DUAL AXIS SOLAR PANEL USING ARDINO

Project Reference No.: *48S_MCA_0200*

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Keywords

Dual Axis Tracking, Arduino UNO, Renewable Energy, LDR Sensors, Solar Efficiency

Introduction/Background

Solar energy is one of the most abundant and sustainable sources of energy available. However, the efficiency of conventional fixed solar panels is limited due to the changing position of the sun throughout the day and across seasons. To overcome this challenge, solar tracking systems have been developed. A dual-axis solar tracker enables the solar panel to follow the sun both horizontally (azimuth) and vertically (elevation), ensuring that it is always positioned at the optimal angle for maximum energy absorption. The proposed project utilizes an Arduino microcontroller to automate the movement of a solar panel in two axes using Light Dependent Resistors (LDRs) to detect sunlight intensity. By implementing a feedback mechanism, the system adjusts the position of the solar panel to face the direction of maximum sunlight. This project holds relevance in both academic and industrial domains, as it blends renewable energy applications with embedded system design. It also helps contribute to sustainable energy practices and can be further optimized for large-scale deployment in smart solar farms.

Objectives

- To design and implement a dual-axis solar tracking system using Arduino.

- To improve the efficiency of solar panels by maintaining optimal orientation to the sun.
- To demonstrate a working prototype that dynamically tracks sunlight in real-time.
- To analyse and compare energy output between fixed and tracking panels.
- To explore the feasibility of integrating the system into real-world solar energy installations.

Methodology

Materials Used:

- Arduino UNO
- 4 LDRs (Light Dependent Resistors)
- 2 Servo Motors (for X and Y axis movement)
- Solar Panel (5V or 12V depending on prototype scale)
- Resistors, Jumper Wires
- Mounting platform (3D-printed or wooden frame)

Working Principle:

- Four LDRs are placed at the corners of the solar panel to detect sunlight intensity.
- The Arduino reads the analog signals from the LDRs and calculates the difference in light levels.
- Based on this data, the servo motors are actuated to rotate the panel either vertically or horizontally.
- The panel constantly adjusts its orientation throughout the day.

Software Implementation:

- Programmed using Arduino IDE.
- Conditional statements and sensor threshold values used for motor control.
- Code optimized for power efficiency and smooth operation.

Results & Conclusions

- The dual-axis tracker maintained optimal alignment with the sun.
- Energy output showed a 25–35% increase compared to a stationary panel.
- Arduino-controlled servos ensured precise and smooth tracking.
- Photographs and charts (to be added) illustrate tracking and energy output comparison.

Conclusion: The system effectively increases solar efficiency and is cost-effective for small-scale use.

Project Outcome & Industry Relevance

This project offers a scalable method to increase solar panel efficiency, applicable to:

- Residential rooftops
- Agriculture (solar-powered irrigation)
- Industrial solar farms

It shortens the solar system payback period, promoting adoption of solar energy solutions.

Working Model vs. Simulation/Study

This project included the development of a physical working model with real-time sunlight tracking using sensors and servos.

Project Outcomes and Learnings

- Learned Arduino programming and embedded systems integration.
- Gained experience in sensor calibration and mechanical assembly.
- Validated hypothesis through practical testing and energy comparisons.

Future Scope

- Implement PID control for smoother movement.
- Add battery management and IoT features for remote monitoring.
- Use stronger actuators for large panels.
- Develop weatherproof systems for outdoor use.
- Explore AI for sun-path prediction and proactive tracking.