Self-Powered Dual Axis Solar Tracking System

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Abstract

A simple yet precise solar position measuring system is required to maximize the output power of a solar panel in order to boost panel efficiency while lowering system costs. Solar position may be monitored using either an active/passive sensor or the sun position monitoring algorithm. Sensor-based sun position measurement devices do not accurately estimate the solar position on a cloudy or intermittent day, and they need precise installation and periodic calibrations. A dual axis solar tracking system is used in this project to gather solar energy. Solar trackers are used to significantly increase the electric output of a photovoltaic panel. The solar tracking system consists of a primary solar panel and four guided panels behind it, two of which are linked to opposing polarities of a horizontal motor and two further panels are connected to opposing polarities of a vertical motor. When the angle of the sun's rays changes, the rays fall on the guided panel, allowing the motor to adjust the angle to maximize intensity. Hence, the solar tracking efficiency is improvised.

Keywords
Tracking, efficiency, electric power, motor and intensity.

1. Introduction
There is a great deal of energy in the sun's core. The energy obtained from the sun in an hour exceeds the energy expended by people in a working year (Rubio et al., 2006). If humans can gather even a fraction of the energy that we receive from solar radiation, we will be able to fulfil the demands of our species for an extremely long time (Hossein et al. 2009). Efforts are constantly made to obtain the greatest amount of energy in order to store the bulk of the energy that we get (Hunter, 2001). Solar thermal energy systems for local hot water and solar systems for micro-electricity generation are driving the increased interest in using renewable energies for detached structures (Abdullah et al., 2004). A solar tracker is a device that orients a payload toward the sun (Peng et al., 2013). The use of solar trackers can be able to increase power production by around a third, compared with modules at a fixed angle (Mereddy et al., 2015). The conversion efficiency is improved when the modules are continually adjusted to the optimum angle as the sun traverses the sky (Wu et al., 2008). To maximum power output from solar panels, the panels must be kept aligned with the sun (Hoffman et al., 1997). According to various studies, a dual axis solar tracking system boosts energy production by around 40% (Hossein et al., 2009).

2. Classification
There are two major types of Solar Tracking systems and are distinguished by the way they move in the number of axis (Yousuf et al., 2009).

1. The Single Axis solar tracking system tracks the sun from east to west rotating on a single point moving either in unison, by panel row or by section.
2. Dual Axis solar trackers rotate on both the x and y axes and track the sun for east to west and as well as from north to south making the panels track the sun in all directions directly (Masoud et al., 2015).

3. Methodology
3.1 Raw Materials used
1. Solar Panels (small) for guided panels
2. Main Solar panel for power generation
3. 3v 15rpm high torque micro metal gear motor
4. Gear and Pinion
5. Aluminium (for frame/support)

6. Metal base

3.2 Assembly and Working

1. Initially, A base is set up which is made up of metal. The base is welded with the supporting frame which holds the total equipment.
2. The equipment consists of a vertical and an inclined frame which are fixed with motors which help to move the solar panel towards maximum intensity.
3. The inclined frame consists of a plus shaped frame on which the guided panels are fixed on them.
4. The main solar panel is fixed above the guided panels and the shadow of the main solar panel falls on the guided panel and this determines that the main solar panel is facing the sun at a perpendicular angle (maximum intensity)
5. Two of the guided panels are connected to one micro gear motor, one panel in forward polarity and the other in reverse polarity. This applies for the other two panels too.
6. When there is a change in the angle of rays of sun, the rays fall on the guided panels which generates enough power to drive the respective connected motor.
7. The motor then adjusts the inclined frame such that there are no rays falling on the guided panels.
8. Finally, the main solar panel faces towards the sun at its maximum intensity. Thus generating maximum power

3.3 Software used for design

1. Siemens NX 12.0 is used to design each and every individual component of the project.
2. The individual components are also assembled in Siemens NX 12.0 and the assembled design is shown in Figure 1. and Figure 2.
3. Some of the commands used to design the components are Sketch, Profile, Line , Rectangle, Circle, Extrude, Revolve, Offset etc.,

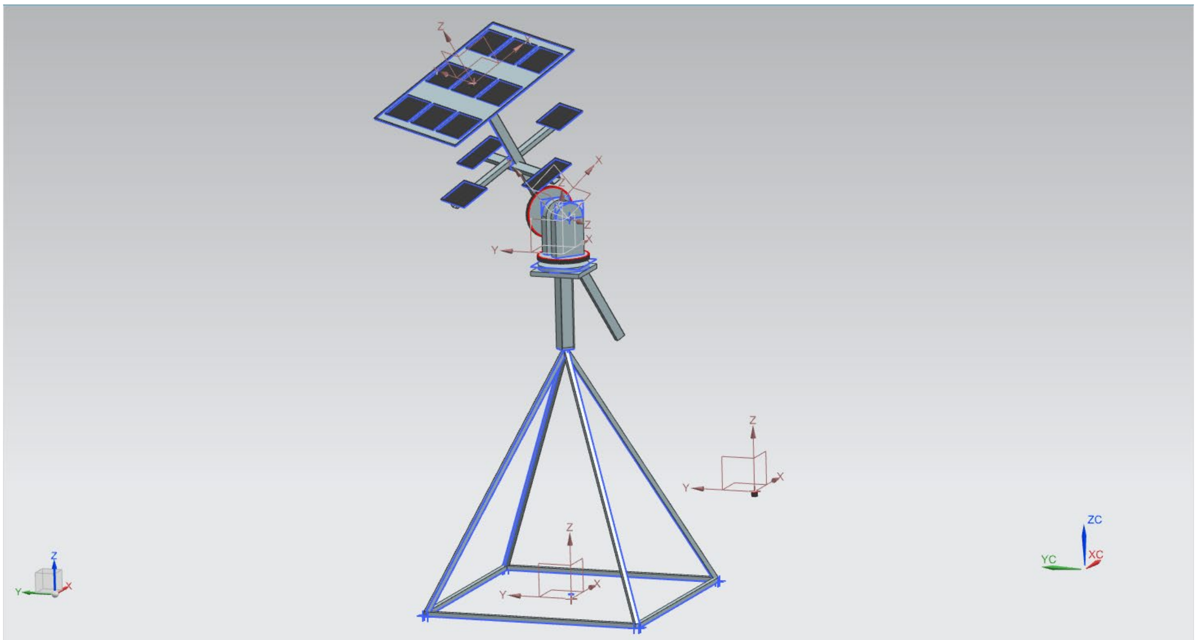

Figure 1. NX Assembly of Dual Axis Solar Tracker (Side View)

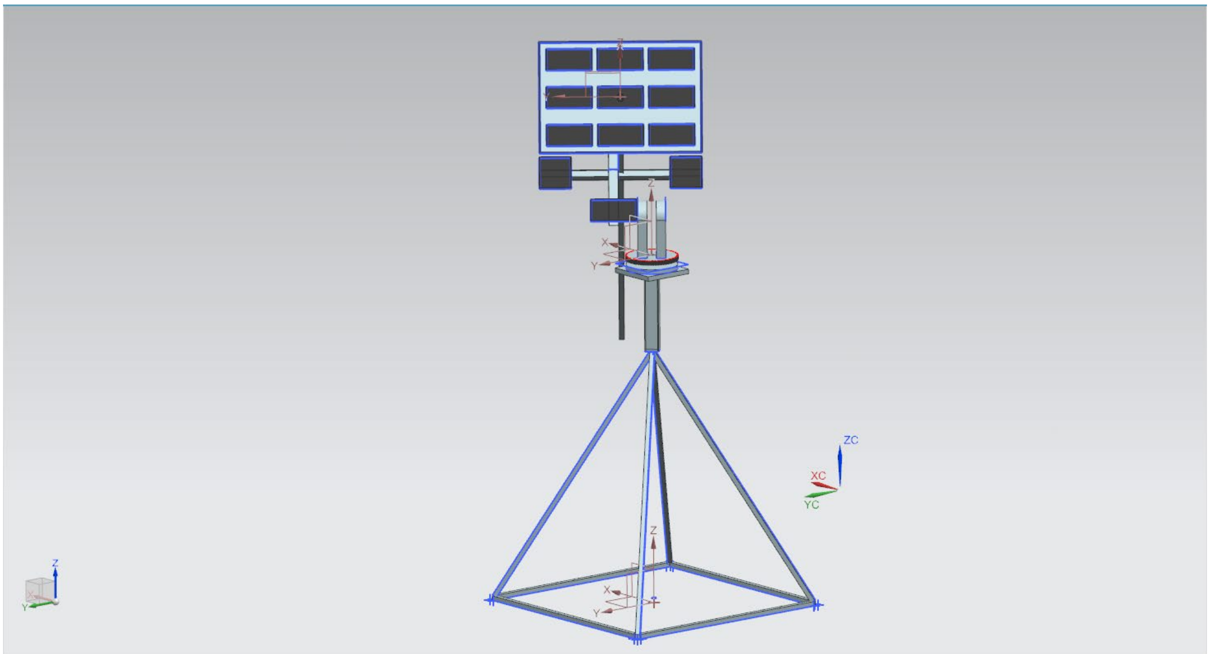

Figure 2. NX Assembly of Dual Axis Solar Tracker (Front View)

4. Fabrication

The fabrication model of self-powered dual axis solar tracking system consists of the assembly of the base frame, pulley consisting of the supports to hold the main panel setup, a plus shaped frame consisting of PV panels to track the position of the sun and to drive the motor and the main panel attached at the top of the aluminium frame. The PV panels are connected to the serve gear motors. Two panels are connected to one motor in opposite polarities and the other two panels in opposite polarities. The sunlight falling on the tracking panel drives the respective motor. The fabricated prototype is shown in Figure 3.

Figure 3. Fabricated Prototype

5. Results

The Figure 4. shows the graph for a fixed static PV panel drawn between time on x-axis and voltage output on y-axis. It shows that the maximum output voltage is obtained only during the midday. Table 1 shows experimental time and voltage of solar panel and Table 2 shows the performance analysis of solar panel with tracking.

Table 1. Performance Analysis of Solar Panel without Tracking

Experiment No.	Time (hrs)	Voltage(V)
1	9am	5.66
2	10am	5.98
3	11am	6.28
4	12pm	6.46
5	1pm	6.68
6	2pm	6.56
7	3pm	6.22
8	4pm	5.86
9	5pm	5.56

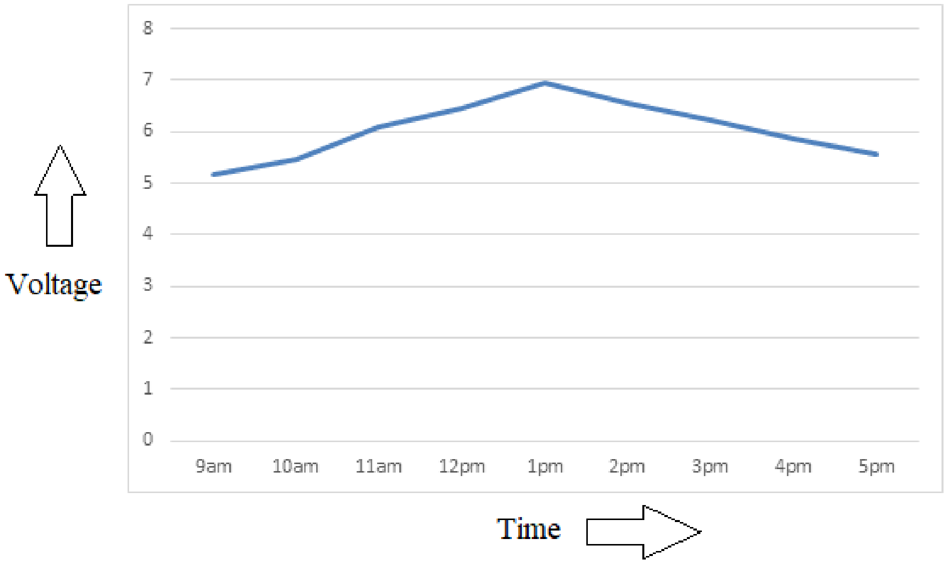

Figure 4. Voltage vs Time of Solar Panel without Tracking

Table 2. Performance Analysis of Solar Panel with Tracking

Experiment No.	Time (hrs)	Voltage(V)
1	9am	5.94
2	10am	6.26
3	11am	6.88
4	12pm	6.94
5	1pm	6.98
6	2pm	6.84
7	3pm	6.56
8	4pm	6.48
9	5pm	6.08

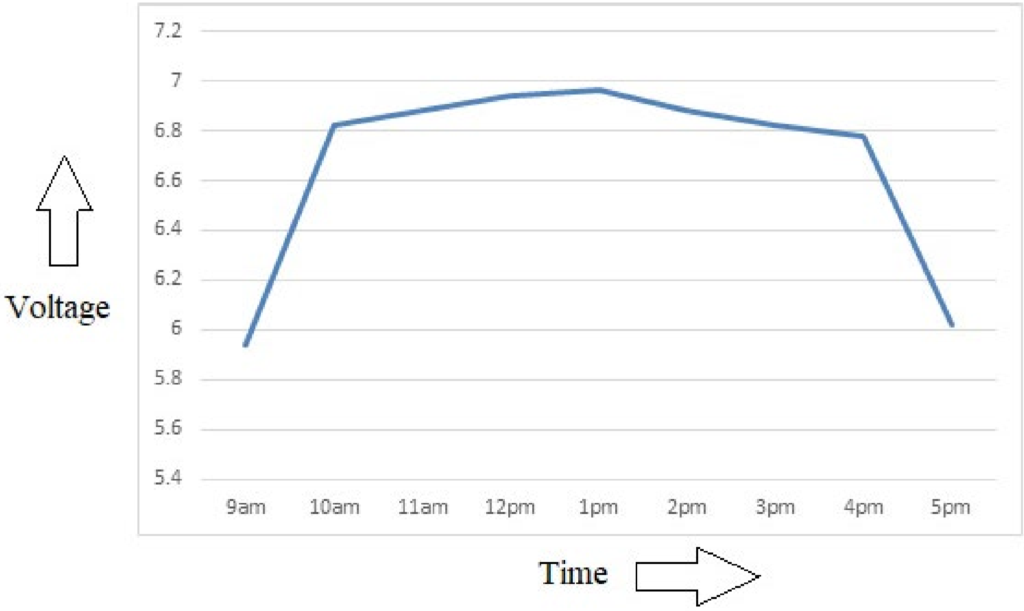

Figure 5. Voltage vs Time of Solar Panel with Tracking

Figure 5. shows the graph for a dual axis tracking PV panel drawn between time on x-axis and voltage output on y-axis. It shows that the maximum output voltage is obtained amlost throughout the day.

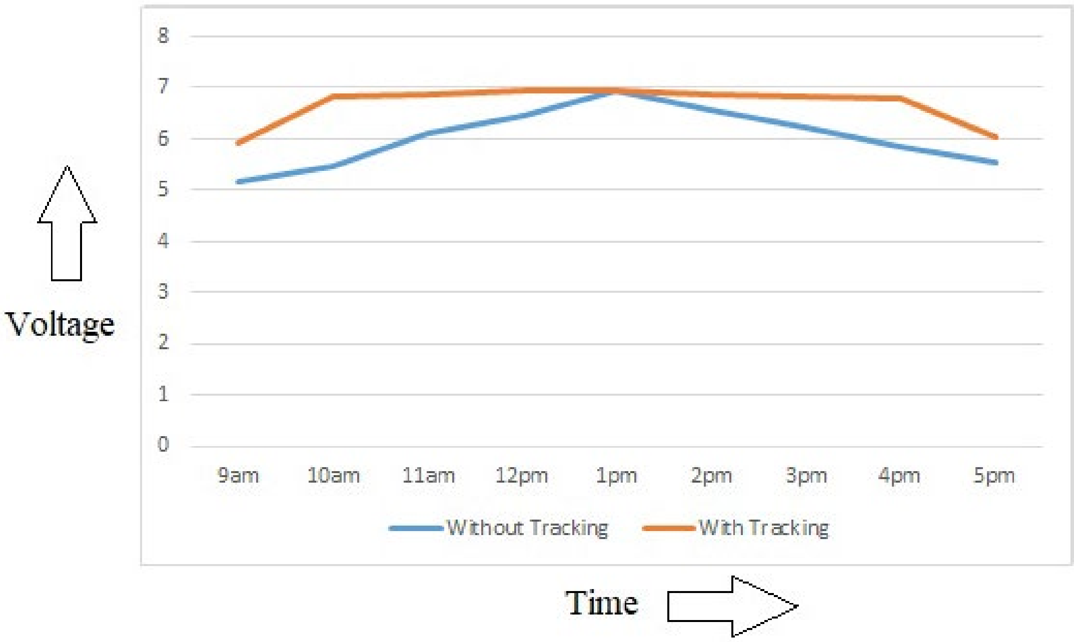

Figure 6. Comparision between Dual axis tracking and without tracking

Figure 6. shows the comparison between the voltages while using dual axis tracking and the fixed panel. It shows that dual axis solar tracking is more efficient as compared to the fixed solar panel.

6. Conclusion

Dual axis solar tracking tracks the sun in both the axis, east to west and north to south . The results obtained between static fixed solar panel and the dual axis tracker has come to a conclusion stating that the dual axis solar tracking improves the efficiency of the PV panel . These panels change their orientation in relation to solar radiation to increase the efficiency and results in maximum production of energy and helps in getting full benefit of optimal angle between solar panels and solar radiations .

7. Scope for future work

The goals of this project were outlined keeping in mind the timeline and resources that ere attainable. However, this initial design can be subjected to many improvements. Initially this design represents a miniature scale model, which can be modified into a much larger scale. Easy to bend cables can be used which do not apply any force on the motor when it is rotating the solar panel.

- The dual axis solar tracking can implemented in large-scale solar arrays to improve the power generation efficiency (Piao et al., 2005).
- Tracking system can also be used in domestic solar water heating systems (Masoud et al., 2009).
- Tracking system can also be implemented in solar collectors and thermosiphon systems
- Implementation of this tracking system in large scale can be done in a very less cost and economic manner Arliker et al., 2015).

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