International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 05 | May – 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Close Loop Dual Axis Solar Tracking System

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ABSTRACT

This paper deals with the design & analysis of the Automatic Sun Tracking Solar Panel based on close loop concept. The main objective of the project is to get the maximum amount of sunlight from sun and converting it to electricity so that it can be easily used and transferred. This can be done by aligning the solar panel perpendicular to sun rays so that maximum sunlight can be converted into electrical form. As this system give maximum efficiency. The main feature of this tracker is that it is dependent on the intensity of sun rays for the east west tracking and it is independent for north-south tracking as it rotates as per the declination angle of the sun. It gives higher efficiency, high reliability. The advantage of this project is to provide access to an everlasting and pollution free source of energy.

Keywords: Close loop concept, Environment friendly, Everlasting.

I. INTRODUCTION

Traditional energy sources such as coal, oil, and natural gas present numerous challenges, including environmental degradation, air pollution and the emission of greenhouse gases that contribute significantly to global climate change. In contrast, renewable energy, particularly solar energy, offers a clean, sustainable, and increasingly cost-effective alternative. Solar energy is abundant, widely available, and produces no direct emissions, making it an essential solution for reducing environmental impact and ensuring a reliable energy future. In recent years, the adoption of solar energy has increased rapidly due to advancements in photovoltaic technology. However, one of the main challenges in conventional solar installations is the inefficiency of fixed-tilt solar panels, which are positioned at a constant angle and cannot adapt to the sun's changing position throughout the day and across seasons. To address this issue, a dual axis solar tracking system can be implemented, which dynamically adjusts the orientation of solar panels along two axis azimuth and elevation to maintain a perpendicular angle to the sun's rays throughout the day. The system uses sensors such as light-dependent resistors to detect the sun's position, or it can be programmed using solar position algorithms based on the declination angle, which varies with the day of the year. The declination angle (δ) is the angular position of the sun at solar noon with respect to the celestial equator and plays a crucial role in determining the optimal tilt of the solar panel. A microcontroller, such as an Arduino or a PIC, processes input from the sensors or algorithm and sends control signals to servo motors or stepper motors, which rotate the panel accordingly.

II.METHODOLOGY

Propose of Work

The orbit of the earth is almost circular at an average distance of 149.6 million km. The axis of rotation of earth is tilted by an angle ε = 23.441° with respect to the normal to the plane of the orbit of earth. The plane orbit of the earth is known as the plane of the ecliptic. The plane passing through the equator of earth is inclined at right angle to the plane of the ecliptic, at an angle ε where ε is angle of obliquity.

Declination angle (δ): - It is the angle of the sun's position in north or south of the earth's equator. The axis of earth is tilted 23.34° from the plane of the orbit of earth around the sun and the earth causes the declination angle to vary from 23.45° north on December 21 to 23.45° south on June 21 during its rotation around the Sun.

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Types of Systems

There are generally two types of system: -

-Fixed: - These are fixed at some position and angle and which remain same until and unless they are changed by some person. These are simple to install.

-Tracking: - These system automatically moves according to the sun position. These are typical and complex to install but gives better efficiency. In this project we are going to use close loop tracking system and it is dual axis tracking system.

The declination angle calculation is pre - define in a program. All the work is processed by Arduino connected to it. The Arduino stores all the position of sun according to the time. The Arduino gives signals to motor driver connected to the motors of the mechanism. Their a motor driver for each axis for forward and backward movement of the mechanism.

III.MODELING AND ANALYSIS

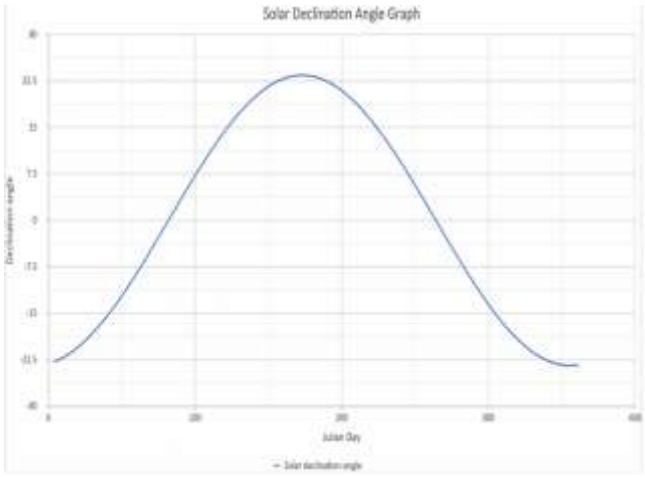

Figure 1: Declination Angle Graph.

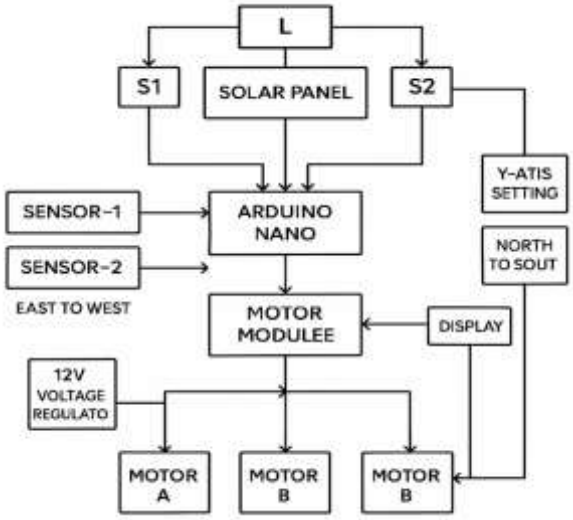

Figure 2: - Block Diagram

Figure 3: -Project Image

IV.RESULTS AND DISCUSSION

The innovative design of the sun tracking solar panel have increased the development of many solar PV systems. It has been showed that the sun trackers can be classified into two that is single axis and dual axis or active or passive trackers. The result represents that the close loop base dual axis Solar trackers are more efficient. The experimental results shows that the efficiency of solar panel to generate electricity is increased by minimum 25-28%. This percentage increase is calculated after reducing all the energy used in the tracking system and mechanism of the project. This technique can be used in villages which are deprived of electricity as connecting them to national grid can be costly. So this can be used as a form of decentralised generation. This increases reliability. The fault clearing time becomes less as it not connected to complex grid.

Table 1. Reading

Time	Solar Panel Voltage	
	Without Tracking	With Tracking
08:00 am	3.62 V	5.78 V
10:00 am	5.10 V	7.08 V
12:00 pm	7.26 V	8.98 V
01:00 pm	8.42 V	9.62 V
02:00 pm	8.15 V	9.58 V

04:00 pm	5.42 V	8.23 V
06:00 pm	3.24 V	6.27 V
08.00 pm	0.12 V	0.38 V

V.CONCLUSION

The dual-axis sun-tracking system greatly enhances the efficiency of solar energy by combining real-time sun tracking with LDRs and seasonal tilt controls with solar declination. Driven by an Arduino Nano and a 12V battery, the system increases energy output by 25–30% relative to stationary panels. Employing low-cost components, it represents an effective, scalable, and affordable solution for small-scale or off-grid solar installations, as well as imparting useful experience in embedded systems and automation.

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