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Solar Tracking Methods: A Comprehensive Survey

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Abstract: In the pursuit of maximizing solar energy utilization, solar tracking systems have emerged as indispensable tools for enhancing the efficiency of photovoltaic (PV) systems. This comprehensive survey delves into the multifaceted landscape of solar tracking methods, elucidating the diverse techniques and strategies employed in optimizing solar panel orientation relative to the sun's position

Solar tracking systems are classified into two primary categories: single-axis and dual-axis tracking. Single-axis tracking systems adjust solar panels along one axis, typically the azimuth axis, while dual-axis tracking systems dynamically alter both azimuth and elevation angles to accurately follow the sun's apparent motion across the sky.Within the realm of solar tracking, passive and active tracking methods are explored. Passive tracking mechanisms rely on natural phenomena such as gravity or thermal expansion to adjust panel orientation, whereas active tracking systems employ mechanical, electrical, or hydraulic actuators driven by motors or other means to actively adjust panel angles based on real-time tracking algorithms.A pivotal aspect of solar tracking systems is the selection and implementation of tracking algorithms. Various algorithms, including sun position algorithms, maximum power point tracking (MPPT) algorithms, and predictive algorithms, are analyzed for their effectiveness in accurately predicting and optimizing solar panel orientation.Furthermore, this survey scrutinizes the role of sensor technologies in solar tracking, encompassing GPS-based tracking, light-intensity-based tracking, weather-based tracking utilizing meteorological sensors, and horizon tracking techniques. These sensor-based methodologies offer different advantages and trade-offs in terms of accuracy, cost, and reliability.

To provide a comprehensive understanding, comparative analyses are conducted, evaluating the efficiency, cost-effectiveness, and energy yield of different tracking methods. These comparative assessments offer valuable insights into the performance characteristics and suitability of various tracking methodologies across diverse applications and environmental conditions.In conclusion, this survey serves as an invaluable resource for researchers, engineers, and policymakers involved in the design, development, and optimization of solar tracking systems for renewable energy applications. By synthesizing the latest advancements and comparative analyses, this survey facilitates informed decision-making and fosters the advancement of sustainable solar energy technologies.

Keywords: Solar tracking, dual axis solar panel, energy efficiency, PV panels and weather monitoring

I. INTRODUCTION

The global transition towards renewable energy sources has fueled significant interest in maximizing the efficiency of solar photovoltaic (PV) systems. Solar energy represents a clean, abundant, and inexhaustible resource with the potential to meet a substantial portion of the world's energy demands. However, the intermittent and variable nature of sunlight poses challenges to harnessing solar energy to its fullest extent. In this context, solar tracking systems have emerged as crucial technologies for enhancing the performance and output of PV installations.Solar tracking systems dynamically adjust the orientation of solar panels to ensure optimal alignment with the sun's position throughout the day. By continuously tracking the sun's trajectory, these systems maximize solar energy absorption and improve the overall efficiency of PV arrays. The primary objective of solar tracking is to maintain a perpendicular angle between the solar panels and the incident sunlight, thereby maximizing the solar irradiance received by the panels.This paper presents a comprehensive survey of solar tracking methods, encompassing a wide range of techniques and strategies employed to optimize solar panel orientation. The survey covers both single-axis and dual-axis tracking systems, each offering distinct advantages and trade-offs in terms of complexity, cost, and performance. Single-axis tracking systems adjust solar panels along one axis, typically the azimuth axis, while dual-axis tracking systems dynamically alter both azimuth and elevation angles to accurately follow the sun's apparent motion across the sky.

In conclusion, this survey aims to provide a comprehensive understanding of solar tracking methods, offering valuable insights for researchers, engineers, and policymakers involved in the design, development, and optimization of solar tracking systems for renewable energy applications.

By synthesizing the latest advancements and comparative analyses, this survey seeks to foster the advancement of sustainable solar energy technologies and contribute to the global transition towards a clean energy future.

II. LITERATURE REVIEW

Here, there are references of five paper which includes(1),(2),(3),(4)and (5). Each paper has proposed their solutions to the related problems. In (1), they have given some points on the solar energy which could be used to solve the energy crisis faced in this generation as there is a large power demand. In (2), they have tried to reposition the solar array to face the sun at all time so it could clear the low energy efficiency issue by making it more effective. In (3), they proposed a solution by fixing the solar panel in a way that it could rotate in all directions so that it could capture maximum radiation from the sun which increases its efficiency by 40%. In (4), they compared the performance.

Of single axis type and got a result as a low efficient compared to dual axis ,so they made the PV panel such that it automatically searches for optimum position to capture maximum sunlight. In (5), they referred that the single axis type is not more reliable,so they proposed a solution by making it to capture maximum illumination.

So these all papers try to provide a solution/techniques which could increase the efficiency of solar energy which is renewable energy.

III. COMPARISON TABLE

Papers	Problem	Solution proposed	Tools used	Results	Merits
Paper 1 (ijraset)	Energy crisis faced in the generation(large Power demand).	Renewable energy (solar energy).	LDR, servo motor, Arduino UNO	Solar tracking is more effective than fixed solar panel and its has high energy gain Up to 35%.	Renewable energy
Paper 2 (ijape)	Low energy efficiency of fixed panels and lacks of spots.	Repositioning of solar array to face sun at all time.	LDR, DHT sensor, micro controllers	More effective than other methods.	Install in any location
Paper 3 (ijrte)	Minimum amount of energy is captured through fixed panels.	Solar panel is fixed in a way were it could rotate in all direction according intensity of radiation.	LDR, servo motor, Arduino UNO and temperature sensor.	Less economical and produces efficiency of the energy more than 40%.	Maximum energy is captured
Paper 4 (semantic scholar)	Performance of the single axis type is low.	Automatically Searches the optimum PV panel position with respect to the sun.	DC Motor, Intelligent drive unit, light intensity sensor.	Produces efficiency of the energy more than 57.77%.	Cost effective
Paper 5 (ijsred)	Single axis type Is not more reliable.	To capture At most source of illumination Sun energy at any location.	Arduino mega, LDR, servo motor, Dual geared motor.	It can initialize it starting position by itself it reduce necessity of photo resistors	Automated system

IV. SINGLE AXIS V/S DUAL AXIS

When considering the implementation of solar tracking systems, the choice between single-axis and dual-axis configurations is paramount, each offering distinct advantages and considerations. Single-axis tracking systems, which adjust solar panels along one axis typically aligned with the azimuth, provide a relatively simpler and more cost-effective solution compared to their dual-axis counterparts. These systems effectively track the sun's apparent movement across the sky from east to west, optimizing energy capture throughout the day. However, single-axis systems have limitations in their ability to track the sun's movement in the vertical plane, leading to sub optimal energy capture during early mornings and late afternoons. On the other hand, dual-axis tracking systems dynamically adjust both the tilt angle (elevation) and orientation (azimuth) of solar panels, enabling optimal alignment with the sun's position in both horizontal and vertical planes. This precision results in higher energy capture efficiency, particularly in locations with high solar elevation angles or seasonal variations. Despite their superior performance, dual-axis tracking systems are associated with higher initial costs and increased complexity, as well as greater maintenance requirements due to moving parts and mechanisms. Consequently, the choice between single-axis and dual-axis tracking systems depends on factors such as budget constraints, geographic location, and desired energy output, with each configuration offering trade-offs between cost-effectiveness and energy yield optimization

Therefore, the choice between single-axis and dual-axis tracking systems depends on various factors, including project budget, site characteristics, and energy output requirements. Single-axis systems may be more suitable for applications where simplicity and cost-effectiveness are paramount, such as large-scale utility installations. In contrast, dual-axis systems offer superior energy capture efficiency and are well-suited for applications demanding maximum energy yield, such as residential rooftop installations or concentrated solar power (CSP) systems.Ultimately, the decision between single-axis and dual-axis tracking should be made after careful consideration of these factors, weighing the trade-offs between simplicity, cost, and energy yield optimization to determine the most suitable solution for the specific project at hand.

V. IMPORTANCE OF DUAL AXIS SYSTEM

The importance of dual-axis solar tracking lies in its ability to significantly boost the efficiency of solar photovoltaic (PV) systems. By dynamically adjusting both the tilt angle (elevation) and orientation (azimuth) of solar panels, dual-axis tracking systems maximize energy capture throughout the day, regardless of the sun's position in the sky. This precision alignment ensures higher energy yield, increased electricity generation, and optimal use of available space. Moreover, dual-axis tracking systems adapt well to variable environmental conditions, making them particularly effective in regions with high solar elevation angles or significant seasonal variations. Additionally, they mitigate shading effects and maximize energy production within a given footprint, making them ideal for installations where space is limited or expensive. Overall, dual-axis solar tracking systems play a crucial role in enhancing the performance and viability of solar PV installations, offering significant benefits in terms of energy output and return on investment.

VI. CONCLUSIONS

From this survey it can be concluded that dual axis type is more reliable and more efficient as compared to fixed or single axis type.It doesn't have any restriction in location for setting up as in case of dual axis it can be installed in any location.It could rotate in all directions so that it could capture maximum energy that is up to 35% to 57% it is more effective as compared to other techniques. The most advantageous thing of dual axis technique is that it is less economical as it can initialize it's starting position by itself so there is reduction in necessity of photo resistors so it is cost effective.the precision and efficiency of dual-axis tracking, stakeholders can make informed decisions based on project requirements, budget constraints, and environmental factors.

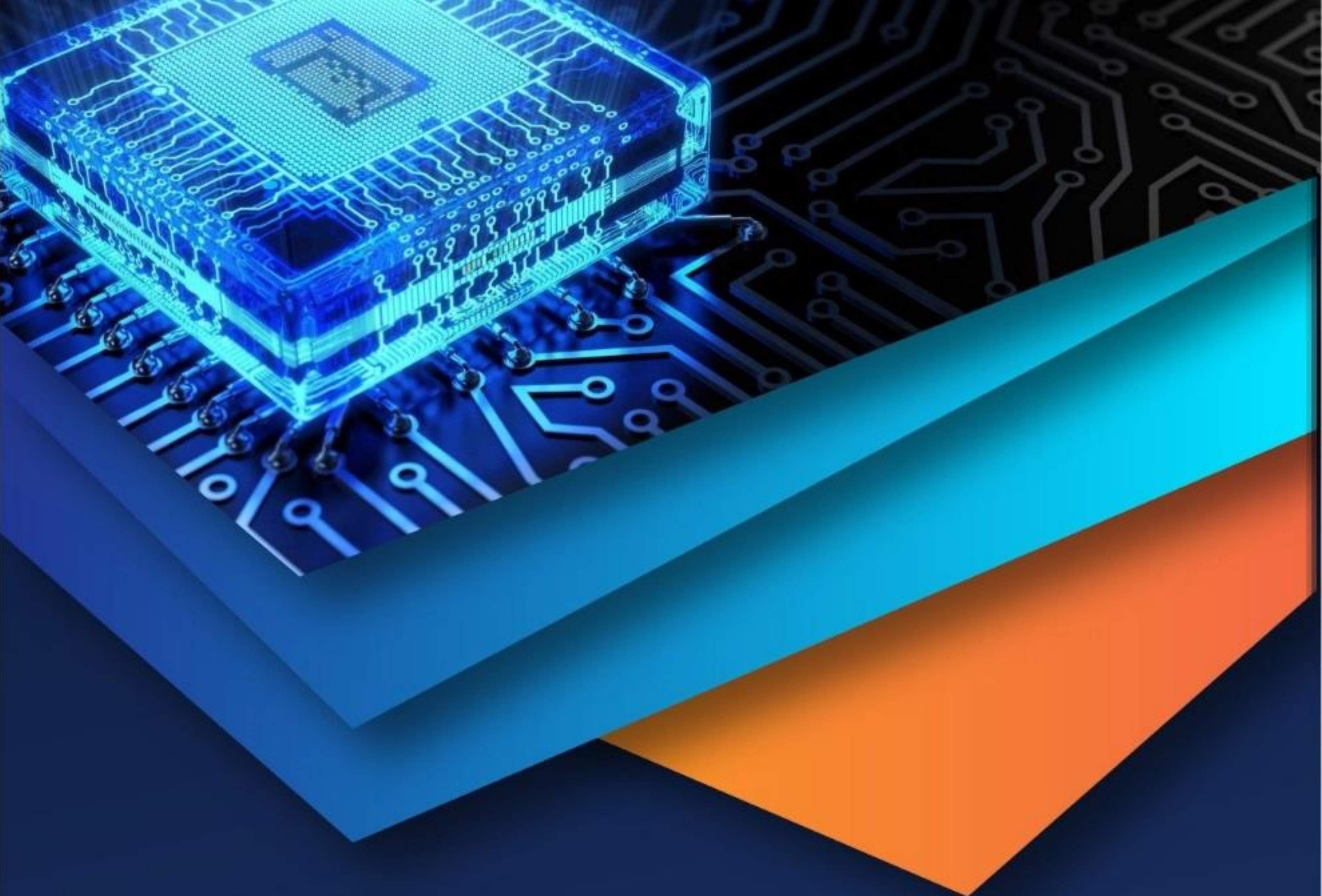
Moreover, the survey has highlighted emerging trends and technological advancements in solar tracking, including advancements in materials, sensor technologies, and predictive tracking algorithms. These advancements hold promise for further improving the efficiency, reliability, and cost-effectiveness of solar tracking systems in diverse applications and settings.

By synthesizing the latest research findings, technological advancements, and comparative analyses, this survey serves as a valuable resource for researchers, engineers, and policymakers involved in the design, development, and deployment of solar tracking systems. It aims to facilitate informed decision-making and foster the continued advancement of solar tracking technologies for sustainable energy generation.As solar energy continues to play a pivotal role in the global transition to renewable energy sources, the optimization of solar tracking systems will remain a crucial area of research and innovation. By leveraging the insights gained from this survey, stakeholders can contribute to the continued advancement and widespread adoption of solar tracking technologies, driving the transition towards a more sustainable and environmentally friendly energy future.

As a overall of survey dual axis solar tracking is more effective and most reliable technique or method as compared to fixed or single axis type.

REFERENCES

[1] Prof. Anmol Ganer,Dual Axis Solar Tracking System with Weather Sensor,Volume 10 Issue VI June 2022.
[2] Mugachintala Dilip Kumar, Tenugu Manish Kumar, Kongari Akshay, Sowdapuram Yashwanth Kumar, Udutha Vikas,Dual axis solar tracking system,Vol. 12, No. 4, December 2023, pp. 391~398
[3] T.M. Thamizh Thentral, Meghna Kannan, V Sai Mounika, Mahima Nair,Dual Axis Solar Tracker with Weather Sensor,Volume-8, Issue-2S11, September 2019
[4] Tiberiu TUDORACHE1, Constantin Daniel OANCEA2, Liviu KREINDLER,PERFORMANCE EVALUATION OF A SOLAR TRACKING PV PANEL,U.P.B. Sci. Bull., Series C, Vol. 74, Iss. 1, 2012
[5] Bhairavnath S. Gotam,Asst.Prof. VikramB.Patil,Prathmesh B. Mali,Atul B. Dhanawade,Dual Axis Solar Tracking System with Weather Sensor and Efficient Power Generation,Volume 4 Issue 2, Mar- Apr 2021



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