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Dual-Axis Solar Tracking Systems for Improved Solar Power Generation Efficiency

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Abstract:

The fluctuation in solar energy happens every day as a result of changes in the day-night cycle and seasonal variations all year long. The world's population is growing at a fast rate. Over the last ten years, non-renewable energy sources like coal and oil have been running out, making it difficult to supply the globe with stable energy. Yet a significant source of primary energy is solar energy. This study proposes a dual-axis solar tracking system that makes use of Arduino as the primary processing unit to capture the maximum amount of solar energy.In this study, an autonomous solar tracker system powered by a microcontroller is anticipated to employ photovoltaic conversion panels. Our goal is to create both a single-axis and dual-axis solar tracker system. The tracker follows the sun and adjusts its location to optimise the sun's production of energy. Two geared DC motors are used to move the solar panel in order to maintain the solar panel's alignment with the sun's light.The experimental model's functioning is based on a DC motor that is intelligently controlled by a specialised drive to move a small solar panel. The presence of two cheap but effective light sensors allow a microcontroller to receive data from them. Experimental analysis is done on the solar tracker device's performance and attributes.

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

1. Introduction

A dual-axis solar tracking system is a type of system designed to increase the efficiency of solar panels by automatically adjusting their orientation to face the sun throughout the day. It uses two axes of movement to track the sun's position in the sky and keep the solar panels aligned with it, maximizing the amount of sunlight they receive[1].

The two axes of movement are horizontal and vertical, with the horizontal axis rotating the panels from east to west and the vertical axis tilting them up and down to follow the changing angle of the sun in the sky. By moving the panels to follow the sun's path, the system can increase the amount of energy they produce by up to 40% compared to fixed, non-tracking systems.

Dual-axis solar tracking systems can be either active or passive. Active systems use motors or actuators to move the panels in real-time, while passive systems rely on changes in temperature or pressure to cause the panels to move. Passive systems are generally simpler and less expensive, but they may not be as accurate as active systems[2].

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Overall, dual-axis solar tracking systems are a powerful tool for increasing the efficiency and effectiveness of solar power systems, especially in areas with high levels of solar radiation. They can help to reduce the cost of energy production and make solar power more accessible to a wider range of people and communities.

A solar tracker is a tool that is used to gather solar energy from the sun.Solar tracking is nothing more than shifting a panel's location in relation to the sun. Typically, the photovoltaic module installed in the solar tracker is more powerful than the stationary system's essential irradiance. Based on performance and coast, solar trackers are categorised. By using a tracking system, we may get a 40–50% increase in efficiency over a fixed panel. One of these, dual axis, offers a 48% efficiency boost over single axis tracking. Due to seasonal fluctuations, dual axis trackers can detect the sun's location anywhere in the sky. The solar tracking systems shown in the following images[3].

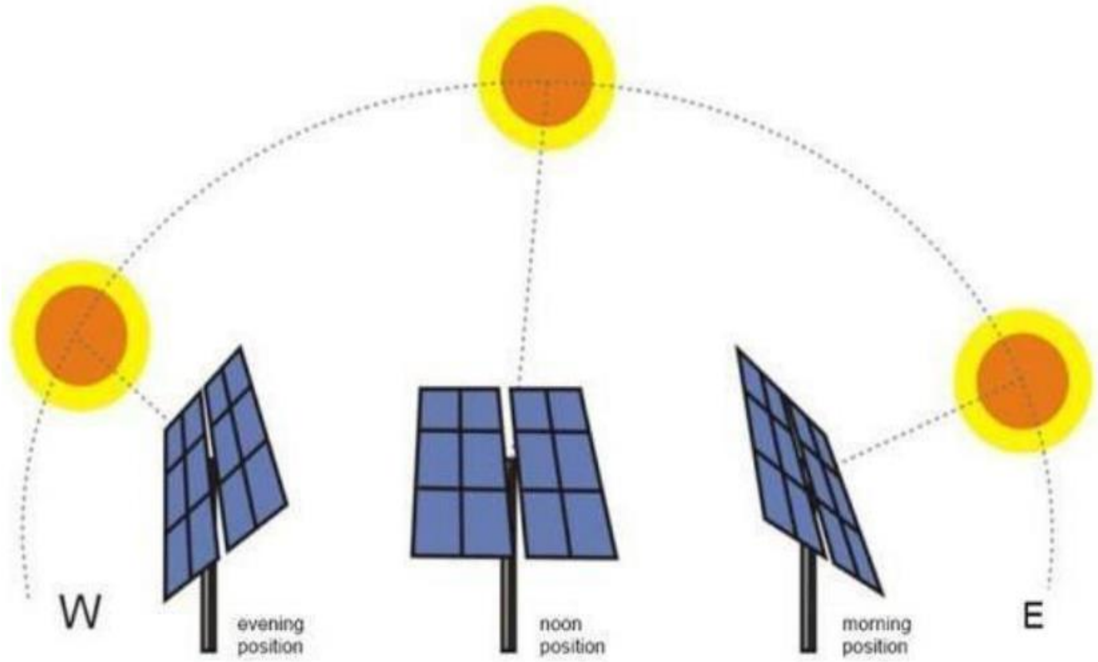

Figure 1. Solar path

2. Literature Survey

Dual-axis solar tracking systems have become an increasingly popular technology for improving the efficiency of solar power generation. As such, there have been numerous research studies and literature reviews on the subject. Here are a few key findings from recent literature surveys:

Efficiency gains: Studies have shown that dual-axis solar tracking systems can improve the efficiency of solar panels by up to 40% compared to fixed, non-tracking systems. This is due to the ability of the system to maintain optimal alignment with the sun's position throughout the day, resulting in increased exposure to sunlight and greater energy production.

Cost-benefit analysis: A literature review conducted by P. J. Sangwaiya et al. (2016) found that while dual-axis solar tracking systems can be more expensive to install than fixed systems, the increased energy production and resulting cost savings over time can make them a worthwhile investment. The study concluded that the payback period for the additional investment in a dual-axis tracking system is generally less than ten years.

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Environmental benefits: Another review by K. S. Reddy and M. K. Tripathy (2018) highlights the environmental benefits of dual-axis solar tracking systems. By increasing the efficiency of solar panels, these systems can reduce the amount of land required for solar power plants and decrease the overall environmental impact of energy production.

Technological developments: Finally, a literature survey by S. S. Patil et al. (2018) emphasizes the importance of ongoing technological development in the field of dual-axis solar tracking systems. Advances in materials science, control systems, and sensor technology are all contributing to the continued evolution of these systems and their ability to maximize energy production from solar panels.

Overall, these literature surveys indicate that dual-axis solar tracking systems are a promising technology for improving the efficiency and sustainability of solar power generation. While there are still challenges to be addressed, ongoing research and development in this area are likely to lead to even greater gains in efficiency and cost-effectiveness in the coming years.

Haneih's (2009) study highlights the importance of solar tracking systems in increasing the efficiency of PV panels in desert regions. The use of two degrees of freedom orientation and close loop control with solar tracking sensors and feedback control loops can help to optimize the alignment of the panels with the sun's position in the sky, leading to greater energy production.

The consideration of the grid arrangement of panels is also important in maximizing the effectiveness of solar tracking systems. By carefully arranging the panels in a way that minimizes shading and ensures optimal alignment with the sun, the overall energy output of the system can be further increased.Overall, Haneih's study underscores the importance of solar tracking systems in improving the efficiency and effectiveness of solar power generation in challenging environments like desert regions. By optimizing the alignment of solar panels with the sun's position in the sky, these systems can help to maximize energy production and make solar power more viable and sustainable.

3. Proposed work

The system utilizes LDR (Light Dependent Resistor) sensors to detect any differences in intensity between the sides of the PV panel. If there is a difference, a signal is produced and sent to the control system (circuit1/circuit2) where it is evaluated. The control system then sends a signal to the motor (motor2/motor1) which rotates the PV panel until it directly faces the sun.

This system appears to be a type of single-axis solar tracking system, as it only rotates the panel around a single axis to align it with the sun's position in the sky. By using LDR sensors to detect any deviations in intensity, the system can quickly and automatically adjust the position of the panel to maximize energy production.Overall, this type of solar tracking system could be a cost-effective way to improve the efficiency of solar power generation, particularly in areas with high levels of sunlight. However, as with any technology, there may be limitations and challenges to consider, such as maintenance requirements and the cost of implementing the system on a larger scale.

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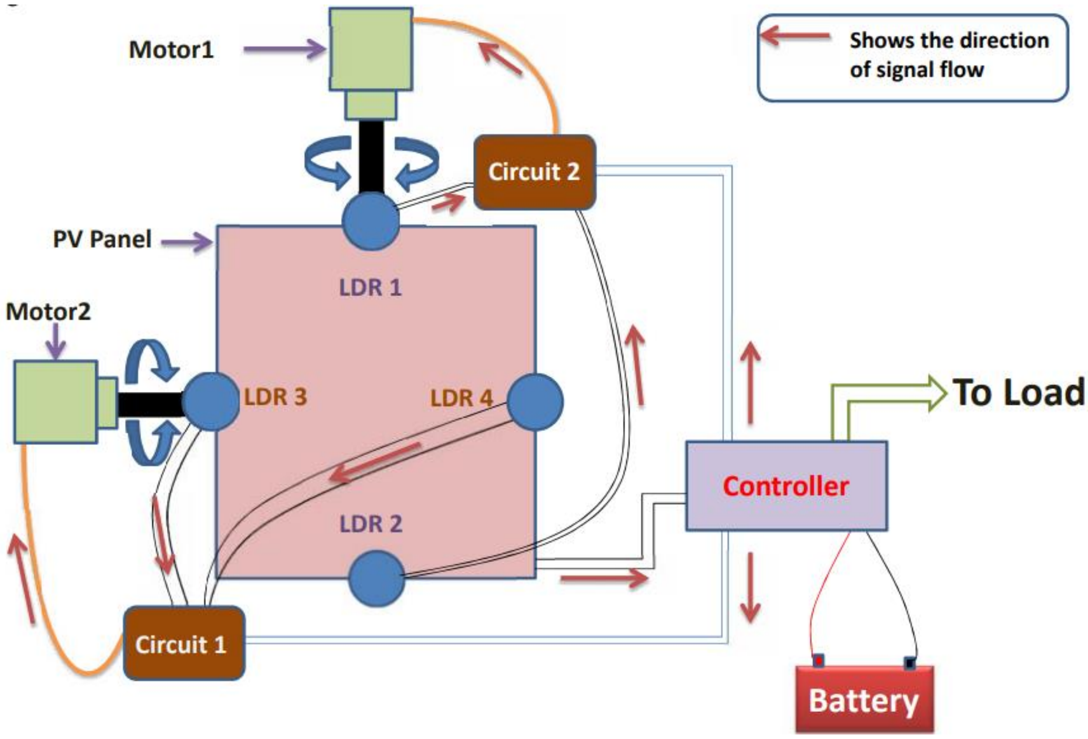

Figure 2: Block diagram of the setup

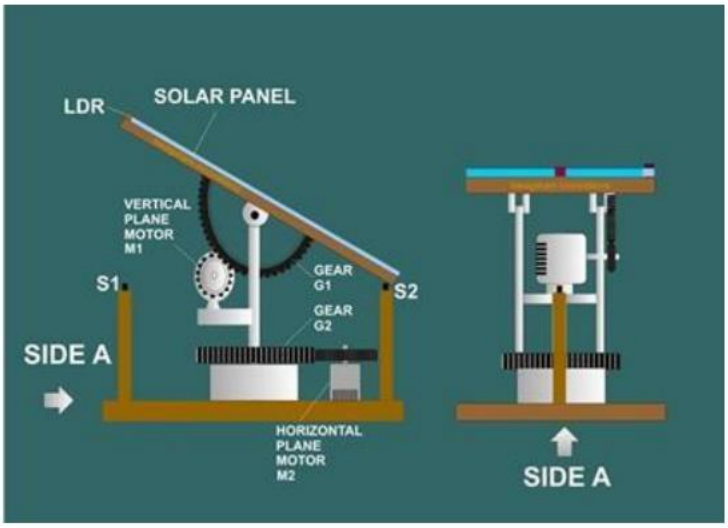

Figure 3. Solar tracking by using sensor, motor and gears

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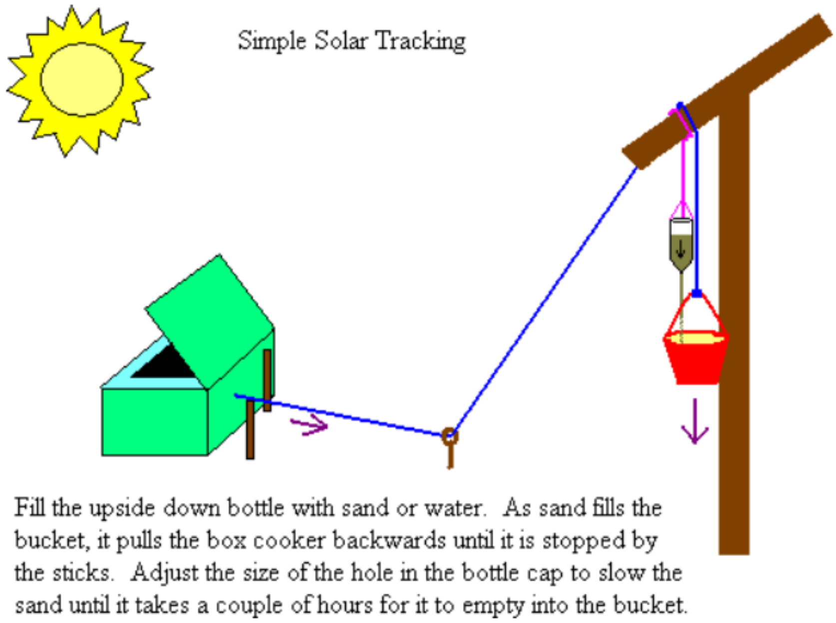

Figure 4. Simple solar tracking by using sand

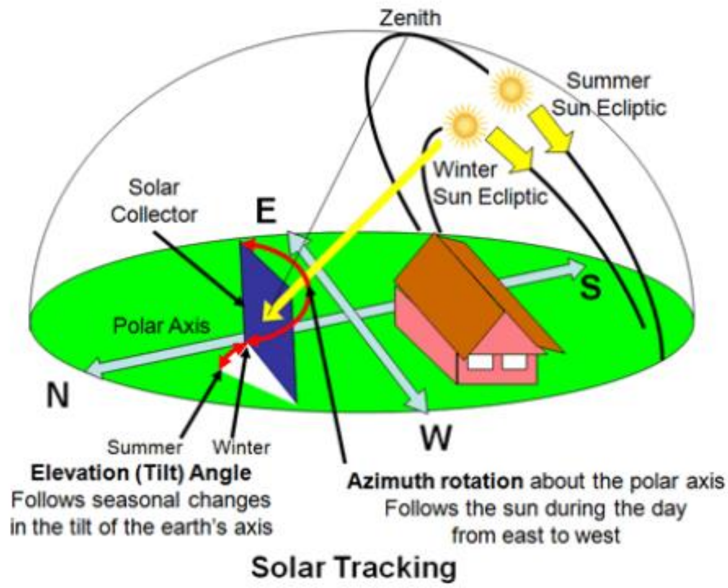

Figure 5. Manual solar tracking

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4. Implementation

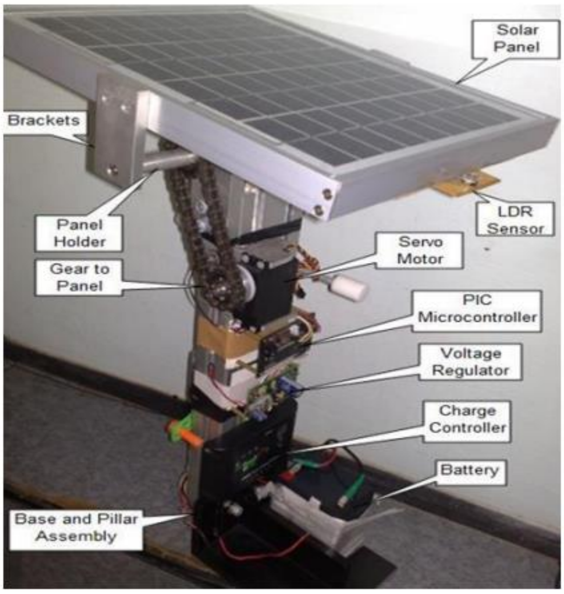

Figure 6. Solar tracking by using chain sprocket and sensors

5. Conclusion

The dual-axis solar tracking system is an effective way to increase the efficiency of solar power generation. By aligning the solar panels with the sun's position in the sky, these systems can maximize energy production and improve the overall performance of solar power plants.Compared to single-axis or fixed solar systems, dual-axis trackers have been shown to provide significantly greater energy output, with studies indicating efficiency gains of up to 40% or more. Additionally, while the initial installation costs of a dual-axis tracker may be higher than other systems, the long-term cost savings resulting from increased energy production can make them a cost-effective investment.

Further research and development in the field of solar tracking systems is likely to lead to even greater efficiency gains and cost savings in the future. Overall, the evidence suggests that dual-axis solar tracking systems are a promising technology for improving the effectiveness and sustainability of solar power generation, particularly in challenging environments like desert regions.

References

[1] Anuraj, A., & Gandhi, R. 2014. Solar tracking system using stepper motor. International Journal of Electronic and ElectricalEngineering, Vol. 7, No. 6, pp. 561–566.

[2] Arsalan, S. 2013. Sun tracking system with microcontroller 8051. International Journal of Scientific & Engineering Research,Vol. 4, No. 6, pp. 2998–3001.

[3] Banerjee, R. 2015. Solar tracking system. International Journal of Scientific and Research Publications, Vol. 5, No. 3, pp. 1-7.

[4] Deb, G., & Roy, A. B. 2012. Use of solar tracking system for extracting solar energy. International Journal of Computer andElectrical Engineering, Vol. 4, No. 1, pp. 42-46.

[5] Gupta B., Sonkar N., Bhalavi B.S. 2013. Design, construction and effectiveness analysis of hybrid automatic solar tracking systemfor amorphous and crystalline solar cells. American Journal of Engineering Research, Vol. 2, No. 10, pp. 221-228.

DOI : https://doi.org/10.56452/2023-04/001

[6] Mousazadeh H., Keyhani A., Javadi A., Mobli H., Abrinia K., 2009. A review of principle and sun-tracking methods formaximizing solar systems output. Renewable and Sustainable Energy Reviews, Vol. 13, pp. 1800-1818.

[7] Stonecypher L.. 2011. How to Build Your Own Automatic Solar Tracker. Retrieved fromhttp://www.brighthub.com/environment/renewable-energy/articles/76226.aspx

[8] Akhil,K. (March 25, 2016). Solar Tracking System. Retrieved on October 3rd, 2019

[9] Gajadharane, M. R., Gijare, N.A., & Joshi, M. H. (June, 2016). Design and development of mechanical Solar Tracking System. Retrieved on October 7, 2019.

[10] Paul, S., Kumar, D., &Basak, S. (2018). Dual Axis Solar Tracker. Retrieved on 8th October , 2019.

[11] Mishra, J., Thakur, R. & Deep, A. (May, 2017). Arduino based dual axis smart solar tracker. Retrieved on September 29, 2019.

[12] Sreega, R., Nithyananthan, K., & Nandhini, B. (July 02nd, 2017). Design and Development of automated Solar Panel cleaner and cooler. Retrieved on 28 September 2019.

[13] John Connors (2017). Solar Vehicles and Benefits of the Technology. Retrieved on September 25, 2019.

[14] Y.Away and M.Ikhsan, ELSEVIER Automation in construction, (2017), 73, pp. 175- 183.

[15] M.Rumbayan, M.D.Putro, IJESC, 6(11): (November 2017), pp.440-450.

[16] S.Bazyari, R.Keypour, S.Farhangi, A.Ghaedi, K.Bazyari, JPEE, (2014), 2, pp. 718- 728.

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