Dual Axis Solar Tracking System

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Abstract*—This paper introduces a solar tracking system designed to enhance the efficiency of solar panels by ensuring optimal alignment with the sun's position throughout the day. The system integrates an Arduino Uno microcontroller, four Light Dependent Resistors (LDRs), four resistors, a battery, two servo motors, and a solar panel. The Arduino Uno processes data from the LDRs to determine the sun's direction and controls the servo motors to adjust the solar panel's orientation accordingly. The system's operation involves reading analog values from the LDRs, calculating average light intensities in different directions, and continuously adjusting the solar panel to maximize sunlight exposure. This system contributes to sustainable energy practices by maximizing solar energy utilization, reducing reliance on non-renewable energy sources, and lowering carbon emissions.

***Keywords*—Arduino Uno, LDR sensors, Servo motors, Solar Tracking**

I. INTRODUCTION

Solar energy is a clean, renewable, and abundant source of energy with the potential to mitigate environmental issues associated with traditional fossil fuels. Solar panels are a common technology used to harness solar energy; however, their efficiency is influenced by factors such as the angle of incidence of sunlight. Solar tracking systems address this limitation by orienting solar panels to face the sun, maximizing sunlight exposure and energy output.

This paper presents a solar tracking system designed to optimize solar panel efficiency. The system employs an Arduino Uno microcontroller, four Light Dependent Resistors (LDRs), resistors, servo motors, a battery, and a solar panel. The Arduino Uno serves as the system's brain, receiving input from the LDRs and controlling the servo motors to adjust the solar panel's orientation based on the sun's position. The LDRs detect light intensity in four directions (North, South, East, West), allowing the system to determine the sun's direction relative to the solar panel. The system's implementation involves mounting the LDRs at strategic positions and connecting them to the Arduino Uno using resistors to create voltage dividers. The servo motors are connected to the Arduino Uno to facilitate the panel's movement. The system is powered by a battery, ensuring continuous operation even in the absence of sunlight. The solar panel's orientation is adjusted continuously throughout the day to track the sun's movement.

By optimizing solar panel orientation, the system aims to increase energy generation and improve overall efficiency. The system's effectiveness in enhancing solar panel efficiency, making it a viable solution for maximizing solar energy utilization and promoting sustainable energy practices.

In existing systems, energy loss is a major problem.One of the issues that we are facing in every system is energy loss. Due to the panels' ability to reflect solar radiation, solar panels lose a significant amount of energy. Ray reflection will happen as a result of one of the causes of panel alignment. The panel must be aligned perpendicular to the solar ray for best efficiency; in old topologies, this was the main issue with solar energy generation. There is a risk that a shift in the sun's track will also affect utilization efficiency due to seasonal change.

II. PROPOSED MODEL

The proposed model utilizes the Arduino Uno microcontroller to control the servo motors based on the input from the LDR sensors. The LDR sensors detect the light intensity in different directions, allowing the system to determine the sun's position. The servo motors adjust the orientation of the solar panel to ensure it is always facing the sun, maximizing the energy output of the solar panel. The system operates continuously, tracking the sun's position throughout the day and adjusting the solar panel orientation accordingly. The flowchart begins by setting up the servo motors and initializing them to their starting positions. It then waits for 500 milliseconds to ensure everything is properly initialized before moving on to the main loop. In the main loop, the code reads analog values from four LDR sensors (LDR1, LDR2,LDR3, LDR4) to detect light intensity in different directions. It calculates the average light intensity in each direction (North, South, East, West) based on the readings from the LDR sensors. The code then compares the average light intensity values to determine the direction of the sun. If the sun is detected more in the North, the vertical servo motor is adjusted to move the solar panel upward. If the sun is detected more in the South, the vertical servo motor is adjusted to move the solar panel downward. Similarly, if the sun is detected more in the West, the horizontal servo motor is adjusted to move the solar panel right. If the sun is detected more in the East, the horizontal servo motor is adjusted to move the solar panel left. The code checks if the servo motors have reached their limits to prevent them from moving beyond their intended range. Finally, the code adds a small delay (10 milliseconds) to stabilize the servo motors' movement. The loop continues to run, continuously adjusting the servo motors based on the sun's position to ensure that the solar panel is always facing the sun.The objective of a dual-axis solar tracker is to increase the efficiency of solar energy conversion by optimizing the angle of incidence between the solar paneland the sun. The solar tracker functions on two axes: primary and secondary. The primary axis helps the tracker move from East to West, and the secondary axis helps the tracker move from North to South. The solar tracker rotates the solar panels to provide direct exposure to sunlight. This helps better directivity with Sun rays, thus increasing the efficiency of the solar system. The solar tracker can give 40% more electricity than a non moving solar panel. It also has a higher degree of flexibility, allowing for a higher energy output on sunny days.

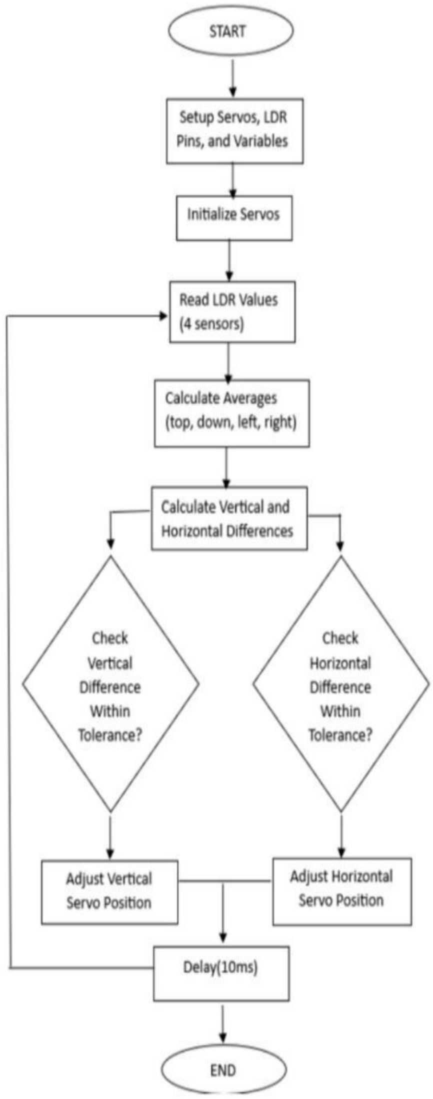
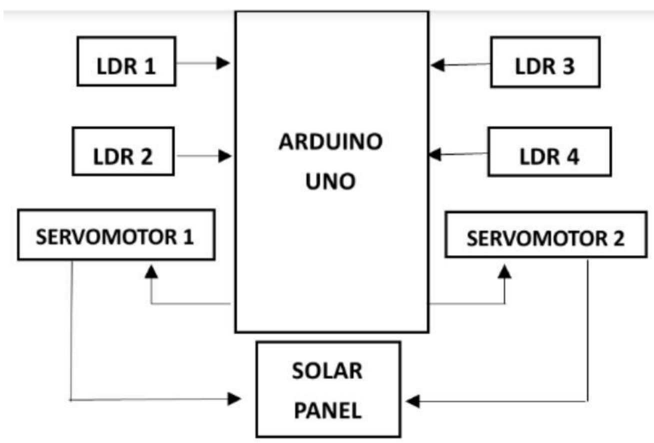


Fig. Flowchart



III. HARDWARE AND SOFTWARE SPECIFICATIONS

The solar tracking system is designed to track the sun's position throughout the day and adjust the orientation of the solar panel to maximize the amount of sunlight it receives. The system consists of the following components: Arduino Uno, LDR sensors, Resistors, Battery, Servo motors, Solar panel.

1. Arduino Uno: The Arduino Uno is the central microcontroller of the system. It receives input from the LDR sensors, processes the data, and controls the servo motors to adjust the orientation of the solar panel.

2. LDR Sensors: Four Light Dependent Resistors (LDRs) are used to detect the light intensity in four different directions: North, South, East, and West. The LDR sensors are

Fig. Block diagram

positioned strategically to capture the sunlight from these directions.

3. Resistors: Four resistors are used to create voltage dividers with the LDRs. These voltage dividers convert the light intensity into voltage values that can be read by the Arduino Uno.

4. Battery: A battery is used to power the system, ensuring that it can operate even when sunlight is not available. The battery is charged using the solar panel.

5. Servo Motors: Two servo motors are used to adjust the orientation of the solar panel. One servo motor controls the horizontal movement (East-West direction), and the other controls the vertical movement (North-South direction).

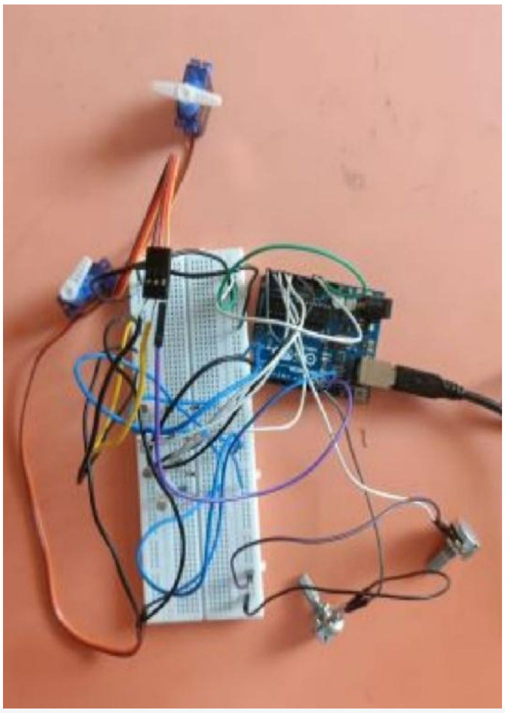
6. Solar Panel: The solar panel is the main component that generates electricity from sunlight. By tracking the sun's position, the solar panel can maximize its exposure to sunlight and generate more electricity.

The system is programmed using Arduino IDE, and the code adjusts the position of the servo motors based on the light Fig. Flowchart intensity readings from the LDR sensors.

IV. RESULTS AND DISCUSSIONS

The dual-axis solar tracking system's efficacy in optimizing solar energy harvesting is demonstrated by experimental testing. Throughout the day, the system effectively keeps the solar panel perpendicular to the sun, which increases energy production significantly when compared to fixed panels. The system's resilience and dependability are validated by evaluating the tracking accuracy and efficiency in a range of environmental circumstances. From 08:15:30 AM to 17:45:30 , the flow rate in rays is measured. Should the computed average power be 12V, the total flow will be End time – Start time equals the total flow length. 17:45:30 - 8:15:30 = 9 hours 30 minutes. Avg = 300 kw per hour, 9 hour usage ! From solar

300kw Per hour ,so for 9 hours production 2,700 kw For street light100 kw per hour ,so for 12 hours 12 * 100 = 1200 kw.



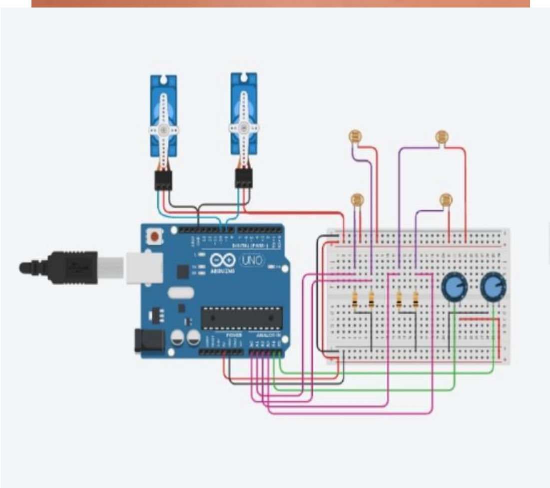


Fig. Prototype of the proposed model

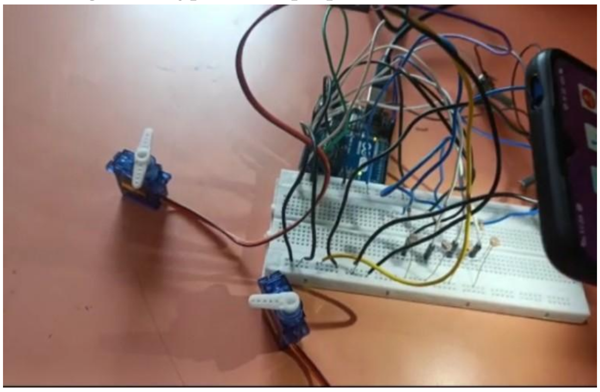


Fig. Simulation of the proposed model

Fig. Execution of the proposed model

V. CONCLUSION

The dual-axis solar tracking system presented in this paper offers a practical solution for optimizing solar panel orientation and improving energy efficiency. By utilizing Arduino Uno, LDR sensors, and servo motors. The technology maximizes the amount of solar energy that can be harvested by precisely monitoring the position of the sun. The experimental findings support the dual-axis solar tracking system's efficacy in raising solar energy harvesting efficiency.. The system's precise tracking capabilities, adaptability to environmental conditions, and superior performance compared to fixed panels highlight its potential for widespread application in renewable energy systems.

Future Work: Future research may focus on further optimizing the control algorithm to improve tracking accuracy and energy efficiency. Additionally, scalability and cost-effectiveness considerations could be addressed to facilitate the deployment of dual-axis solar tracking systems in commercial and residential settings.

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