International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Dual Axis Solar Tracker

Prof. Monica Ugale[1], Reva Gandhi[2], Pavneet Singh[3], Shreya Shankar[4], Vanshay Narang[5], Saurav Singh [6]

[1]*Professor, B.E. Mechanical, Dr. D Y Patil College of Engineering, Pune*

[23456]*Student, B.E. Mechanical, Dr. D Y Patil College of Engineering, Pune*

DOI: https://doi.org/10.55248/gengpi.4.523.44612

A B S T R A C T

The variation in the sun takes place every day through the night and even seasonally throughout the year. The world's population is rapidly expanding. Nonrenewable energy sources such as coal and oil have been depleted over the last decade, posing a severe challenge to the world's ability to provide reliable energy. However, solar energy is a significant source of primary energy. In this project, we present a dual-axis solar tracking system that uses Arduino as the main processing unit to capture the maximum amount of solar energy. Photovoltaic conversion panels are intended to be used in this project's autonomous microcontroller-based solar tracker system. Our goal is to create a single-axis and dual-axis solar tracker system. The tracker follows the sun and changes its location so that power production is maximized. Two geared DC motors move the solar panel, allowing the sun's light to remain aligned with the solar panel. The experimental version of the device is based on a DC motor that is intelligently controlled by a dedicated drive till it moves a small photovoltaic panel, with the presence of two simple but efficient light sensors receiving signals from a microcontroller. The performance and attributes of the solar tracker gadget are tested.

Keywords: Dual axis solar tracker, Arduino, LDR Sensor, Servo motor.

1. INTRODUCTION

Climate change variability has reached a crucial threshold in the current environment. The primary sources of climatic changes include natural causes and man-made destructions such as global warming and greenhouse gases, which are altering climatic conditions all over the world.

Demand for stable and abundant electrical energy supplied from renewable energy sources has increased during the last decade. Renewable energy is critical to the country's energy crisis. The government began to reduce the use of traditional energy sources while encouraging individuals to utilize renewable energy sources such as hydro and solar. Solar power is one kind of renewable energy. Solar energy is a vast, unending source of energy. The reason for this is that the sun is the sole source available anywhere. The globe receives around 1.8*1011MW of solar power. Photovoltaic systems will be able to absorb the most power as a result of the system. It has been discovered that using a dual-axis tracking system instead of a fixed system can enhance power production by 40% - 60%. Over the last two or three decades, solar energy systems have emerged as a potential source of renewable energy, and they are being used for a variety of domestic and industrial purposes.

Such systems are built around a solar collector, which collects solar energy and converts it into either electrical or heat energy.In general, the quantity of solar energy captured by the collector determines the amount of power generated in such applications, and thus the difficulty of developing tracking schemes capable of following the trajectory of the sun throughout the day on a year-round basis has received magnificent coverage in this project.

A solar tracker is a device that collects solar energy released by the sun. Solar tracking is just shifting the location of the panel in relation to the sun. Photovoltaic modules combined in a solar tracker are often more powerful than critical irradiance in a stationary system. Solar trackers are categorized based on their performance and cost. When compared to a fixed panel, tracking the system allows us to capture 40-50% more efficiency. When compared to a single-axis tracker, the dual-axis tracker has a 48% higher efficiency. Dual-axis trackers have the advantage of capturing the location of the sun anywhere in the sky due to seasonal fluctuations.

2. LITERATURE

1. **Balabel et al., (2013)** used a mathematical analysis to achieve optimal operational efficiency of solar photovoltaic modules. He committed to the design and testing of the control system. The analysis was based on estimated altitude angle data from Taif City, Saudi Arabia. The researcher showed that the sun tracking algorithm can be divided into closed-loop and open-loop systems depending on its control.
2. Rhif et al. (2010) reviewed the literature on the tracking procedure for the dual-axis sun tracker using a sliding mode control law. Using this autonomic dual-axis solar tracker can enhance electricity production by up to 40%. The result showed the usefulness of the sliding mode control in the tracking process, its strength, and the high quality of the sliding mode observer.
3. **In 2016, Yuwaldi Away and M. Ikhsan** from Indonesia newly designed a dual-axis sun tracker sensor based on tetrahedral geometry. Three LDRs were arranged on three sides of the tetrahedron. The system spins to obtain equal outputs from all three LDRs based on a comparison of their outputs. This system is further tested in single and multiple light source arrangements. It offers the advantage of less complexity with fewer LDRs and a wide range of Factors of View (FOV).
4. **In 2017, Indonesian researchers Meita Rumbayan and Muhamad Dwisnanto Putro** presented a single-axis monitoring technique to improve panel efficiency.
5. There were eight LDRs as sensors - four at four corners and four at four sides of a solar panel, a servo motor as an actuator, and an Arduino as the controller. The proposed system results consist of system design, hardware design, and algorithm design.
6. **In Qushm Island, Shahriar Bazyari, Reza Keypour, Shahrokh Farhangi, Amir Ghaedi, and Khashayar Bazyari examined various photovoltaic solar panel tracking systems in 2014.** This paper also includes the received solar radiation density associated with summer, autumn, and winter. Further, it includes the graphical comparison in fixed panel systems, single-axis tracking systems, and dual-axis tracking systems. As a result, the panel with a single-axis tracker receives 1.35 times more energy than the fixed panel, while the dual-axis tracker receives 1.04 times more energy than the fixed panel single-axis tracker.
7. **In 2014, Yingxue Yao, Yeguang Hu, Shenglong Gao, Gang Yang, and Jinguang Du** designed and prototyped a dual-axis solar tracking system that works on both solar time-based strategy as well as on sensor-based sun positioning strategy. The proposed system rotates 15°/hr. Due to the combination of both strategies, the proposed system requires less energy input with tracking error which is below 0.15°

3. Problem Statement

The common problem in solar Tracking is the complex movement of the sun. Every day, the sun travels from east to west following a defined solar path for a certain longitude. But the sun moves through 46° north and south from 21st June to 21st December.A dual-axis solar tracker can account for both the daily and seasonal motion of the sun. A sustainable power source gathered by solar panels in the form of sunlight is converted into power which would then be able to be utilized to give capacity to electric loads. Several individual solar cells are contained by solar panels which are themselves made out of layers of silicon, phosphorus which gives the negative charge, and boron which gives the positive charge. Solar panels absorb photons, causing an electric current to flow. The energy released by photons impacting the exterior of the solar panel allows electrons to be ejected from their nuclear rings and discharged into the electric field. created by solar cells which at that point move these free electrons into a directional flow and this procedure is called the Photovoltaic effect..

4. CAD Design

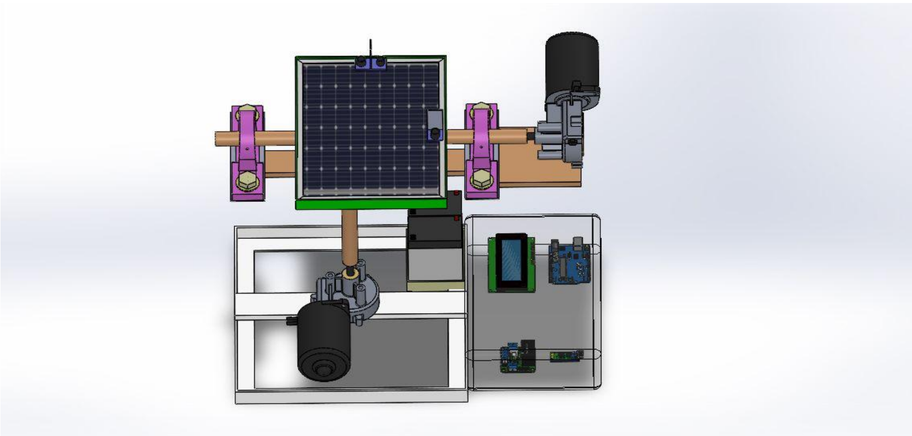


Figure- isometric front view

5.Calculation

1)Power generated

Combined weight of the panel and frame=3.03kg

weight due to frame= =3.03*9.81=29.72 N

Torque on vertical shaft

T1 = Force × width of panel frame
29.72*130=3.79 x 10^3 N-mm=3.79 Nm

Torque on horizontal shaft

T2 = Force × width of panel frame
=29.72*440=12.848 x 10^3 N-mm =12.848 Nm

Power transmitted by the horizontal shaft,

$$P = \frac{2\pi NT}{60}$$

N=36

$$= \frac{2\pi \times 36 \times 3.79}{60}$$

=15.28 Watt

Power transmitted by vertical shaft,

$$P = \frac{2\pi NT}{60}$$

N=36

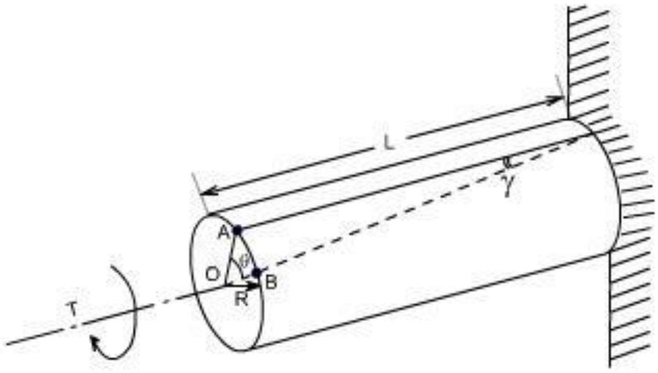
$$= \frac{2\pi \times 36 \times T}{60}$$

$$= \frac{2\pi \times 36 \times 12.848}{60}$$

=48.411 Watt

2)Design of shaft

Now, T_1 and T2 are the torque here, so we will check the shaft for failure here



$$T1 = \frac{\pi\ \sigma s\ d^3}{16}$$

$= \pi /16 \times 135 \times d^3$

D= 5.21 mm

$$T2 = \frac{\pi\ \sigma s\ d^3}{16}$$

D2 = 7.74 mm

So for the design to be safe,diameter of the shaft has to be greater than 5.21 and 7.74 for horizontal and vertical respectively.

3) Selection of bearing

For 20mm Shaft diameter we take standard breaking no. P204

P=pedestal bearing

2=spherical ball or deep groove ball bearing

=04=5 × 4 = 20mm

5.Conclusion

While the current project is based on tracking solar panels. These panels alter their orientation with respect to solar radiation to maximise efficiency, which results in maximum energy generation and allows them to take full advantage of the best angle between solar panels and solar radiation. The implementation of a solar tracking system was made obvious due to our thorough investigation and preparation of our aims and objectives. The primary goal of this project was to create basic equipment. on a low-cost basis. We were able to achieve our goal using trial and error method. In this three-month project, we applied our engineering expertise and were successful in conceiving and building a low-cost solar tracking system. Because the issue of global warming must be controlled by making use of alternatives that are environmentally friendly.

Acknowledgement

This acknowledges my sincere thanks to my project guide Prof. Monica Ugale, who helped me in selecting the project topic, and understanding the subject, whose valuable guidance and continuous encouragement throughout this work made it possible to complete this project work well in advance.

We also wish to express our deep sense of gratitude to Dr. P. Malathi, Principal, DY Patil College of Engineering , Akurdi. Dr. Prawin Nitnaware, Head, Department of mechanical engineering, DY Patil College of Engineering, Akurdi.

We are also thankful to other staff members of our esteemed college, DY Patil College of Engineering , Akurdi. for their special attention and suggestions towards the project.

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