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Dual Axis Solar Tracking System Using Arduino

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Abstract: The aim of this project to create or to build a prototype solar tracking system to improve the performance of photo voltaic modules. The operation involves a continuous alignment of the photo voltaic modules with the sun rays to optimize the extraction of Sun’s energy or the conversion of Sun’s energy into Electrical Energy.The project involves developing of software for tracking through Microcontroller Unit. Two DC motors are used to get control in horizontal and vertical ones by using a Arduino Microcontroller Unit. Four LDR (Light Dependent Resistor) are used to collect the date of sun's intensity or irradiation.

Keywords: Solar panel, LDR sensors, Microcontroller, tracker, motor.

I. Introduction

Solar energy is a rapidly growing field in the renewable energy sector due to its abundant availability and environmental benefits. As the world continues to seek sustainable energy sources to combat climate change and reduce dependence on fossil fuels, solar power stands out as a promising solution. One of the key challenges in maximizing the efficiency of solar energy systems is ensuring that solar panels are always oriented towards the sun to capture the maximum amount of sunlight. This is where solar tracking systems play a crucial role.

Solar tracking systems are designed to adjust the orientation of solar panels to maximize their exposure to sunlight throughout the day. By continuously aligning the panels with the suns position, solar tracking systems can significantly enhance energy capture and conversion efficiency. Traditional fixed-mount solar panels operate at a fixed angle relative to the sun, resulting in suboptimal energy generation, especially during mornings, evenings, and seasonal variations. In contrast, dual-axis solar tracking systems enable panels to follow the sun's movement both horizontally (azimuth) and vertically (elevation).

The introduction of microcontroller-based solar tracking systems, such as Arduino Microcontroller, represents a significant advancement in solar energy technology. These systems leverage microcontrollers computational power and versatility to precisely control the movement of solar panels based on real-time environmental data. By integrating sensors such as Light Dependent Resistors (LDRs), microcontrollers can accurately determine the sun's position and adjust the orientation of the panels accordingly. This level of automation and precision enhances energy capture efficiency and maximizes the utilization of available solar resources.

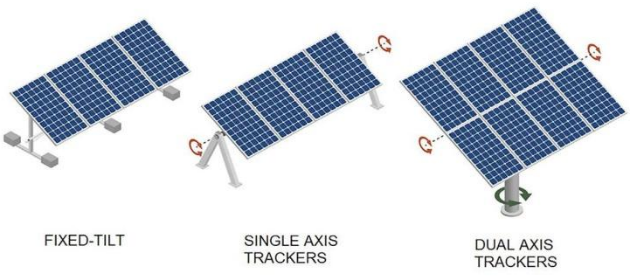


Fig-1. Different types of Solar Tracking Systems

II. System Design

As we see in the block diagram, there are four Light Dependent Resistors (LDRs) which are placed on a common plate with solar panel. Light from a source strikes on them by different amounts. Due to their inherent property of decreasing resistance with increasing incident light intensity, i.e. photoconductivity, the value of resistances of all the LDRs is not always same. Each LDR sends equivalent signal of their respective resistance value to the Microcontroller which is configured by required programming logic. The values are compared with each other by considering a particular LDR value as reference. One of the two dc servo motors is mechanically attached with the driving axle of the other one so that the former will move with rotation of the axle of latter one.

The axle of the former servo motor is used to drive a solar panel. These two-servo motors are arranged in such a way that the solar panel can move along X-axis as well as Y-axis. The microcontroller sends appropriate signals to the servo motors based on the input signals received from the LDRs. One servo motor is used for tracking along x-axis and the other is for y-axis tracking. In this way the solar tracking system is designed.

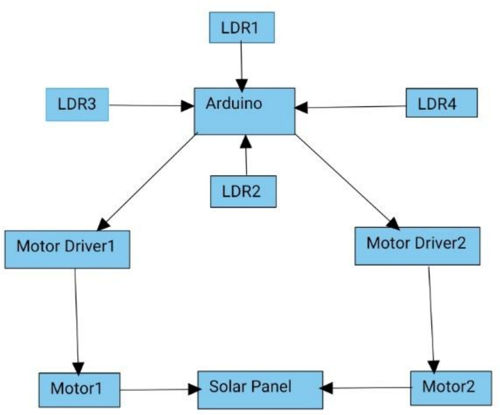


Fig-2 Block diagram of Dual Axis Solar Tracking System

III. Implemantation

A dual-axis solar tracker is a device that helps to maximize the amount of sunlight that a solar panel receives by automatically adjusting the position of the panel in two dimensions - azimuth (horizontal) and elevation (vertical). Here are the basic steps involved in the working of a dual-axis solar tracker:

1. **Light Sensors:** The tracker is equipped with light sensors that detect the intensity and direction of sunlight. These sensors are typically placed on top of the tracker or on the solar panel itself.
2. **Arduino:** Arduino is used to process the data from the light sensors and calculate the optimal position for the solar panel. The microcontroller then sends signals to the motors to adjust the position of the panel.
3. **Motors:** The tracker has two motors that move the panel in two dimensions. The azimuth motor rotates the panel horizontally to track the movement of the sun throughout the day, while the elevation motor tilts the panel vertically to account for the changing angle of the sun throughout the year.
4. **Power Supply:** The tracker is typically powered by a small solar panel or a battery. This ensures that the tracker can operate independently of the electrical grid.

Overall, a dual-axis solar tracker can significantly increase the efficiency of a solar panel by ensuring that it is always aligned with the sun. This can result in a higher output of electricity, which can be especially useful in remote areas or off grid applications

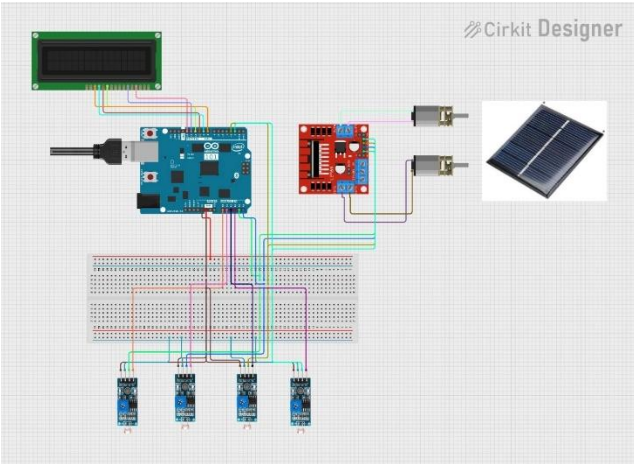


Fig-3: Circuit Diagram of Dual axis solar tracking system

The Arduino program works according to the following conditions:

If all four LDRs are HIGH:Do not send any signal to motors, system is receiving maximum sunlight

If both LDRS of RIGHT are HIGH:Rotate the system to the right to receive maximum sunlight.

If both IDRs of LEFT are HIGH:Rotate the system to the left to receive maximum sunlight

If both LDRs of TOP are HIGH:Rotate the system so that the solar panel rotates upwards to receive maximum sunlight

If both LDRs of BOTTOM are HIGH:Rotate the system so that the solar panel rotates downwards to receive maximum sunlight.

If TOP-LEFT LOR is HIGH:Rotate the system to the left and upwards using both motors simultaneously to receive maximum sunlight.

If BOTTOM-LEFT LOR IS HIGH:Rotate the system to the left and downwards using both motors simultaneously to receive maximum sunlight.

If TOP-RIGHT LOR IS HIGH:Rotate the system to the right and upwards using both motors simultaneously to receive maximum sunlight.

IF BOTTOM RIGHT LDR is HIGH:Rotate the system to the right and downwards using both motors simultaneously to receive maximum sunlight.

Else do not send any signal to the motor driver.

The system will receive maximum sunlight based on the above conditions. This will make solar power generation most efficient throughout the year.

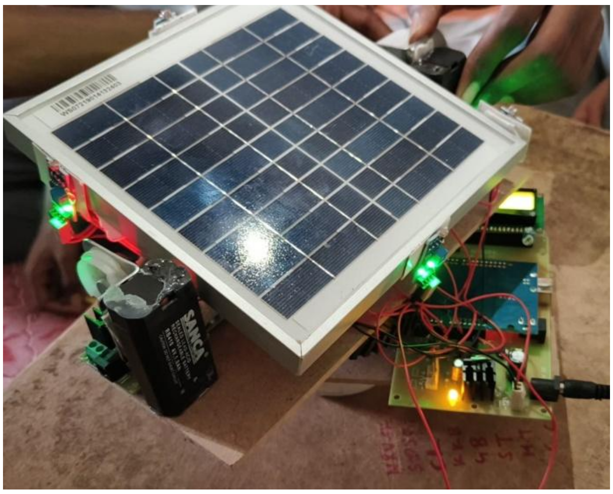


Fig-4: Prototype

IV. Result

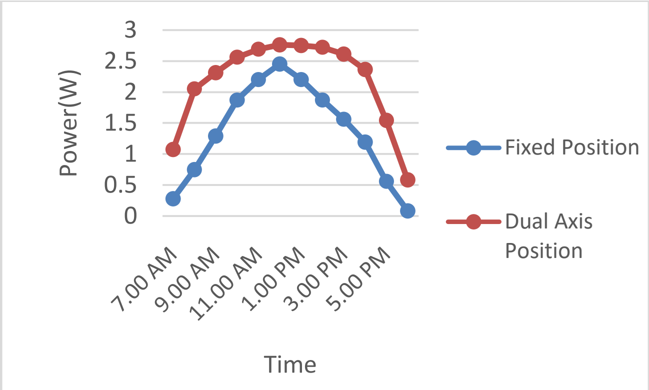
To determine the variation in solar panel production between fixed position and dual axis, the following tables and graphs will determine. Here 3W solar panel is used to examine the difference.

The tabular column shows the power production between the fixed position and dual axis position:

Time / Position	Fixed Position(W)	Dual Axis Position(W)
7.00 AM	0.28	1.07
8.00 AM	0.749	2.05
9.00 AM	1.29	2.31
10.00 AM	1.69	2.56
11.00 AM	2.07	2.69
12.00 PM	2.33	2.76
1.00 PM	2.2	2.75
2.00 PM	1.87	2.72
3.00 PM	1.56	2.61
4.00 PM	1.19	2.36
5.00 PM	0.56	1.54
6.00 PM	0.083	0.58

Table 1: power production of solar between fixed and dual axis

Graph-1 Difference between fixed and dual axis position



From the data in the table and graph, we examine that the efficiency of the solar panel has increased to 55-60%. So, we concluded that the fixed position solar has lower efficiency in the production of power compared to dual axis solar tracking system. With this the dual axis solar tracking system produce more power compared to other solar tracking systems, fixed position solar system.

V. Conclusion

The aim of this project was to design a dual axis tracking system which can sense the incident solar light on the panel and move it in the direction of maximum solar light incident. The tracking controller is implemented by means of Arduino microcontroller. The necessary software is developed via Arduino Uno IDE. In building the solar tracking system, LDRs (Light Dependent Resistors) are used to determine solar light intensity. The proposed solar tracking system can track sunlight automatically.

From this study the main conclusions are:

1. Proposed system is low cost and compact as compared to the other tracking systems in use for same application.
2. It is very easy to program and modify because it is Arduino based and no external programmer is required.
3. The designed system is automatic and provides better efficiency of the panel.
4. Reflection on the Solar panel has been decreased and, the efficiency of solar energy generation is increased.
5. Solar trackers are slightly more expensive than their stationary counterparts, due to the more complex

technology and moving parts necessary for their operation. But solar trackers generate more electricity in roughly the same amount of space needed for fixed tilt systems, making them ideal optimizing land usage.

The purpose of renewable energy from this paper offered new and advanced idea to help the people. It has been proved through previous research that solar tracking system with single-axis freedom can increase energy output by approximately 20%, whereas the tracking system with double axis freedom can increase the output by more than 40%. Therefore, this work in this paper is to develop and implement a dual-axis solar tracking system with both degree of freedom and the detection of the sunlight using sensors.

The proposed system is eco-friendly.

References

[1]. https://www.electroduino.com/dual-axis-solar-tracker-using-lm339-and-l293d-motor-driver-ic/.
[2]. Sun Tracking System-A Review,2009, 3875-3880 by C. Y. Lee, P. C. Chou, C. M.Chiang,and C. F. Lin.
[3]. Implementation of Solar Tracking Pilot Project, Global journal of Technology and Optimization, Vol-2, 2011 by N. Barsoum.
[4]. The Solar Tracking System by Using Digital Solar Position Sensor, American Journal of Engineering and applied sciences 3(4): 678-682, 2010.2nd edition by R. M. Osgood, Jr., Ed. Berlin, Germany: Springer Verlag, 1998.
[5]. Sun Tracking System with PLC Control for PV Panels, International Journal of Green Energy, by S. Cemil, (2007)
[6]. Optimum Design and Implementation of Tracking PV Power System based on Plc and Microcontroller, 14th international Middle East power system conference, Dec, 2011, paper ID-128 by O. Gouda, G. Amer, T. Elkhodary, and M. Awaad. The Design and Implementation of a Solar Tracking Generating Power.