

Development and Fabrication of Sun Tracking Solar Panel with Cleaning System

Rushikesh Bhoite¹, Ketna Dhoble¹, Sujesh Ghag^{1*}, Aishwarya Gole¹, Sreejith Sreenivasan²

Abstract

The global energy crisis is currently the most pressing issue. Renewable energy resources are being prioritized in today's world to decrease the need on conventional resources. Solar energy is gaining popularity as a means of increasing renewable energy adoption in a variety of fields. Solar panels which convert sun's energy into electrical energy are inefficient and costly. Solar tracking systems are the most appropriate technology to increase the efficiency of solar cells by tracking the sun rays. Furthermore, solar panels are typically installed in dusty environments. The dust collects on the panel, obstructing the sun's incident light. It indirectly reduces the power generation capacity of the panel. In this project, a prototype of microcontroller-based sun tracking solar panel with cleaning system has been fabricated.

Keywords: Renewable energy, solar panels, solar tracking, prototype, cleaning system

INTRODUCTION

As the price of energy supplies such as fossil fuels fluctuates, renewable energy is fast gaining traction. More energy to be generated because of solar panel which will be able to maintain a profile according to angle of sun rays. At any time of day, this solar system model will track the sun to maximize the quantity of sunlight incident on the solar panel [1].

The dust that settles on solar panels reduces their efficiency as well. By adding a cleaning system, we can maximize the efficiency so that no more money will be paid to a cleaning agency and this system will be time saving. Besides that, frequent cleaning will ensure that the solar panel works with good transmittance [2].

PROBLEM DEFINITION AND OBJECTIVES

A solar panel is a pre-packaged, interconnected collection of solar collectors. In commercial and domestic applications, the solar panel can be employed as a photovoltaic system to create and supply power, successfully creating sustainable energy. Solar panels, as we all know, are fixed at a set angle,

and do not follow the sun's movement, thus they do not receive the greatest amount of sunlight throughout the day. Another key issue is determining whether or not a solar power unit's storage battery is being charged [3].

Objectives

- To build a solar system model which will track the position of the sun.
- To implement a cleaning system to the solar system model.
- Aim to put the prototype system into action.
- To improve and maximize the solar panel's efficiency.
- External power supply is not required.

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METHODOLOGY/DESIGN

The light dependent resistor (LDR), which is employed as a sensor and whose resistance decreases with increasing light intensity, is responsible for the entire operation of the sun tracking system. The experimental setup is shown in Figure 1. The side shaft gear motors are used to rotate the solar panel at two different axis. In a solar tracking system, we used LDRs to monitor light intensity [4]. The major goal of this system is to keep the solar panel aligned with the sun's rays in order to enhance the amount of energy received and hence increase efficiency.

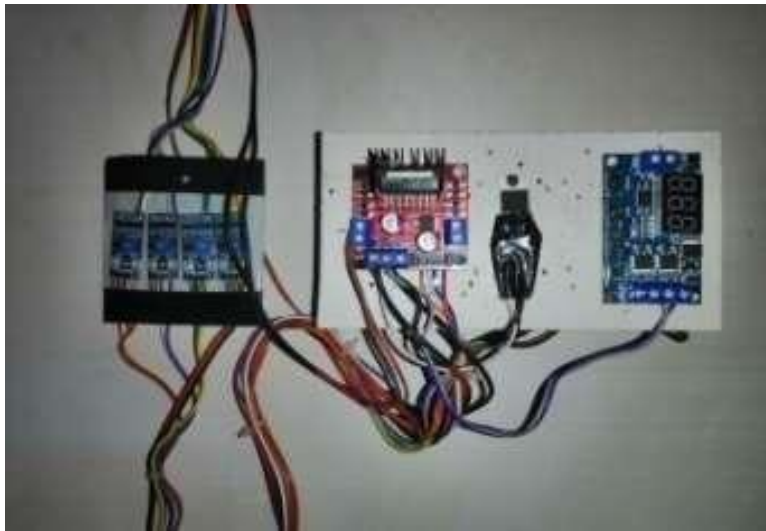


Figure 1. Experimental setup.

The panel is made up of two pairs of LDRs that track the sun's exact position along the inclined axis and the axis. With increasing incident light, the resistance of the LDR sensor decreases. The resistance decreases when the highest intensity radiation is used. This data is supplied to the L298N motor driver, which provides for simultaneous speed and direction control of two DC motors. The circuit assembly is shown in Figure 2 [5, 6].

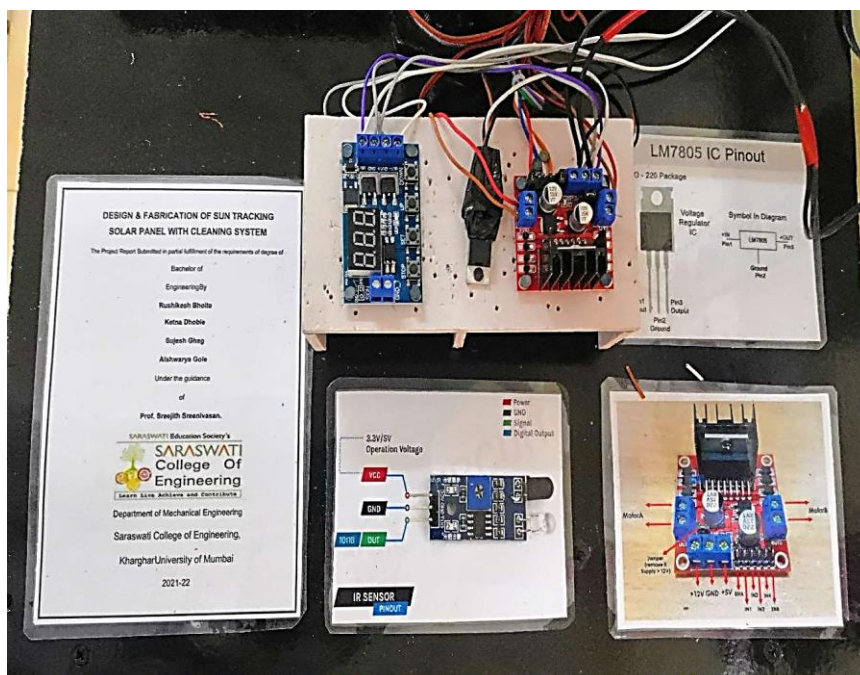


Figure 2. Circuit assembly.

The solar panel cleaning system consists of a sponge set on solar panel with help of neon magnets driven by DC motors through threaded bolt and nut and the actions are controlled by a timer module [7]. The neon magnets are kept on a strip, and it is moved along the length of the solar panel in horizontally forward and backward direction, which carries out the cleaning action [8, 9].

The motor will rotate the bolt and the motion of nut will get converted into linear motion. The system can be moved in a horizontal direction until the limiting switches. And hence the cleaning process gets repeated until timer module stops. This process gets repeated after specific interval of time. And interval time and loop time is set in timer module [7].

EXPERIMENTATION

For further calculation of efficiency of solar panel, we took the readings which are given below:

Figure 3 shows setup of LDR and solar panel.

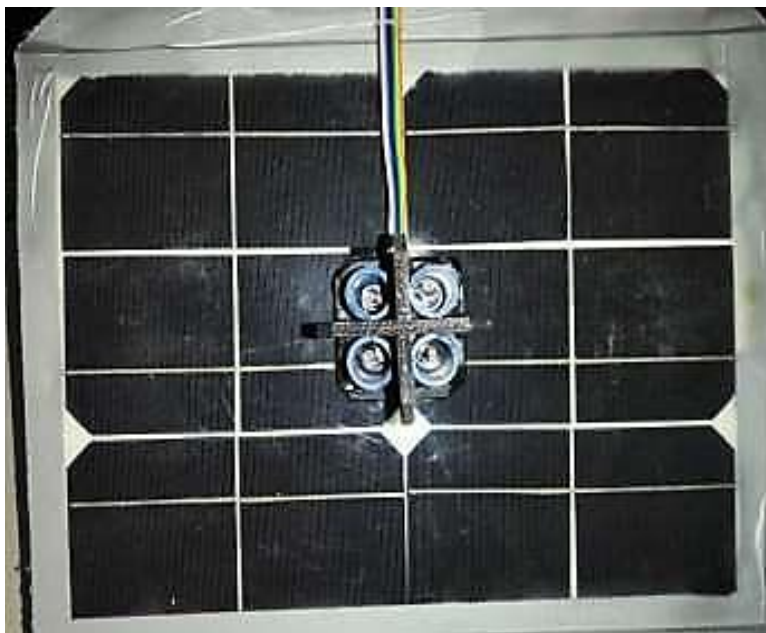


Figure 3. Setup of LDR and solar panel.

Calculation

Rating of Panel

$$V_{mp}=5.8 \text{ V}$$

$$I_{mp}=2 \text{ A}$$

Calculating Power/m²

- Size of Panel =14×9 in
=35.56×22.86 cm
- Size of solar panel =0.3556×0.2286
=0.0812 m²
- Power/m² of panel = $\frac{\text{power of panel}}{\text{Area of panel}}$
= $\frac{11.6}{0.0812}$
=142.86 W/m²

Sun tracking and cleaning system is shown in Figure 4.

RESULT**Case 1**

Table 1 and Figure 4 show the output of cleaned solar panel with sun tracking.

Table 1. Output of cleaned solar panel with sun tracking.

S.N.	Time (t)	Voltage (v)	Current (I)	Power (p)	Efficiency (e)%
1	7:10 AM	4.771	1.851	8.831	10.88
2	8:10 AM	4.799	2.018	9.684	11.93
3	9:10 AM	4.894	2.307	11.290	13.90
4	10:10 AM	4.958	2.449	12.290	14.95
5	11:10 AM	5.0139	2.650	13.286	16.36
6	12:10 PM	4.978	2.782	13.848	17.05
7	1:10 PM	4.893	2.608	12.746	15.69
8	2:10 P M	4.853	2.444	11.860	14.61
9	3:10 PM	4.804	2.385	11.457	14.11
10	4:10 PM	4.765	2.346	11.178	13.77
11	5:10 PM	4.708	2.277	10.720	13.20
12	6:10 PM	4.579	1.626	7.445	9.17

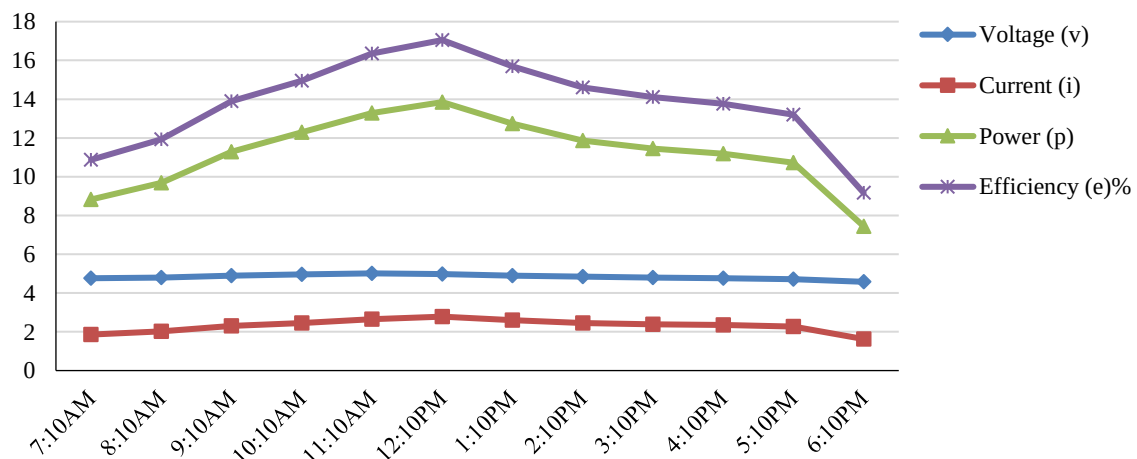
**Figure 4.** Output of cleaned solar panel without sun tracking.**Case 2**

Table 2 and Figure 5 show output of cleaned solar panel without sun tracking.

Table 2. Output of cleaned solar panel without sun tracking.

S.N.	Time (t)	Voltage (v)	Current (I)	Power (p)	Efficiency (e)%
1	7:10 AM	4.120	1.807	7.444	9.17
2	8:10 AM	4.391	1.866	8.193	10.09
3	9:10 AM	4.792	2.013	9.646	11.88
4	10:10 AM	4.817	2.120	10.21	12.57
5	11:10 AM	4.971	2.356	11.711	14.42
6	12:10 PM	4.957	2.503	12.407	15.28
7	1:10 PM	4.819	2.346	11.305	13.92
8	2:10 PM	4.789	2.307	11.048	13.61
9	3:10 PM	4.774	2.282	10.894	13.42
10	4:10 PM	4.765	2.0622	9.826	12.1
11	5:10 PM	4.338	1.905	8.263	10.18
12	6:10 PM	4.334	1.75	7.584	9.34

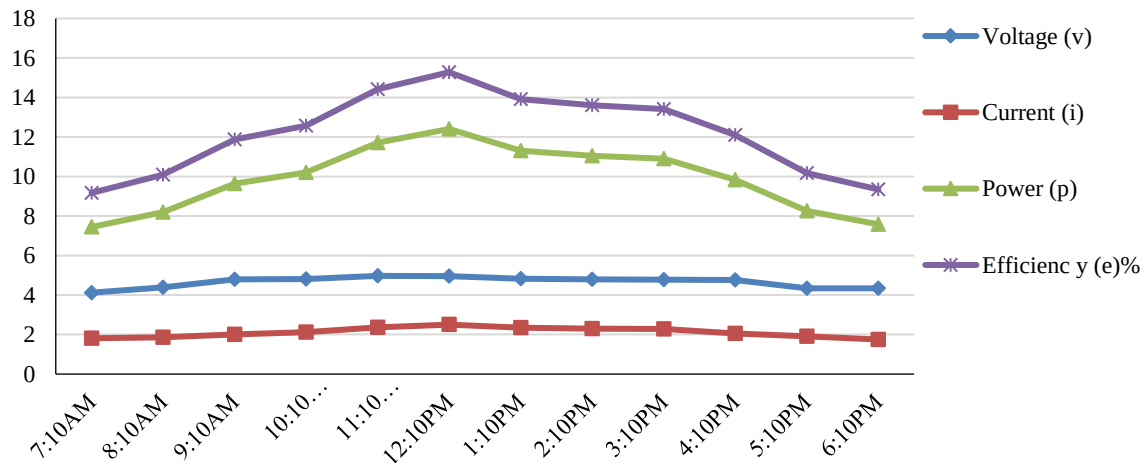


Figure 5. Output of cleaned solar panel without sun tracking.

Case 3

Table 3 and Figure 6 show output of dusty solar panel without sun tracking.

Table 3. Output of dusty solar panel without sun tracking.

S.N.	Time (t)	Voltage (v)	Current (I)	Power (p)	Efficiency (e)%
1	7:10 AM	3.968	0.435	1.726	2.13
2	8:10 AM	4.049	0.592	2.397	2.95
3	9:10 AM	4.250	0.822	3.493	4.30
4	10:10 AM	4.441	1.082	4.805	5.92
5	11:10 AM	4.670	1.165	5.440	6.70
6	12:10 PM	4.582	1.542	7.065	8.7
7	1:10 PM	4.337	1.547	6.709	8.26
8	2:10 PM	4.250	1.464	6.222	7.66
9	3:10 PM	4.179	1.415	5.913	7.28
10	4:10 PM	3.968	1.023	4.059	4.99
11	5:10 PM	3.934	0.876	3.446	4.24
12	6:10 PM	3.927	0.651	2.556	3.15

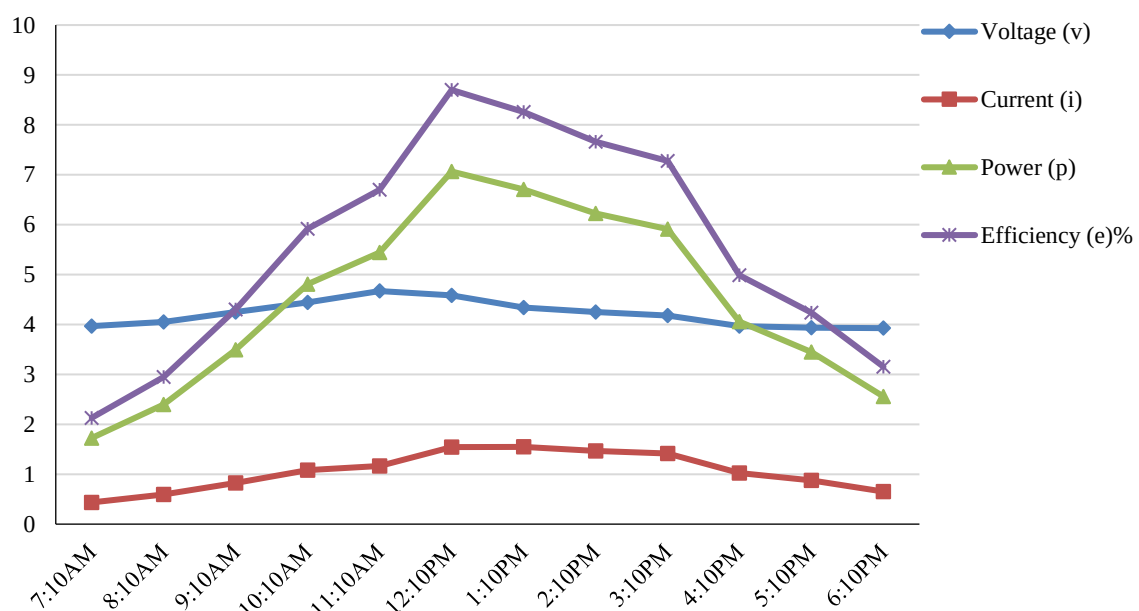


Figure 6. Output of dusty solar panel without sun tracking.

Case 4

Table 4 and Figure 7 show output of dusty solar panel with sun tracking.

Table 4. Output of dusty solar panel with sun tracking.

S.N.	Time (t)	Voltage (v)	Current (I)	Power (p)	Efficiency (e)%
1	7:10 AM	3.999	0.773	3.091	3.81
2	8:10 AM	4.256	0.935	3.979	4.9
3	9:10 AM	4.304	1.195	5.143	6.33
4	10:10 AM	4.6168	1.464	6.757	8.32
5	11:10 AM	4.680	1.768	8.274	10.19
6	12:10 PM	4.555	1.959	8.923	10.99
7	1:10 PM	4.544	1.856	8.433	10.39
8	2:10 PM	4.512	1.802	8.13	10.01
9	3:10 PM	4.804	2.385	11.457	14.11
10	4:10 PM	4.765	2.346	11.178	13.77
11	5:10 PM	4.708	2.277	10.720	13.20
12	6:10 PM	4.579	1.626	7.445	9.17

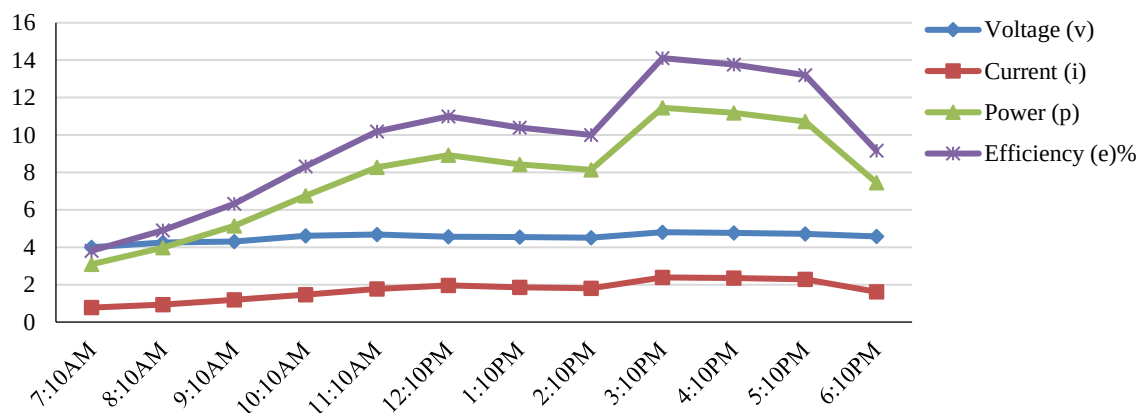
**Figure 7.** Output of dusty solar panel with sun tracking.**Case 5**

Table 5 and Figure 8 show comparison of efficiency in different cases.

Table 5. Comparison of efficiency in different cases.

S.N.	Case 1 Efficiency (E)%	Case 2 Efficiency (E)%	Case 3 Efficiency (E)%	Case 4 Efficiency (E)%	Case 5 Efficiency (E)%
1	10.88	9.17	9.17	2.13	3.81
2	11.93	10.09	10.09	2.95	4.9
3	13.90	11.88	11.88	4.30	6.33
4	14.95	12.57	12.57	5.92	8.32
5	16.36	14.42	14.42	6.70	10.19
6	17.05	15.28	15.28	8.7	10.99
7	15.69	13.92	13.92	8.26	10.39
8	14.61	13.61	13.61	7.66	10.01
9	14.11	13.42	13.42	7.28	9.05
10	13.77	12.1	12.1	4.99	7.85
11	13.20	10.18	10.18	4.24	6.10
12	9.17	9.34	9.34	3.15	5.10

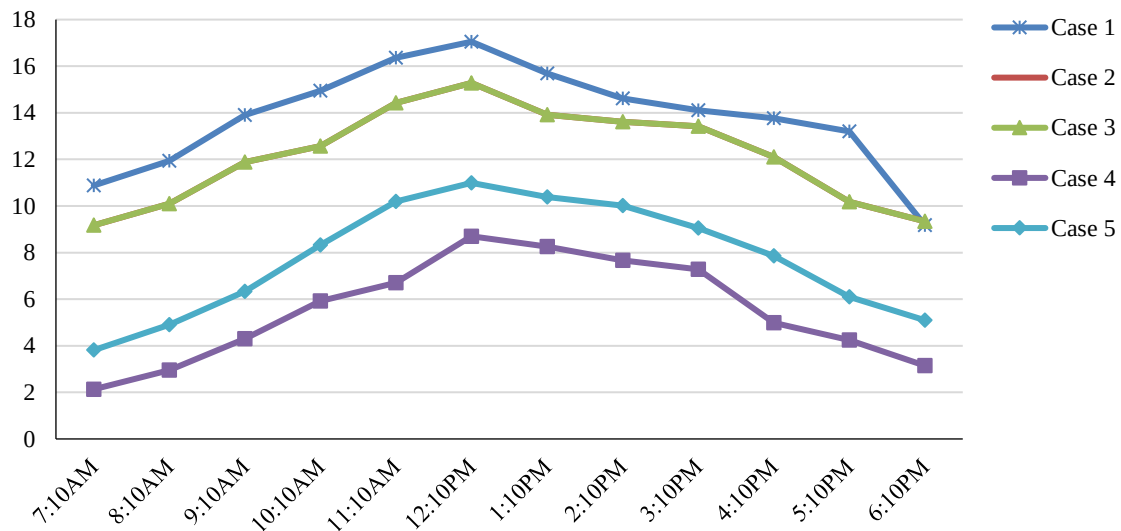


Figure 8. Comparison of efficiency in different cases.

In case 5, there is comparison of efficiency in different cases; when we look, the blue line has the higher value (efficiency (%) of cleaned solar panel with sun tracking) as compared to the others; this shows that the cleaned solar panel with tracking are more efficient than others (Figure 9) [10, 11].

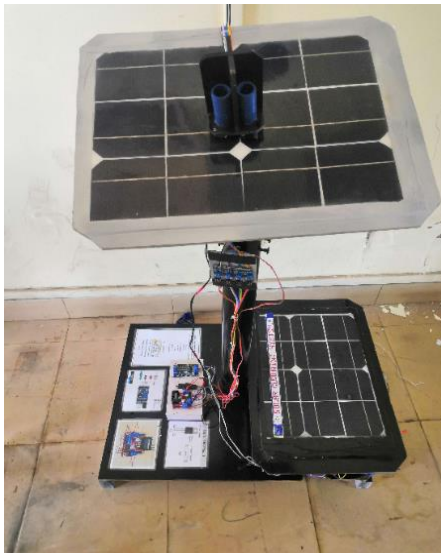


Figure 9. Prototype of sun tracking and cleaning system.

CONCLUSION

This report describes an intriguing and straightforward attempt to implement Sun Tracker using LDR and L298N motor drivers. Instead of using a linear actuator, a bevel gear is used. It helps in increasing the efficiency of the overall tracker. The design helps to extract the most power from solar radiation by tracking it with a sun tracker. This is achievable if the solar panel is always aligned with the sun's incident beams [12]. The following characteristics are included in the methodology:

- An easy-to-use and cost-effective solar tracking and cleaning system.
- The ability to fine-tune the tracking precision. Even in inclement weather, it provides accurate tracking.

Many researchers provide cleaning system for solar panel, but they provide costly and high energy consumption and low efficiency methods. But when we use this method on large scale to increase

efficiency, it becomes very cheap and less energy consumption methods increase efficiency more than that of normal. The increase in efficiency is shown in case 5. More than that, normal efficiency and increasing this amount of efficiency on large scale is very useful and production of energy units is increased in less amount of infrastructure costs.

Future Scope

There is a wide scope of using application-based system which can be useful for the cleaning the solar panel automatically. The owner can also keep an eye for the dust accumulation on the panel and the energy generation from the panels using the different sensors mounted on it. According to it, one can also press the button on the electrical device and clean the solar panel before it reaches the pre-set value at which the system should run for the better efficiency.

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