Solar Tracker System

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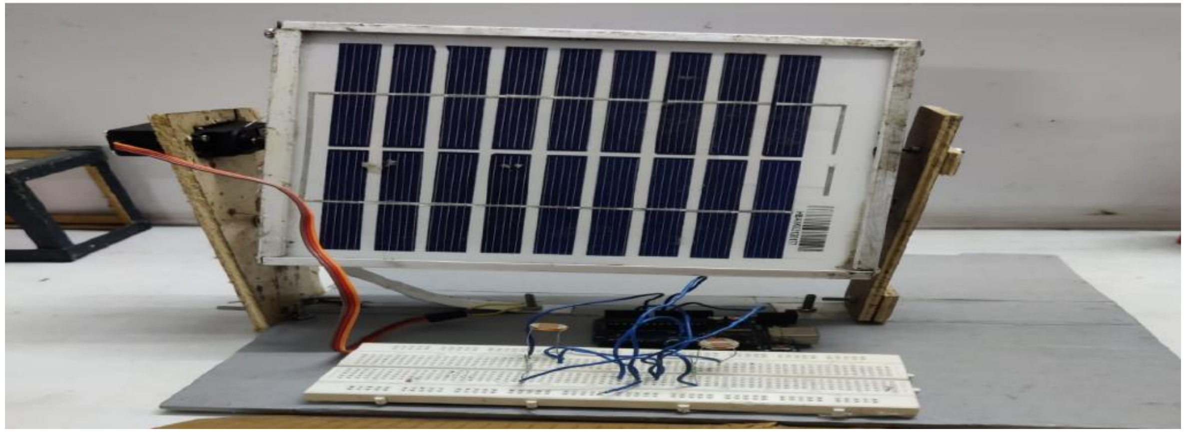
Abstract

- This project focuses on enhancing solar energy efficiency using a single-axis solar tracker integrated with IoT capabilities.
- An Arduino/ESP32 microcontroller controls a servo motor based on readings from two LDR sensors to align the solar panel with the sun’s position along the east–west axis.
- Real-time data such as light intensity and panel angle are sent to the ThingSpeak cloud for remote monitoring and analysis.
- The system increases energy generation efficiency compared to fixed panels while maintaining a simpler mechanical structure than dual-axis systems.

Objectives

- Track the sun’s position along a single (east–west) axis using LDR sensors.
- Maximize solar panel exposure for improved energy output.
- Implement IoT-based real-time data logging and remote monitoring.
- Demonstrate an affordable and efficient solar tracking mechanism.



Block Diagram (Concept)

- Two LDR sensors detect sunlight intensity from left and right directions.
- The ESP32/Arduino processes sensor data and controls a single servo motor.
- The servo motor adjusts the solar panel’s position along the east–west axis.
- Data such as light intensity and servo angle are sent to ThingSpeak via Wi-Fi for visualization.
- Components: ESP32/Arduino, LDRs, Servo Motor, Solar Panel, ThingSpeak Cloud.

Hardware Components

1. ESP32 or Arduino UNO – main controller and Wi-Fi communication.
2. LDR Sensors – detect light intensity on each side.
3. Servo Motor – moves the solar panel east–west.
4. Mini Solar Panel – captures solar energy.
5. Resistors and Breadboard – for circuit connections.
6. ThingSpeak Cloud – IoT data visualization and monitoring.

Working Principle

- LDRs are used as the main light sensors. The servo motor is fixed to the structure that holds the solar panel. The program for Arduino/ESP32 is uploaded to the microcontroller. The working of the project is as follows:
- LDRs sense the amount of sunlight falling on them.
- For east–west tracking, the analog values from two LDRs are compared.
- If the left LDR receives more light, the servo motor moves the panel in that direction.
- If the right LDR receives more light, the servo moves in that direction.
- This ensures that the panel always faces the direction of maximum sunlight.
- The data (light values and servo position) are sent to the IoT cloud for monitoring.

Results and Discussion

- • The tracker maintains optimal orientation to the sunlight along a single axis.
- • Improved energy generation efficiency compared to fixed panels.
- • Stable data visualization and monitoring through ThingSpeak.
- • Reliable performance under normal lighting conditions.
- • Simpler design and lower cost compared to dual-axis systems.

Advantages

- Increased energy efficiency through better sunlight alignment.
- IoT-based remote monitoring capability.
- Compact and easy to implement design.
- Cost-effective compared to dual-axis systems.
- Scalable for larger solar installations.

Conclusion

- The IoT-based single-axis solar tracker effectively aligns the solar panel toward maximum sunlight using LDR sensors and a servo motor. By integrating IoT technology through platforms like ThingSpeak, the system enables real-time monitoring and data analysis.
- This project demonstrates an efficient, affordable, and modern approach to renewable energy tracking with room for future enhancements such as dual-axis movement and weather-based automation.