International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Raspberry Pico Based Dual Axis Smart Solar Tracking System

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Abstract :
One of the most critical global concerns is the energy crisis, which has led to a growing emphasis on renewable energy solutions. Solar panels have become increasingly popular in recent years as they efficiently convert solar energy into electrical energy. Their affordability and minimal environmental impact make them a preferred choice. Solar panels release electromagnetic radiation during electricity production. The primary objective is to develop an effective autonomous solar tracking system that constantly adjusts the solar panel's position to remain perpendicular to the sun's rays. In this system, a photoresistor serves as the sensor, detecting sunlight to facilitate automatic adjustments. Both horizontal and vertical axes on the dual-axis solar panel are rotated to enhance device efficiency. This dual-axis mechanism provides precise control over the panel's elevation relative to the sun, ensuring optimal energy capture. Solar tracking systems are specifically designed to maximize solar panel efficiency by aligning them with the sun's position throughout the day. These systems utilize sensors and motors to continuously adjust the panel's orientation, resulting in increased energy production and a better return on investment compared to fixed solar panels.

I. INTRODUCTION

The Raspberry Pico-based dual-axis Smart solar Tracking System represents a groundbreaking solution crafted to enhance solar panel functionality through sun tracking. This innovative system meticulously monitors and adjusts the solar panels' orientation in real-time to align with the sun's trajectory, ensuring optimal energy capture. Continuous adjustments enable the system to maximize energy generation potential and significantly boost overall efficiency. Throughout this presentation, we will delve into the system's pivotal features, elucidate its numerous benefits, and provide a comprehensive overview of its technical intricacies. The Smart solar Tracking System, built around the Raspberry Pico microcontroller, employs advanced algorithms and sensors to precisely track the sun's movement across both horizontal and vertical axes. This dynamic tracking capability allows the system to maintain the solar panels' ideal angle for sunlight absorption throughout the day. As a result, energy production is substantially increased, leading to higher output and improved performance compared to static solar panel setups. Key features of the system include automated sun tracking, which reduces the need for manual intervention and ensures consistent energy optimization. Additionally, the system's compact design and efficient power management contribute to its versatility and suitability for various solar panel installations. By harnessing the power of technology, the dual-axis Smart solar Tracking System represents significant advancement in renewable energy solutions, offering enhanced

efficiency and sustainability in solar energy generation.

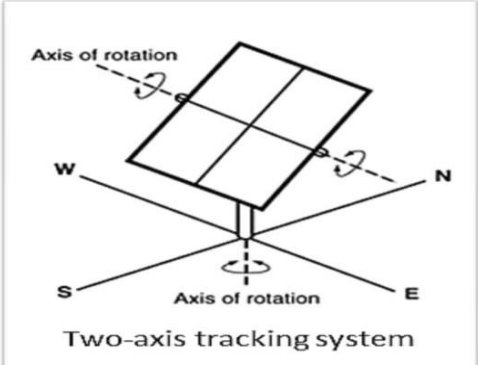
II. LITERATURE SURVEY

The paper by Andres A. centers on sun oriented following, a method that includes altering the position of sun oriented boards to take after the sun's way all through the day. The creator highlights the significance of sun powered following in improving the productivity of sun powered vitality frameworks, as it can altogether increment the sum of vitality collected by the boards. The paper presents a writing study on the different sun oriented following methods accessible, counting single-axis, dual-axis, and azimuth-altitude following, among others. The creator moreover talks about the variables that impact the choice of a following framework, such as the area of the sun based boards, the sort of sun powered cells utilized, and the application of the sun based vitality framework. The paper concludes by emphasizing the require for assist investigate to create more proficient and cost-effective sun based following frameworks to upgrade the appropriation of sun powered vitality innovation. The paper by Chng et al. (2019) centers on the plan and establishment of a sun powered following gadget, which is utilized to progress the proficiency of sun powered boards by adjusting them with the sun's position. The creators start by talking about the significance of sun oriented vitality as a clean and renewable source of control, and the require to make strides the effectiveness of sun powered boards to make them more financially viable.

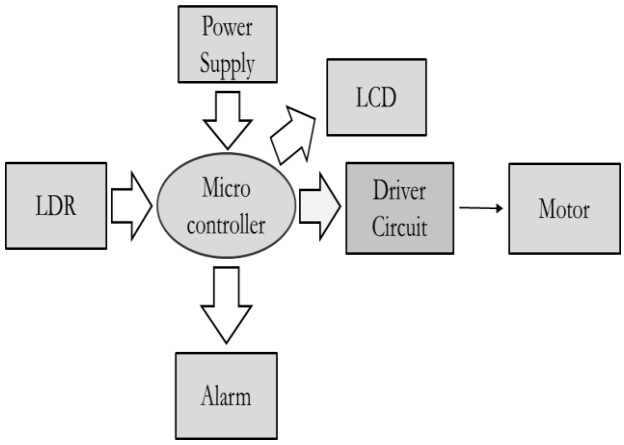
III. METHODOLOGY

WORKING:

The dual-axis smart solar tracking system powered Following Framework is a advanced innovation outlined to upgrade sun oriented board effectiveness through sun following. It works with two tomahawks: the azimuth pivot for flat revolution and the rise pivot for vertical tilting of the sun based board. Utilizing sensors and calculations, the framework calculates the sun's real-time position and alters the panel's introduction in like manner. This energetic following guarantees most extreme daylight assimilation all through the day. By ceaselessly optimizing the panel's point, the framework altogether boosts vitality yield and effectiveness, driving to expanded control era and considerable vitality savings.



IV. BLOCK DIAGRAM:



The Raspberry Pico-based dual-axis smart solar tracking system is an innovative solution designed to enhance solar panel performance. It utilizes advanced components such as a microcontroller, Light Dependent Resistor (LDR) sensor, driver circuit, motor, buzzer, and power supply. This system optimizes solar panel orientation to maximize sunlight absorption, ultimately increasing energy generation and efficiency.

1. Power Supply:
Provides electrical control to all components of the system. May incorporate batteries, voltage controllers, or other control administration circuitry.

2.LCD:
LCD (Liquid Crystal Display) can be a valuable component for providing visual feedback and information display. The LCD can be used to show real-time data related to sun tracking, such as the current position of the solar panel, sun angle, intensity of sunlight, and other relevant parameters.

3. Microcontroller:
The microcontroller interfaces with sensors like the Light Dependent Resistor (LDR) to gather real-time information about sunlight intensity and position. Based on this input, the microcontroller calculates the

optimal orientation of the solar panel along both the azimuth and elevation axes. The microcontroller also communicates with the driver circuit to control the motor responsible for adjusting the solar panel's position. It sends signals to the driver circuit to rotate the panel horizontally (azimuth axis) and tilt it vertically (elevation axis) for precise sun tracking.

4. LDR:
The Light Dependent Resistor (LDR) serves as a crucial sensor for detecting sunlight intensity. The LDR's resistance changes in response to varying light levels, making it a reliable component for measuring ambient light conditions. LDR is typically placed on the solar panel or near it to monitor the amount of sunlight falling on the panel. The LDR's resistance value decreases as sunlight intensity increases, allowing the system to determine whether the panel is receiving sufficient sunlight for optimal energy generation.

5. Motor:
The motor's primary function is to physically rotate the solar panel horizontally (azimuth axis) and tilt it vertically (elevation axis) based on real-time sun tracking data received from the microcontroller. Motor used in this project is typically a stepper motor or a DC motor with appropriate gearing and torque capabilities to handle the movement requirements of the solar panel. The motor receives control signals from the driver circuit, which interprets commands from the microcontroller and translates them into specific movements of the motor shaft. The motor's precision and reliability are crucial for ensuring accurate sun tracking and maximizing energy generation from the solar panel. It works in tandem with the driver circuit and microcontroller to achieve seamless operation and efficient solar tracking in the dual-axis smart solar tracking system.

6.Driver Circuit:
The driver circuit plays a crucial role in controlling the movement of the solar panel along both the azimuth and elevation axes. The driver circuit receives signals from the microcontroller, such as the Raspberry Pico, and converts them into specific commands for the motor. The driver circuit typically includes motor drivers or motor control modules that can interpret the signals from the microcontroller and drive the motor accordingly. Driver circuit ensures precise and accurate movement of the solar panel, allowing it to continuously track the sun's movement throughout the day. It also includes circuitry for power management and motor protection to prevent damage and ensure reliable operation.

7. Alarm:
Alarm can be integrated to provide notifications or alerts regarding the system's status or any abnormal conditions. The alarm can be implemented using a buzzer or a similar audio output device. The alarm in this block diagram serves as a visual or audible indicator to alert users or operators about specific events or situations. For example, the alarm can be programmed to sound when the system detects a malfunction, such as a sensor failure or motor error. It can also alert users when the solar panel is not tracking the sun properly or when the system encounters environmental conditions that may affect its performance.

V. RESULTS

The Raspberry Pico-based dual-axis smart solar tracking system demonstrates impressive results in optimizing solar panel performance and enhancing energy generation efficiency. By continuously tracking the sun's movement and adjusting the solar panel's orientation along both the azimuth and elevation axes, the system maximizes sunlight absorption throughout the day. This dynamic tracking capability significantly improves the overall efficiency of the solar panel, resulting in increased energy output and higher energy savings.

One of the key benefits of the system is its ability to maintain the solar panel at the optimal angle relative to the sun, ensuring maximum sunlight exposure and minimizing energy wastage. This optimized orientation leads to enhanced power generation, making the system particularly effective in locations with varying solar angles or seasonal changes in sunlight intensity.

Additionally, the Raspberry Pico microcontroller's advanced capabilities allow for precise sun tracking calculations and seamless coordination with the driver circuit and motor. The integration of sensors like the Light Dependent Resistor (LDR) further enhances the system's accuracy in detecting sunlight intensity and adjusting the panel's position accordingly.

Overall, the Raspberry Pico-based dual-axis smart solar tracking system delivers impressive results by maximizing solar panel efficiency, increasing energy production, and contributing to sustainable energy solutions. Its effectiveness in optimizing sunlight capture makes it a valuable technology for enhancing

renewable energy utilization and reducing dependence on traditional power sources.

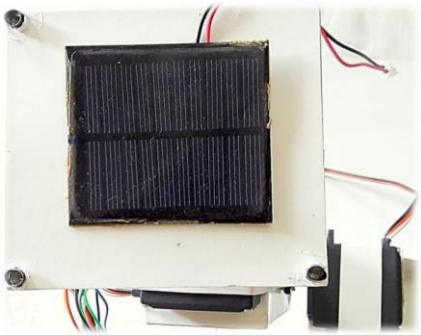
VI. CONCLUSION

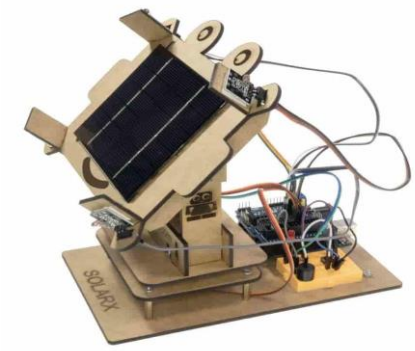
In conclusion, the Raspberry Pico-based dual-axis smart solar tracking system represents a significant advancement in renewable energy technology. Its innovative design, incorporating advanced tracking capabilities and intelligent control systems, offers a highly efficient and cost-effective solution for solar energy generation. By optimizing the orientation of solar panels towards the sun, the system maximizes power output and improves overall energy efficiency, leading to increased return on investment for solar projects.

The integration of the Raspberry Pico microcontroller ensures reliable performance and flexibility in implementing complex tracking algorithms. Its compact size and affordability make it suitable for a wide range of solar installations, from small residential setups to medium-scale commercial projects.

Besides, the Savvy sun powered Following System's capacity to adjust to shifting sun based points and natural conditions improves its viability and unwavering quality. It gives a user-friendly interface and exact sun following capabilities, guaranteeing ideal sun oriented vitality utilization all through the day.

Overall, the Raspberry Pico-based dual-axis solar tracking based following framework offers a solid, effective, and available way to tackle the control of the sun. Its benefits amplify past fair vitality era, contributing essentially to maintainability endeavors and decreasing dependence on conventional vitality sources. As renewable vitality proceeds to play a vital part in tending to worldwide vitality challenges, this framework stands out as a promising arrangement for a greener and more feasible future..





VII. FUTURE POSSIBILITIES

The Raspberry Pico-based dual-axis smart solar tracking oriented following framework are tremendous and promising. As innovation proceeds to advance, a few headways and improvements can be imagined for this imaginative arrangement. One potential future advancement is the integration of manufactured insights (AI) calculations into the framework. AI can empower the sun powered following framework to learn and adjust to changing natural conditions, encourage optimizing sun powered board introduction and vitality era. This can lead to indeed more noteworthy effectiveness picks up and moved forward execution, particularly in energetic climate conditions or areas with complex sun designs. Moreover, progressions in sensor innovation can contribute to improving the system's precision and unwavering quality. Unused sensors with higher exactness and affectability might give more point by point information on daylight escalated and board situating, permitting for better alterations and maximizing vitality capture.

Furthermore, the versatility of the Raspberry Pico microcontroller opens entryways for applications in larger-scale sun based establishments, such as sun powered ranches or mechanical offices. The framework can be adjusted and extended to suit

different sun oriented boards, advertising a comprehensive and effective sun based vitality arrangement for different needs. In the future, proceeded investigate and improvement endeavors can lead to advancements like vitality capacity integration, prescient support capabilities, and made strides client interfacing, making the Raspberry Pico-based dual-axis solar tracking powered following framework indeed more flexible, effective, and user-friendly.

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