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Sun Track Pro

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KEYWORDS

Arduino, Motor driver, Motor, DHT11 sensor, LDR sensor

ABSTRACT

The project, "Sun Track Pro," presents an innovative and eco-friendly solution for optimizing solar energy generation by incorporating dual axis solar tracking and weather monitoring capabilities. This project is founded on Arduino technology, utilizing an Arduino controller to coordinate the precise movements of dual-axis tracking, motor drivers for motor control, a DHT11 sensor for weather monitoring, an LCD display for real-time information, and LDR sensors positioned on four sides for precise tracking adjustments. At its core, this system is designed to maximize solar panel efficiency by continuously aligning them with the sun's position in the sky.

The dual-axis tracking mechanism, enabled by motor drivers and LDR sensors, ensures that solar panels are oriented optimally throughout the day, capturing the maximum available sunlight. Additionally, the project integrates a DHT11 sensor to monitor real-time weather conditions, including temperature and humidity. This data is displayed on an LCD screen, providing valuable information for assessing solar panel performance under different weather conditions. By combining dual-axis solar tracking with weather monitoring, this project offers a comprehensive and eco-friendly approach to improving solar energy harvesting, reducing energy costs, and contributing to sustainable energy solutions.

1. INTRODUCTION

The "Sun Track Pro", project is designed to enhance the efficiency of solar energy harvesting while incorporating weather monitoring capabilities. In recent years, solar energy has emerged as a promising alternative to traditional energy sources due to its sustainability and environmental benefits. However, one of the challenges with solar energy is maximizing its efficiency, especially in areas with varying weather conditions and changing sunlight angles throughout the day. This project aims to address this challenge by implementing a dual-axis solar tracking system combined with weather monitoring sensors to optimize energy generation and improve system reliability.

Solar tracking systems are mechanisms that orient solar panels or photovoltaic arrays to track the sun's position throughout the day, ensuring that they are always perpendicular to the sun's rays. By continuously adjusting the orientation of solar panels, solar tracking systems can significantly increase energy output compared to fixed panels. However, conventional single-axis tracking systems only track the sun's movement along one axis (usually the horizontal axis), limiting their effectiveness, especially in locations with high latitude or where the sun's path varies significantly throughout the year. The dual-axis solar tracking system implemented in this project overcomes this limitation by tracking the sun's movement along both the horizontal and vertical axes, ensuring optimal alignment with sunlight at all times.

In addition to the dual-axis solar tracking functionality, this project incorporates weather monitoring sensors to gather real-time data on environmental conditions such as temperature, humidity and atmospheric pressure. Weather conditions can have a significant impact on solar energy generation, with factors such as cloud cover, precipitation and temperature affecting sunlight intensity and panel performance. By integrating weather monitoring capabilities into the solar tracking system, users can obtain valuable insights into how environmental factors influence energy production. This information can be used to adjust system operation, optimize energy harvesting strategies and improve overall system resilience in responses to changing weather conditions.

II. LITERATURE SURVEY

Dual-Axis Solar tracking Mechanisms, Gupta et al. (2020) developed a microcontroller based dual-axis tracker using LDR sensors to follow up the sun. Their results showed a 30-40% increase in efficiency compared to fixed system.

Ali et al. (2021) implemented a Servo motor-controlled tracking system with real-time solar positioning algorithms, improving power output significantly.

Arduino and IoT-based solar tracker, Patel et al (2022) developed an Arduino and IoT based solar tracker that adjusts panel orientation using real-time sun position data. Their system improved energy generation by 35% over fixed panels.

Singh et al (2023) incorporated AI-based weather prediction into tracking systems to optimize energy capture during cloudy conditions.

III. SYSTEM MODEL

A. Existing system

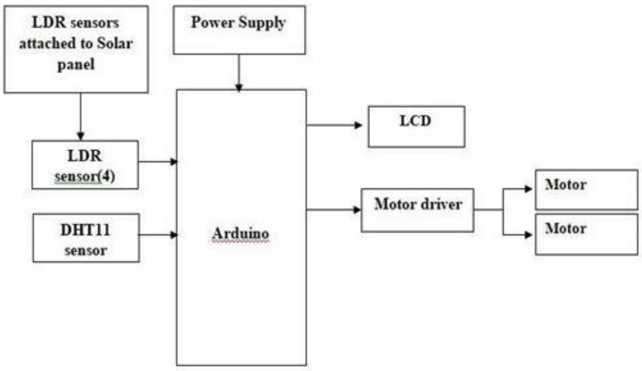
The existing methods for solar energy generation typically rely on fixed solar panel installations that do not have the capability to dynamically adjust their orientation in response to the sun's position. These static installations are often set at a fixed angle or orientation, resulting in sub-optimal energy capture as the sun's angle changes throughout the day and across seasons. Additionally, conventional solar systems may lack real-time weather monitoring capabilities, leaving them vulnerable to reduced efficiency during adverse weather conditions. These limitations lead to reduced energy output and missed opportunities for maximizing the potential of solar energy. Therefore, there is a need for more advanced and responsive solar tracking systems, such as the proposed "Dual axis Solar Tracking System with Weather Monitoring," to optimize solar energy generation and enhance the sustainability of solar power solutions.

B. Proposed system

The proposed method introduces a Dual Axis Solar Tracking System with Weather Monitoring, designed to significantly enhance solar panel efficiency. This system leverages LDR (Light Dependent Resistor) sensors strategically positioned on four sides of the solar panel to precisely determine its orientation with respect to the sun. The LDR sensors continuously measure the intensity of light falling on them, allowing the system to calculate the sun's position. This data is processed by an Arduino controller, which in turn commands motor drivers to adjust the solar panel's position along bot horizontal and vertical axes. By dynamically tracking the sun's movement, the system ensures that the solar panel is always optimally aligned to capture maximum sunlight throughout the day and across seasons.

In addition to dual-axis solar tracker, this system incorporates weather monitoring using a DHT11 sensor, which measures temperature and humidity levels in real-time. The gathered weather data is displayed on an LCD screen, providing critical insights into environmental conditions that can impact solar panel performance. The proposed method not only increase the overall efficiency of solar panels but also contribute to sustainable and eco-friendly energy solutions, reducing energy costs and environmental impact.

Block Diagram:



IV. BENEFITS OF DUAL AXIS SOLAR TRACKING SYSTEM WITH WEATHER MONITORING

There are several benefits to using this dual axis tracker combined with weather monitoring, including:

Increased Energy Efficiency: A dual-axis tracking system follows the sun's movement across both azimuth and elevation angles to maximize solar panels exposure to sunlight. It increases energy output by 30-40% compared to fixed solar panels and 10-20% over single axis trackers.

Optimal Performance in Variable Weather Conditions: Integrated weather monitoring helps to adjust the panel's position based on real-time environmental data (cloud cover, temperature, wind speed). If extreme weather conditions are detected, the system can tilt panels to a safe position to preventing damage.

Adaptive Solar Energy Harvesting: Sensors detect changes in sunlight intensity and adjust the panel's tilt for optimal efficiency. Can operate efficiently in partially shaded environments by tracking the brightest part of the sky.

Economic & Environmental Benefits: Higher efficiency reduces the number of solar panels required for a given power output, lowering material costs. Maximizing solar energy reduces reliance on fossil fuels, lowering carbon footprints.

V. APPLICATIONS

Solar Power Plants: Increase energy output and reduce losses in large-scale solar power plants.

Agricultural Automation: Power irrigation systems, greenhouses and other agricultural infrastructure with optimized solar energy.

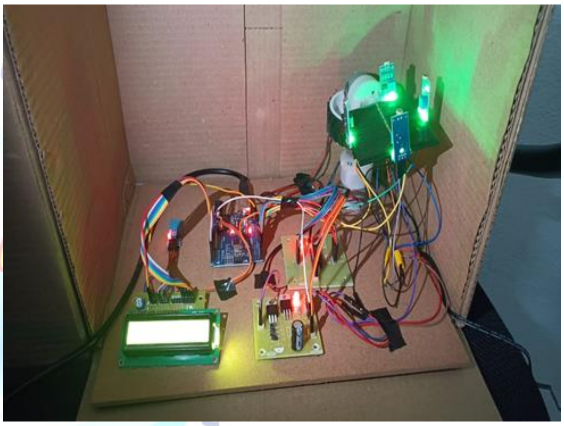
Telecom and Data Centers: Reduce energy costs and ensure reliable power supply for telecom towers and data centers.

Remote sensing: Monitors environmental conditions while using solar energy efficiently.

Research and Development: Support research institutions and universities in studying and developing new solar energy technologies.

Weather Monitoring Stations: Provide accurate and reliable weather data for forecasting, research and other applications.

VI. RESULT



The experimental results of the dual-axis solar tracking system with weather monitoring demonstrate significant improvements in energy efficiency and system performance compared to fixed solar panels. The tracking system continuously adjusts the solar panels position based on the sun's real-time movement. Additionally, integrated weather sensor module which include DHT11 sensor for detecting temperature and humidity provides valuable insights into environmental conditions affecting solar efficiency.

Overall, the experimental results validate the effectiveness of the dual-axis tracking system in improving solar energy harnessing, making it a promising solution for enhancing renewable energy utilization. And real-time weather data helps in optimize energy production and predicting system performance.

VII. CONCLUSION

In conclusion, the development of the dual-axis solar tracking system with weather monitoring represents a significant advancement in renewable energy technology and environmental monitoring. By integrating precise solar tracking mechanisms with real-time weather sensors, the project offers a comprehensive solution for optimizing solar energy generation and enhancing environmental awareness. Throughout the project, extensive research and development efforts have been dedicated to designing a robust and efficient system capable of meeting the diverse needs of various applications.

One of the key findings of this project is the substantial increase in energy production achieved through the implementation of dual-axis solar tracking technology. By continuously adjusting the orientation of solar panels to track the sun's movement in both azimuth and elevation angles, the system maximizes solar energy throughout the day.

Furthermore, the integration of weather monitoring capabilities into solar tracking system enhances its functionality and versatility across different applications. The ability to monitor environmental parameters such as temperature and humidity. Overall, the dual-axis solar tracking system with weather monitoring advances the adoption of renewable energy technologies and promoting sustainable development practices across various sectors including residential, commercial, industrial, agricultural and environmental applications.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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