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Solar Panel with Sun Position Tracking and Automatic Cleaning System

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Abstract: The project focuses on solving the problem of dust settling, stability issues of solar tracking unit and overtime decrease in efficiency of solar panels. The project is based on fabricating an automated system which can clean and track the solar panels automatically and efficiently. It works on reducing the losses caused by tracking and cleaning which could be adjusted to be fully automated as well as manually controlled as per the requirements. The major common problems in normal solar cleaning and tracking projects is the use of sensors which get affected due to adverse conditions and settling of dust due to which the mechanism provides incorrect readings. Hence these problems are solved in our project which focuses on cleaning of panels and eliminating the use of sensors like proximity sensors, etc. The project designed can be used in solar power plants and industries where timely cleaning and maintenance of Solar Panels is a necessity.
Keywords: Automatic, Eliminating, Efficiency, Dust Settling, Maintenance, Tracking, Cleaning.

I. INTRODUCTION

With the rise in use of Solar Panels in industries for power generation there is a rise demand for the solution of the problems faced by power generation. Some these problems involve the reduction of over time power generation due to settling of dust in solar panel and effective mode to track the position of sun due to the inaccuracies in the use of sensors in extreme weather conditions. Our project focuses exactly solving these problems.

The effective way devised for solving these problems in the project was to completely eliminate or reduce the use of sensors due to their inaccuracies in extreme weather conditions. The project focuses on the use time for the application of tracking and cleaning purpose. There two mechanisms used in the project one is for the purpose of tracking the position of the sun and the other is for the purpose of cleaning of solar panel.

The Tracking Mechanism consist of simple design in which motor is to wind and unwind the string based on the code functions which are given on a timely basis. The motor rotates a specific in speed such as to cover the total time of 12hr or till the time the sun is clearly visible in the sky. The Cleaning Mechanism is designed to clean solar panels by moving left to right along the length of the solar panel surface. The Cleaning consists of motorized wheels which is drive the mechanism. The mechanism also consists of motorized brush and a fixed water supply provided by the perforated pipes and pump which is used to remove the dust settled on the solar panels.

II. MATERIALS AND METHOD

A. List of Materials used in the fabrication of the mechanism

Sr No	Components	Material/Specifications	Features/ Applications	Quantity
1	DC Motors	Torque: 6-8 kgf-cm Speed: 60 RPM	To transfer the power to the wheels	2
2	Frame	Aluminium (Rectangle Tube)	To support the components	1
3	Wiper	Rubber	To clean the dust	1
4	Wheels	Wheel Diameter = 4 inches	To drive the cleaning mechanism and carry the weight	6

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5	Mist Nozzles/ Pipes	Coolant pipe	To spray water	1
6	Pump	Manometric head =15m	To deliver the water at required height	1
7	DC Motors	Torque: 1-2 kgf-cm Speed: 4 RPM	To transfer the power to the wheels	1
8	Frame	Mild Steel	To support the components	1
9	Solar Panel	Polycrystalline, 165W, Output-12 Volts	To check the power output	1
10	Tank	20 L	To store water	1
11	Safety Circuit	-	To check the water level and for safety	1

B. Methods used in Tracking and Cleaning Mechanism

For Tracking the basic requirement is that the solar panel must be able track the position of the till the time sun's solar energy can be used for generating power. Hence the solar tracking model is coded to track the position of the sun for 12hr. Here the rpm of the motor is controlled by controlling the PWM signal of the DC Motor to obtain the required RPM. The algorithm for the process of tracking is mentioned below:

1) System is ON (at t=0).
2) Rotate the motor on a set RPM.
3) Change Direction (at t=12hrs).
4) Stop the system when reaches the initial start position.

For Cleaning Mechanism, the basic requirement is the mechanism should be able to clean the solar based on the number of times the mechanism passes over the solar panel surface. The algorithm for this process of cleaning is mentioned below:

a) System is ON.
b) Rotate the motor on a set RPM, turn on the water supply, rotate the brush.
c) Change Direction when Limit Switch is triggered.
d) Repeat till the number times the set to pass through the surface of the panels.
e) Stop the system when reaches the mechanism triggers the limit switch.

C. Real life model

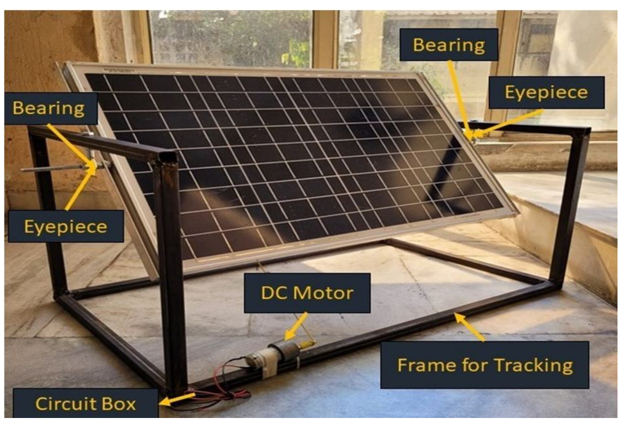

Fig. 1 Tracing Mechanism

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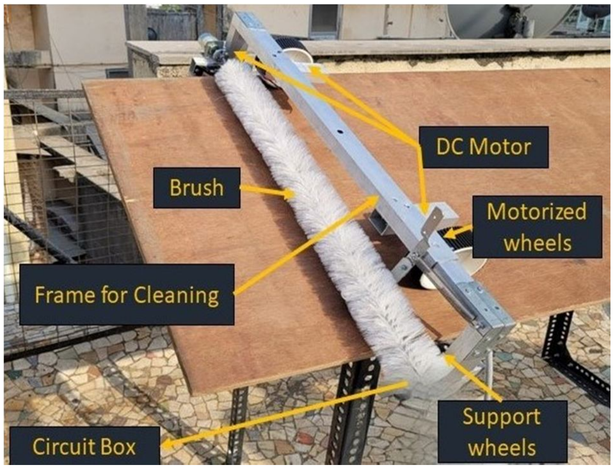


Fig. 2 Cleaning Mechanism

III. CALCULATIONS USED IN THE FABRICATION PROCESS OF THE MECHANISMS

A. Calculations for Tracking Mechanism

The major components used in the tracking mechanism is the motor, bearing, shaft, rope and the frame. The motor selection process involves two steps: 1. Finding the torque required based on the requirement. 2. Finding the rpm required based on the requirement. The bearing, shaft, rope and frame can thus be designed based on the input parameters of motor and the required output necessary

B. Suitable RPM Selection for Motor

Rotating angle of solar panel with respect to time and RPM calculation:
There are 12 hours between sunrise and sunset
The solar panels can rotate almost 180°.
But for the simplicity of code and application the angle for rotation is 90° from the centre Axis rod
∴ The angle per minute is given by,

$$\frac{degree}{min} = \frac{90^0}{12 * 60} = \frac{1}{8} = 0.125$$

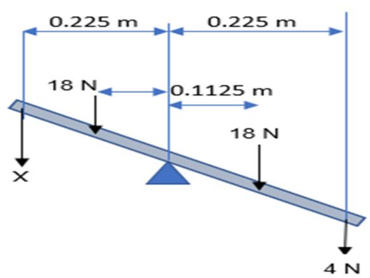
1^0 degree per 8 minutes
As per our Motor selection, we need 12 revolutions in 12 hours a day
Thus, we need 1 revolution in 1 hour in a day

$$\therefore \frac{1}{60}\frac{rev}{min} = 0.0167rpm$$

∴ The rpm required is 0.0167 rpm

C. Suitable Torque Selection for the Motor

Total weight of solar panel = 3.6 kg
Rpm required = 0.0167 rpm
Balancing weight = 400 g = 0.4 kg = 4kN



Moment of inertia = $\frac{ML^2}{12} = \frac{3.6*0.450^2}{12} = 0.06075\, kgm^2$

$$\alpha = \frac{\omega_2 - \omega_1}{t}$$

$\omega_1 = 0$

$\omega_2 = \frac{2*\pi*N}{60} = \frac{2*\pi*0.0167}{60} = 1.74 * 10^3 \frac{rad}{s}$

$\alpha = \frac{\omega_2 - \omega_1}{t} = \frac{1.74 * 10^3 - 0}{1} = 1.74 * 10^3 \frac{rad}{s}$

Torque required (T) = I α

$= 0.06075 * 1.74 * 10^3$

$= 1.06 * 10^4\ Nm$

To find unknown force X:

T = Σ $moment\ about\ fulcrum$

$1.06 * 10^4 = X(0.225) + 18(0.1125) - 18(0.1125) - 4(0.225)$

$X = F = 4.00047\, N$ = 0.400047 kgf

Motor shaft radius = 0.2 cm

Therefore, Torque that should be applied by motor in order to rotate the solar panel at given acceleration,

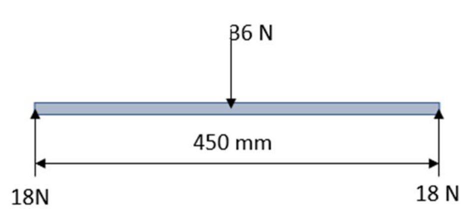
Torque = 0.400047 * 0.2
= 0.080 kgf-cm
= 80 g-cm

Therefore, the motor selected is DC motor with torque capacity of 1-2 kgf-cm and 4 rpm (can be controlled as per the requirement)

D. Selection of Shaft for Tracking Mechanism

Shaft diameter = 8 mm … (based on availability)
… (half shaft type)

E. Selection of Bearings for Tracking Mechanism



m = 3.6 kg
W = 3.6*10 = 36 N

Selecting Eye Joint Bearing: because Low cost

Two bearing used

Hence $F_r = 18N$

N = 0.0167 rpm

$L_{hrs} = 16000\ hours$

Probability = 92 %

Equivalent Bearing Load (P_E):

$$P_E = (x * V * F_r + y * F_a) * S * K_t$$

V = 1 ……… inner Rotating race

X = 1 ……… pure Radial Load

$F_a = 0$

S = 1.1 ……… assume steady load

$K_t = 1$

$P_E = (1 * 1 * 18 + 0) * 1.1 * 1$

$P_E = 19.8\,N$

Since bearing is rotating at very low rpm hence bearing should be design based on Static capacity

Hence Selecting Eye Joint Bearing with following Specifications:

Series no = PHS 8

Inner bore diameter = d = 8 mm

Outer bore diameter = D = 22 mm

Screw = M8 * 1.25 mm

H = 14 mm

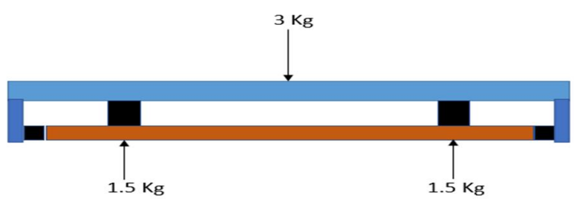
Static Capacity = C = 6.5kN = 6500N

F. Calculations for Cleaning Mechanism

The major components used in the cleaning mechanism is the motor, bearing, shaft, rope and the frame. The motor selection process involves two steps: 1. Finding the torque required based on the requirement. 2. Finding the rpm required based on the requirement. The frame can thus be designed based on the input parameters of motor and the required output necessary.

G. Motor Selection Torque and rpm

Torque required:



Radius of Wheel Used = 5.4 cm

Total Weight per wheel = 1.5 kg

No of Wheel (N) = 4

No of Wheel carrying weight (N1) = 2

We = 2 kg

Ww = weight on each Wheel = We/N1= 2/2 = 1

Torque (in kg-cm) = Ww* Radius of Wheel

= 1 * 5.4

= 5.4 kg-cm

H. RPM Required

The Speed of the motor should such that it cleans the solar panels efficiently. Hence a speed of 40-60 rpm is sufficient for the operation

Therefore, the motor selected based on availability is DC motor with 6-8 kgf-cm and 60 rpm (but can be controlled as per the requirement).

IV. RESULTS AND DISCUSSION

The Tracking mechanism is 85-90% accurate in tracking the position sun using time-based model. The efficiency of Solar Panel increased up to 80% with the help of tracking mechanisms.

The Cleaning mechanisms is able to clean the dust settled on Solar Panel. The cleaning mechanisms increases the overtime efficiency up to 85%.

The addition results of the Automatic System for Cleaning and Tracking Mechanism are mentioned below:

1) Less weight as compared to the available models in the industry
2) Solving Stability and inaccuracies issues of Tracking Models
3) Increasing Panel Efficiency by Cleaning of Panels
4) Increasing Product Life & Durability of Solar Panels
5) Maintain constant output during Peak hours

V. CONCLUSION

This aims at solving the problem of manual cleaning of solar panels by substituting it with an automatic mechanism. It also has the fully functional solar tracking model that was coded to track the position of the sun and optimizing the maximum solar energy production every time by making it on timely basis by eliminating any dependence on sensors. With the stability-related issues of the solar tracking units solved, Power wastage was reduced in tracking and cleaning could be adjusted to be fully automated as well as manually automated as per the requirements. The problem of dust settling, and overtime decrease in efficiency of solar panels is resolved by automating the cleaning and tracking process of the solar panels. This helps to deal with solar energy, utilize it in the most efficient way possible, gain in-depth knowledge about renewable sources available and their usage. This also equipped us with skills pertaining to sustainability and development of solar energy as a renewable source and the ways to deal with energy production issues that arise frequently, along with eliminating any dependance on the need for fossil fuels.

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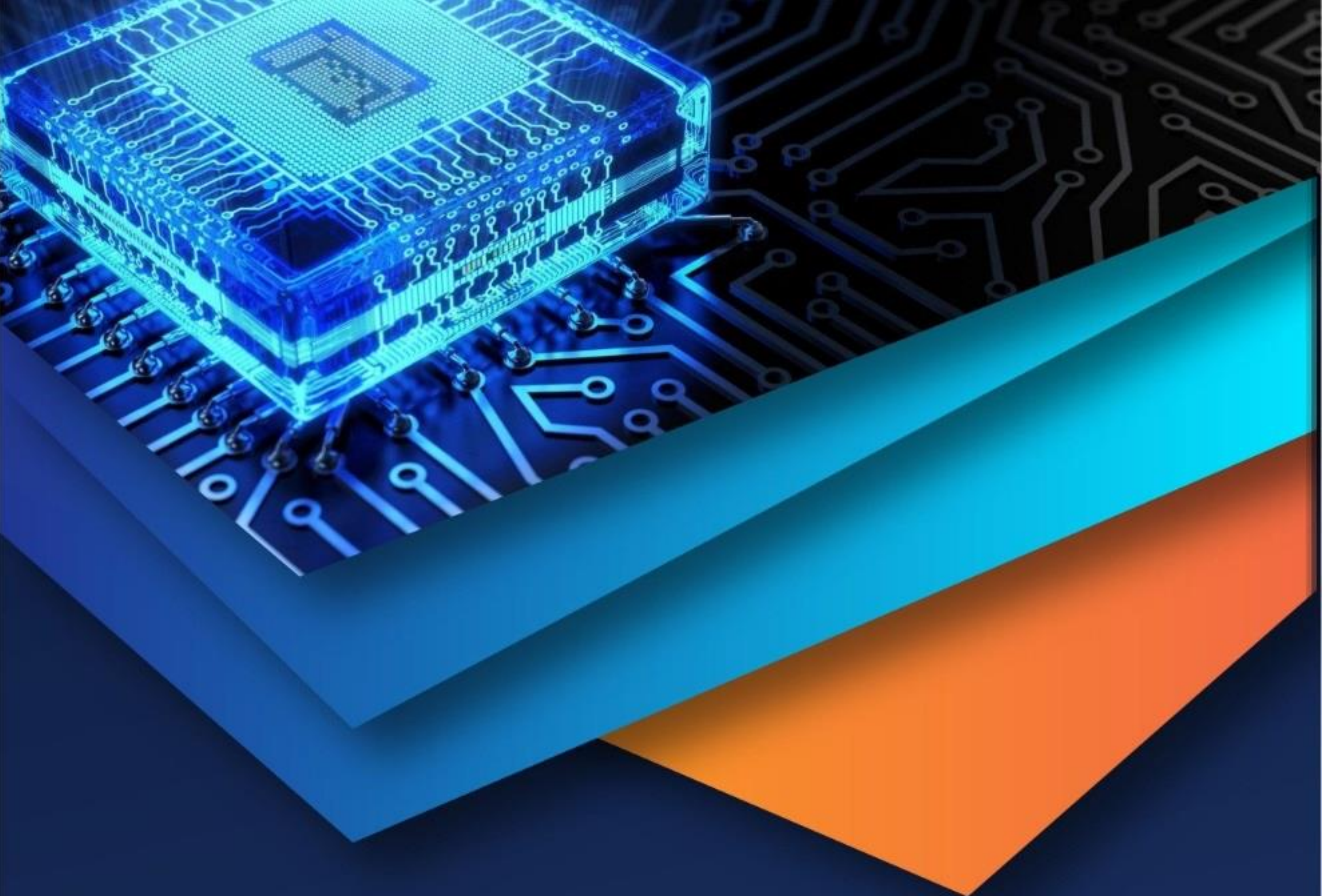
REFERENCES

[1] Bauskar & Nikita, Solar Panel Cleaning By using Arduino, 2020.
[2] Mohammad & Bin, Solar Panels Cleaning System, 2020
[3] Bingol & Okan, Microcontroller based Solar-Tracking system and its implementation, 2005.
[4] Joshi & Abhijeet, Experimental Investigations on the performance of Solar Photovoltaic system for different industrial weather conditions with dust accumulation, 2020.
[5] Najeeb & Nithin, Microcontroller based Solar-Tracking system and its implementation, 2018.
[6] V.B Bhandari "Design of Machine Element", Tata McGraw Hill Publishing company, eight condition, 2003.



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