Solar Tracking System

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Abstract: *The paper deals with an automatic control system for the utilization of the duration for which solar power is available. Solar Tracking System is used to enhance the output power. The efficiency can be increased by using automatic solar tracking rather than using a fixed solar rack.*

In this paper, we are comparing two experimental setups. In the first setup, the Average output power is calculated without solar tracking. In the second setup, Average output power is calculated using solar tracking. On the 1st day i.e on a cloudy environment, by comparing the two experimental setups there is a 39.4% increase in the output power and on the 2nd day i.e on a sunny environment, by comparing the two experimental setups there is a 66.6% increase in the output power than that of the normal conventional solar panels. Eventually, in the proposed system, on an average, around 50% increase in the output power when compared to the normal conventional solar panels.

Keywords: **Photovoltaic Panel, Servo Motor, Solar Tracker**

1. INTRODUCTİON

Solar energy is a free source of energy and is one of the renewable sources available to us and its technologies can either be classified into passive solar or active solar depending on how they capture solar energy and convert it into electricity. The principle used in the Active solar energy system is the same as that of the passive energy system except that the passive solar energy system uses a fluid such as water to absorb the heat.A solar tracker is a device that directs a payload toward the sun. We intend to plan the framework, which will naturally follow the sun's position and thusly alter the direction of the solar panel to get the most extreme yield power from the sunlight-based cell. The optics in concentrated sun-based applications acknowledges the immediate components of sunlight so it must be situated relevantly to gather vitality.

Mohammed Mansoor O, Sishaj P Simon has proposed an array of plane mirrors that are placed in their inter-row spacing at a suitable angle (Θ_{ms}) to enhance the sunlight harvesting on the panel. Here what they did is that they have placed an array of mirrors which rotates accordingly the sun's position, they have shown the experimental result that an energy extraction of around 30% higher than the normal conventional solar panels[2].
Yongqiang Zhu, Jiahao Liu, Xiaohua Yang have presented the design and performance of the single-axis tracking system with a novel tracking system. They have presented the predicted solar relative model by tracking mathematical expressions based on the sun-earth geometrical relationships. they have shown the simulation results which proves that single-axis tracking is way better in increasing output power than normal conventional solar panels[3].

R. Catau, H. Cremer, P. van Kan, have proposed a transparent high-concentrated solar energy system for instance in roof lights, glass walls, and as a heater and also allows light to pass through into the buildings. They have also implemented a tracking system to follow the position of the sun [4].

2. Need of Solar Tracking

Global warming has increased and demands us to the usage of the green energy produced by renewable sources such as solar power. Consequently, solar tracking is increasingly being applied as an ecological power generating solution. Solar trackers are typically used for ground-mounted photovoltaic panels and free-standing photovoltaic installations like photovoltaic trees. A solar tracking system maximizes the output power from the solar cell by moving the panels to follow the sun direction throughout the day, which optimizes the angle at which the panels receive solar radiation. The solar tracking system helps to minimize this by attempting to situate boards with the goal that light strikes them perpendicular to their surface.

When photovoltaic panels are uncovered to sunlight, the angle at which the sun's rays meet the floor of the photovoltaic panel (known as the "angle of incidence") determines how properly the panel can convert the incoming photovoltaic radiation into electricity. The narrower the perspective of incidence, the more power aphotovoltaic panel can produce.

3. Structure of Solar Tracking

Figure 1 describes the working and structure of the photovoltaic tracking system.

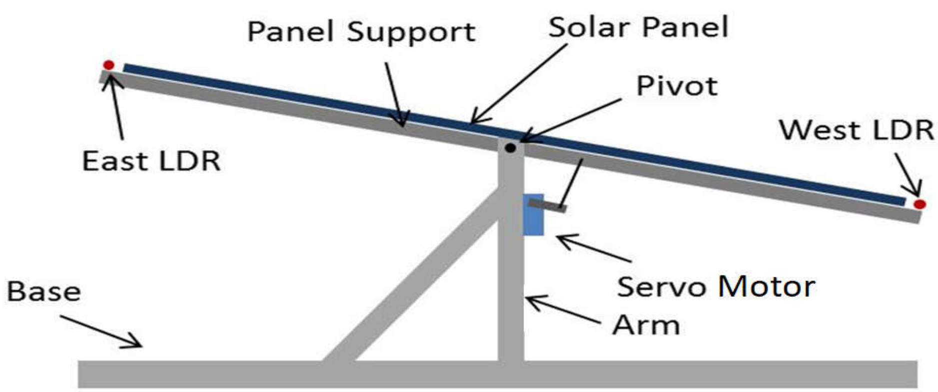

Figure 1. Structure of Solar Tracking System

Here are the two LDR's which play a vital role in the rotation of photovoltaic panel. Arm and the base together give support for the whole setup. Rotation of the solar panel is done by the servo motor. Pivot is at the exact center of the solar panel which provides centering to panel. A solar panel is fixed on the panel support. The two LDR's are fixed at either end of the panel support. By comparing the light intensity values on both the East and West LDR's, the direction in which the panel is rotated is decided.

4. Functionality of Solar Tracking System

Figure 2 describes the functional circuit diagram of the solar tracking system. The below circuit consists of two major integrated circuits namely LM339 and L293D. LM399 consists of four comparators inside of it, so it is called as **Quad comparator**, these comparators work parallelly without being depending on each other. The operation of the L293D is to drive the motor, so it is called as a **motor driver.**

DC motor is connected to pin OUT1 and pin OUT2. The light intensity values of the two LDR's are compared by the comparator, say if light intensity value of 1st LDR is greater than the 2nd one then a positive sign appears at pin IN1 and a negative sign appears at pin IN2 then the motor rotates at one direction and if light intensity value of 1st LDR is less than the 2nd one then a negative sign appears at pin IN1 and a positive sign appears at pin IN2 then the motor rotates at another direction.

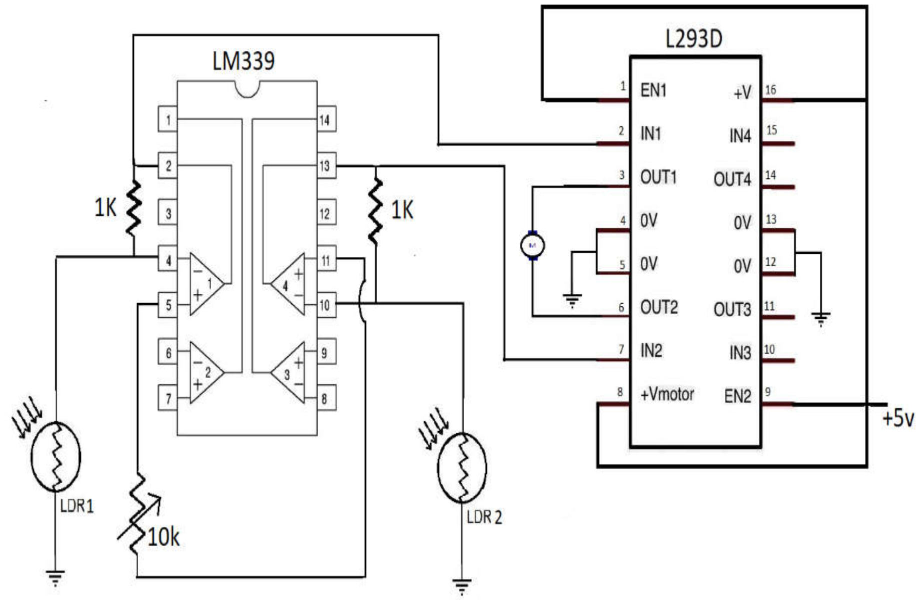

Figure 2. Functional Circuit Diagram of Solar Tracking System

DC motor is connected to pin OUT1 and pin OUT2. The light intensity values of the two LDR's are compared by the comparator, say if light intensity value of 1st LDR is greater than the 2nd one then a positive sign appears at pin IN1 and a negative sign appears at pin IN2 then the motor rotates at one direction and if light intensity value of 1st LDR is less than the 2nd one then a negative sign appears at pin IN1 and a positive sign appears at pin IN2 then the motor rotates at another direction.

5. Implementation

Initially, the supply for the geared motor is given by the 12v battery, and the part of the power which is getting from the photovoltaic panel is used to charge the 12v battery and the rest of the power from the solar panel is used to drive the load. Whenever the main switch is turned on, the circuit takes some time to get into fully operational because of the capacitors. Once the circuit is fully operational the process is executed which is mentioned in the functioning of the circuit diagram of the solar tracking system.

6. Project Setup

In the below Figure 3, we can observe the arrangement of the solar panel, geared motor, 12V battery, and the main circuit for the photovoltaic monitoring system. The main circuit and the geared motor are driven by the 12v battery and the battery charging is through the movable solar panel.

The output power of the solar panel is calculated by a multimeter by multiplying the values of the output voltage and output current. A part of the power that is produced by the solar panel is used to charge the battery and the remaining power is utilized for on-grid. Here the load, which is solar panel is situated on the 2 arms stand which gives the durability to the motor because the total weight of the solar panel is carried away by the 2

arms stand.
The screen shot of entre project setup is shown in below Figure 3.

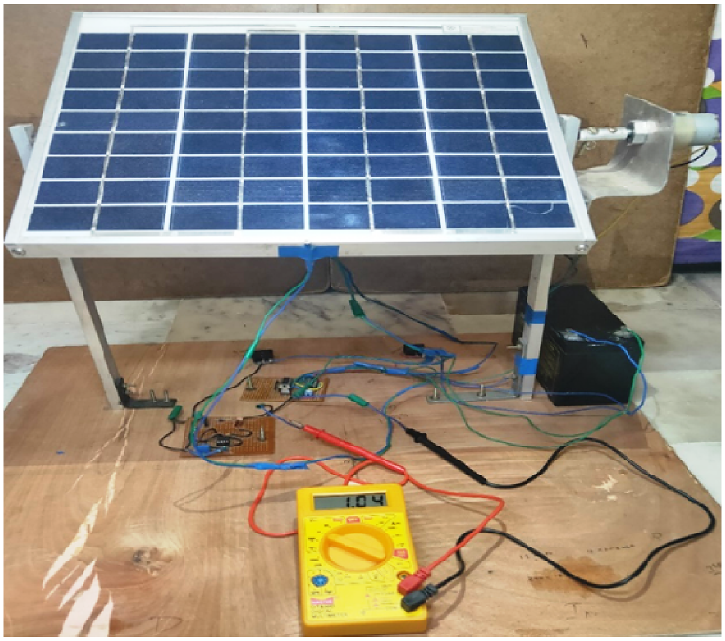

Figure 3. Screenshot of Project Setup

7. Observations of Experimental Setups

The below Tables 1 shows the comparison table of output power using with and without solar tracking system.

Time (Hours)	Output Power without Solar Tracking (Watts)	Output Power with Solar Tracking (Watts)
10:00	1.36	1.36
11:00	3.58	3.8
12:00	4.7	4.7
13:00	1.36	3.75
14:00	1.35	3.6
15:00	0.11	0.16
16:00	0.06	0.11
17:00	0.017	0.03
P_{avg}	1.56	2.18

Table 1. Comparison Table for Two Experimental Setups during a Cloudy

Day

The below Tables 2 shows the comparison table of output power using with and without solar tracking system.

Time (Hours)	Output Power without Solar Tracking (Watts)	Output Power with Solar Tracking (Watts)
10:00	2.97	2.97
11:00	2.95	3.22
12:00	2.73	4.63
13:00	2.6	4.2
14:00	2.65	4.32
15:00	1.91	3.85
16:00	1.15	3.69
17:00	0.2	1.68
P_{avg}	2.14	3.57

Table 2. Comparison Table for Two Experimental Setups during a Sunny Day

The comparison tables for the two experimental setups are shown in above Table 1 & 2. Here we have noted the output power for, with solar tracking setup and without solar tracking set up at different times, and at last, we have calculated the total average output power for both the experimental setups. On a cloudy day, we have observed that there is a 39.4% increase in the output power than that of normal conventional solar panels, and on a sunny day, we have observed that there is a 66.6% increase in the output power than that of a normal conventional solar panel. Eventually, on average, around 50% of the output power can be increased than the normal conventional solar panels.

8. Output Characteristics

The output Characteristics of without Solar Tracking during a Cloudy Day is shown in Figures 4.

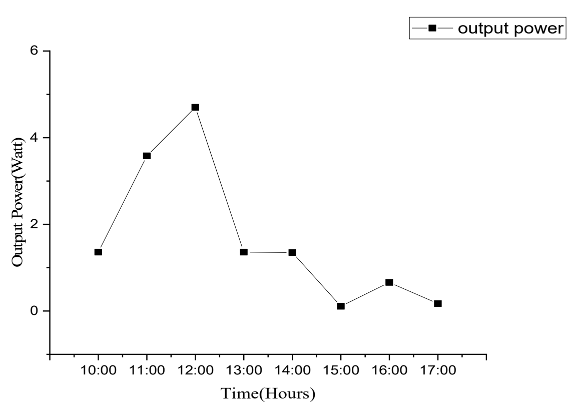

Figure 4. Characteristics of without Solar Tracking during a Cloudy Day

The output Characteristics of with Solar Tracking during a Cloudy Day is shown in Figures 5.

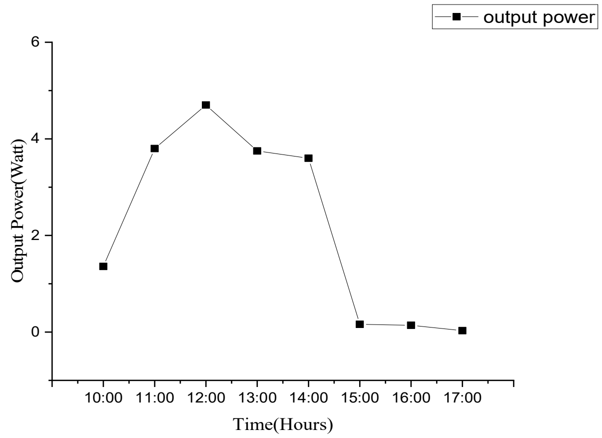

Figure 5. Characteristics of with Solar Tracking during a Cloudy Day

The output Characteristics of without Solar Tracking during a Sunny Day is shown in Figures 6.

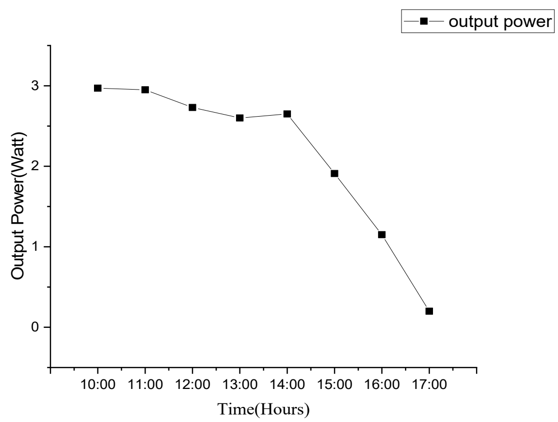

Figure 6. Characteristics of without Solar Tracking during a Sunny Day

The output Characteristics of with Solar Tracking during a Sunny Day is shown in Figures 7.

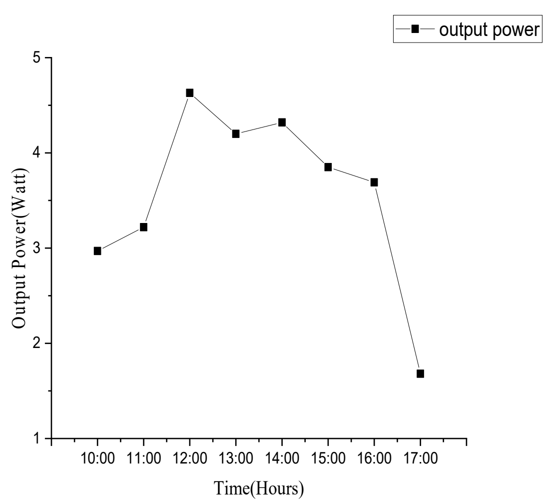

Figure 7. Characteristics of with Solar Tracking during a Sunny Day

9. Conclusion

This paper has shown the experimental results of the overall performance of the Solar Tracking System with a component factor of 1.39 on a cloudy day and 1.66 on a sunny day respectively. By considering the average of the 2 days i.e on (sunny day and cloudy day), the Solar Tracking System can lead to an improvement of 52.3% in the complete common output power. By this solar tracking method, we increased the total output strength with the aid of most utilization of the duration for which photovoltaic strength is available. Therefore, the proposed Solar Tracking System is a handy way of increasing power received from the photovoltaic panel.

10. Future scope

The solar panel which is used in the photovoltaic tracking system and the normal conventional system is the same, except that in the solar tracking system the solar panel is movable to improve the percentage increase in the output power than the normal conventional solar panel.

11. References

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