-degree fixed angle: -

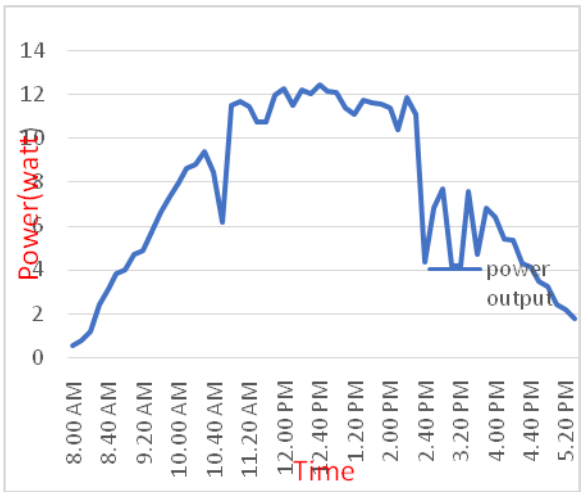
We have fixed the plate at 14-degree inclination from surface facing towards the south and inclined to north and taken the reading for whole day from that the below graph is plotted.



From this graph we can see that the power output in the morning from 8 AM to 10 AM is below 8 watt which is 60% output of total capacity of the solar plate.it is increasing as time increases after 10 AM the power output is fastly increasing. Between the time 11 to 2 PM the output is between 10 to 12 Watt which is 100% and highest power output during a day after 2 PM it is decreasing as time passes and the power output after 3 PM is below 8 watts as it is in the morning. The power output at the end of the day is nearly 1 Watt. When we calculate the energy output for whole day from this graph we get the 4460 watt min energy which is somewhat less than the 12 degree inclination output the continuous up down can be shown in the graph which is due to clouds or intensity of the rays falling on the plate The peak power output is at 1.40 PM during whole day and the minimum power output is at 8 Am in the morning.

5.3. Graph for 16-degree fixed angle: -

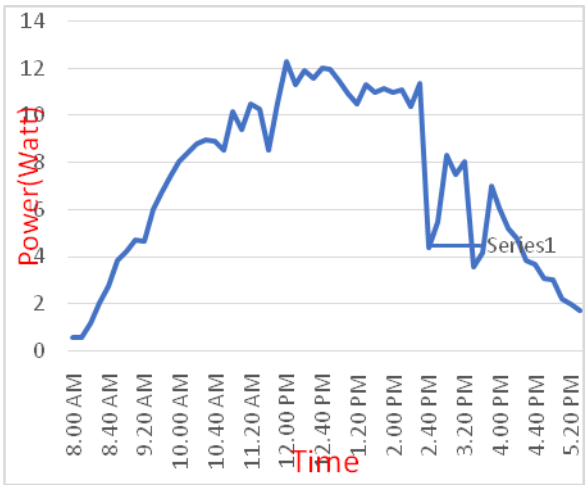
We have fixed the plate at 16-degree inclination from surface facing towards the south and inclined to north and taken the reading for whole day from that the below graph is plotted.



From the graph we can see that it has continuous increase in the morning up to 10.30 Am the energy output up to 10.30 AM is below 8 watt which is 60 % of the solar plate capacity after that between 11 PM to 2.40 PM the power output is between 10 watt to 12 watt which is 100 % .After 2.40 PM it is continuously decreasing and it is below 8 watt as it is in the morning. The power output at the end of the day is nearly 1 Watt. When we calculate the energy output for whole day from this graph we get the 4330 watt min energy which is somewhat less than the 14 degree inclination output the continuous up down can be shown in the graph which is due to clouds or intensity of the rays falling on the plate at the evening time. The peak power output is at 12.40 PM during whole day and the minimum power output is at 8 Am in the morning

5.4. Graph for 18-degree fixed angle: -

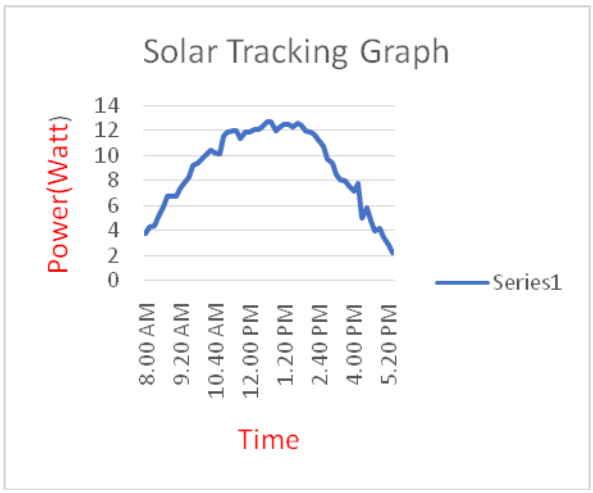
We have fixed the plate at 18-degree inclination from surface facing towards the south and inclined to north and taken the reading for whole day from that the below graph is plotted.



From the graph we can see that it has continuous increase in the morning up to 10.30 Am the energy output up to 10.30 AM is below 8 watt which is 60 % of the solar plate capacity after that between 11 PM to 2.40 PM the power output is between 10 watt to 12 watt which is 100 % .After 2.40 PM it is continuously decreasing and it is below 8 watt as it is in the morning. The power output at the end of the day is nearly 1 Watt. When we calculate the energy output for whole day from this graph we get the 4189 watt min energy which is somewhat less than the 16 degree inclination output the continuous up down can be shown in the graph which is due to clouds or intensity of the rays falling on the plate at the evening time. The peak power output is at 12.00 PM during whole day and the minimum power output is at 8 Am in the morning.

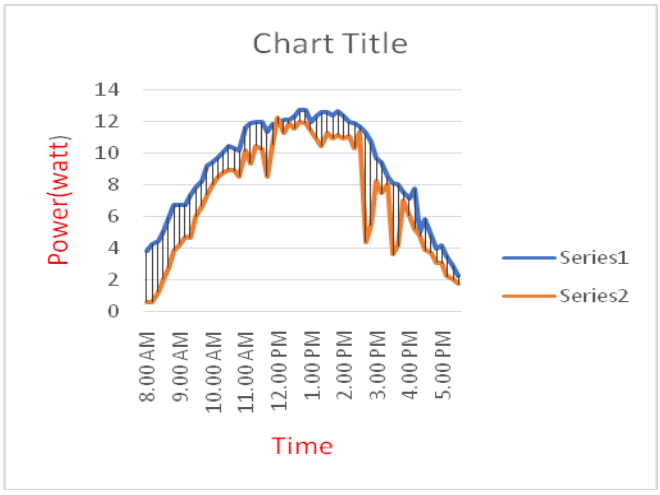
5.5. Graph for tracking system: -

We have mounted 10-watt solar plate on our tracker tracked the sun for whole day we took the reading in whole day and we got following graph of it.



From this graph we can see that the power output at morning 8 AM is near about 4 watt which is very much high compared to other fixed type of plates. Only between 8 to 9.40 AM it is below 8 watt and after that up to 10.20 Am it is between 8 to 10 watts. After 10 Am the power output for plate is between 10-12 watt which is 100 % power output.it shows maximum power output at the time of 12.50 PM. Up to 3 PM it shows power output up to 10 Watt after that up to 3.40 PM it is between 10 and 8 watt after 4 PM it falls below 8 watt. The power output at the end of the day is 2.2 watt which is comparatively high. After calculating the energy we get the value 5195 watt min.when we compare the power output with all the other graphs we can see that the power is much high during whole day by using our tracking system.

5.6Comparison between tracking and without tracking



As we can see from above graph the power output of tracking system is much more than the power output of without tracking system. The change in the power output is high in the morning and evening time and it is normal at the afternoon time. So that's why we should use solar tracking systems for more gain of solar energy.by modifying this we can also do more in this to gain more and more energy

6.CONCLUSION: -

The proposed solar tracker automatically tracks the sun capturing maximum solar power with help of dual axis solar tracking system. We have presented the concept idea regarding tracking of sun without microcontroller. The proposed dual axis solar tracker automatically tracks position of sun and maximize the solar power with help of dual axis movement of panel. As compared to single axis, dual-axis system provides high abundant electrical energy output when compared to the fixed mount system. The Dual axis tracker is having 25% more efficiency than the fixed plate.

7.Future scope

- By modifying this model, we can add worm and worm wheel in the system for accurate balancing and power transmission.
- By this tracking system we can store more energy for our household purpose.
- Improving the mechanical structure.
- Improving the load carrying capacity.
- Reducing the cost of mechanical structure.
- Putting solar panel with total system.

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