

Sun Solar Tracking Panel Using Arduino

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Abstract: This project focuses on the development of a sun solar tracking system using an Arduino microcontroller to increase the efficiency of solar panels. The system uses light-dependent resistors (LDRs) to sense sunlight intensity and automatically adjusts the panel position using servo motors. By continuously tracking the sun's movement, the panel receives maximum sunlight throughout the day, resulting in higher energy output compared to fixed systems. The design is simple, cost-effective, and suitable for improving renewable energy applications.

Keywords: sun solar. tracking system

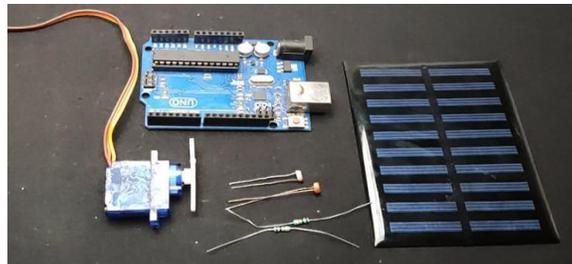
I. INTRODUCTION

With the increasing demand for renewable energy, solar power has become one of the most promising and sustainable energy sources. However, the efficiency of solar panels is often limited because they are fixed in one position and cannot continuously face the sun. As the sun moves across the sky, the angle of sunlight changes, reducing the amount of energy captured by the panel.

To overcome this limitation, a sun solar tracking system can be used. This project introduces a solar tracking panel based on an Arduino microcontroller that automatically follows the movement of the sun. The system uses light-dependent resistors (LDRs) to detect the direction of maximum sunlight and servo motors to adjust the position of the panel accordingly.

By keeping the panel aligned with the sun throughout the day, the system increases the amount of solar energy captured, thereby improving overall efficiency. This project demonstrates a simple, cost-effective, and efficient method to enhance solar power generation using embedded systems and automation.

II. COMPONENTS USED



1. Arduino Board (Arduino Uno)

- The main controller of the system.
- Reads input from sensors and sends signals to motors.
- Processes data and controls panel movement.

2. Solar Panel

- Converts sunlight into electrical energy.
- Mounted on a movable structure to track the sun.
- Efficiency increases when aligned with sunlight.



3. LDR (Light Dependent Resistor)

- A light sensor whose resistance changes with light intensity.
- Used to detect the direction of maximum sunlight.
- Usually placed in pairs for comparison.

4. Servo Motors

- Used to rotate the solar panel.
- Controlled by Arduino signals.
- Enables movement in one or two axes.

5. Resistors

- Used with LDRs to form a voltage divider circuit.
- Helps Arduino read accurate sensor values.

6. Power Supply

- Provides power to Arduino and motors.
- Can be a battery or DC adapter.

7. Breadboard

- Used to build the circuit without soldering.
- Makes connections easy and adjustable.

8. Jumper Wires

- Connect all components together.
- Ensure proper signal and power flow.

9. Mounting Structure

- Holds the solar panel and motors.
- Allows smooth and stable movement.

III. LITERATURE SURVEY

Solar energy systems have gained significant attention due to the growing need for renewable and sustainable energy sources. Research shows that the efficiency of solar panels can be greatly improved by tracking the sun's movement, ensuring that the panels are always oriented toward maximum solar radiation.

Early studies focused on fixed solar installations, which are simple and low-cost but suffer from reduced efficiency as the position of the sun changes throughout the day. This led to the development of solar tracking systems, which can be broadly classified into single-axis and dual-axis trackers. Single-axis trackers follow the sun's movement in one direction, while dual-axis trackers can adjust both horizontal and vertical angles for more precise alignment.

Several research works have employed microcontrollers such as PIC and ARM processors to implement automated solar tracking. In recent years, the Arduino platform has become popular due to its low cost, ease of use, and open-source community support. Studies using Arduino often integrate light-dependent resistors (LDRs) as sensors to detect sunlight intensity and servomotors for panel movement. These systems demonstrate improved energy output compared to static solar panels.

Researchers have also explored different control algorithms and sensor configurations to enhance tracking accuracy. Some systems use digital sensors like photodiodes or digital sunlight sensors for more accurate measurement, while



others combine GPS or real-time clock modules to predict sun positions. Overall, literature indicates that solar tracking systems significantly increase generated power, making them an important enhancement for solar energy applications.

IV. SCOPE OF THE PROJECT

Functional Scope

1. Automatic Sun Tracking – The system continuously detects the sun's position using LDR sensors and adjusts the solar panel's orientation.
2. Dual-Axis Movement – The panel can move horizontally and vertically to capture maximum sunlight throughout the day.
3. Energy Optimization – By aligning the panel with the sun, the system increases power output compared to fixed panels.
4. Arduino Control – All operations are managed by the Arduino microcontroller for precise and reliable movement.
5. Low-Cost Implementation – Uses cost-effective components like servo motors, LDRs, and Arduino for easy assembly and maintenance.
6. Expandable Design – Can be scaled for larger panels or integrated with additional sensors like temperature or light intensity monitors.

NON-FUNCTIONAL SCOPE

1. Reliability – The system should operate consistently throughout the day under varying sunlight conditions.
2. Efficiency – The tracking mechanism must respond quickly to changes in sunlight to maximize energy capture.
3. Durability – Components should withstand outdoor conditions such as heat, dust, and mild rain.
4. Maintainability – Easy to assemble, troubleshoot, and repair if required.
5. Cost-effectiveness – The system should use affordable components to keep the overall cost low.
6. Usability – Simple design that requires minimal user intervention once installed.
7. Scalability – The design should allow easy upgrades, like adding larger panels or additional sensors.

V. METHODOLOGY/ABSTRACT

Abstract

This project presents a solar tracking system using an Arduino microcontroller to enhance the efficiency of solar panels. The system uses light-dependent resistors (LDRs) to detect sunlight intensity and servo motors to adjust the panel's position automatically. By tracking the sun throughout the day, the panel maintains optimal alignment with sunlight, improving energy output compared to fixed solar panels. The design is cost-effective, simple to implement, and suitable for small-scale renewable energy applications.

Methodology

1. Component Selection – Choose Arduino, LDR sensors, servo motors, resistors, solar panel, and mounting structure.
2. Sensor Placement – Place LDR sensors on the panel to detect sunlight intensity from different directions.
3. Circuit Design – Connect LDRs, resistors, and servo motors to the Arduino using a breadboard and jumper wires.
4. Programming Arduino – Write a code that:
 - o Reads LDR sensor values.
 - o Compares light intensity from multiple sensors.
 - o Sends control signals to servo motors to adjust panel position toward maximum sunlight.
5. Mechanical Setup – Mount the solar panel on a dual-axis servo mechanism to allow horizontal and vertical movement.
6. Testing and Calibration – Test the system under sunlight, calibrate sensor sensitivity and motor movement for accurate tracking.



7. Energy Measurement – Compare energy output of tracking panel versus a fixed panel to evaluate efficiency improvement.

VI. ADVANTAGE

1. Increased Efficiency – Continuously tracks the sun, maximizing sunlight exposure and energy output.
2. Cost-Effective – Uses affordable components like Arduino, LDRs, and servo motors.
3. Automatic Operation – Requires minimal human intervention once installed.
4. Dual-Axis Tracking – Moves in both horizontal and vertical directions for optimal sunlight capture.
5. Scalable Design – Can be expanded for larger solar panels or integrated with additional sensors.
6. Renewable Energy Friendly – Enhances the use of clean, sustainable solar energy.
7. Simple Maintenance – Easy to troubleshoot and repair due to modular components.

VII. APPLICATIONS

1. Residential Solar Systems – In homes to increase electricity generation from solar panels.
2. Commercial Solar Installations – On offices, factories, or shopping complexes to improve energy efficiency.
3. Remote Power Supply – For powering remote sensors, communication towers, or small off-grid systems.
4. Agricultural Use – To provide power for irrigation pumps, greenhouse lighting, or farming equipment.
5. Educational Projects – Used in schools and colleges to demonstrate renewable energy concepts and automation.
6. Solar-Powered Vehicles – Enhances efficiency of solar cars, boats, or robotic systems that rely on solar power.
7. Street Lighting Systems – For solar street lights that require maximum energy collection during the day.

VIII. CONCLUSION

The Arduino-based solar tracking system effectively improves the efficiency of solar panels by continuously aligning them with the sun. Using LDR sensors and servo motors, the system automatically adjusts the panel's position in both horizontal and vertical directions, ensuring maximum sunlight exposure throughout the day.

Compared to fixed solar panels, this approach significantly increases energy output while remaining cost-effective and easy to implement. The project demonstrates how simple automation and embedded systems can enhance renewable energy utilization, making solar power more reliable and efficient for various applications.

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