DUAL AXIS SOLAR TRACKER

[1]Bharat Modi, [2]Mohit Agrawal, [3]Monika Jareda, [4]Pradhum Malhotra, [5]Shreya Meena

[1]Associate Professor, [2,3,4,5]Undergraduate Students
Department of Electrical Engineering,
Swami Keshvanand Institute of Technology Management and Gramothan,
Jaipur, Rajasthan, India.

***Abstract*: The world is now moving towards renewable energy sources due to various factors like pollution and the cost of non-renewable energy sources. One of the major renewable energy sources is Sun. In this paper, An Arduino-based Dual-axis solar tracking system is proposed to get maximum solar energy. The Arduino is used to give a command to rotate the solar panel. Solar trackers are used to improving the power gained from solar energy. Solar power changes due to the seasonal variation and tilting of the earth which changes the position of the sun in the sky. In this regard dual-axis, solar tracking is practically implemented and performance is compared with fixed mount and single-axis solar tracking systems. Finally, an experimental result evident that the proposed method gives better efficiency compared to fixed mount and single-axis solar tracking systems.**

***Keywords*: Renewable Energy, Photovoltaic Panel, Dual Axis Solar Tracker, Arduino, LDR, A Driver circuit, Solar power.**

1. INTRODUCTION

Fossil Fuels product that rules the energy area is on the edge of exhaustion. Moreover, the repercussion of over-dependence on non-renewable energy sources can be seen in the cost of fuel and the climate. It is bounteously accessible as perfect energy. Solar Tracker is an instrument that helps the solar panel to follow the direction of the sun. To utilize this renewable solar energy solar trackers are employed [1]. For the static solar panel, there is no movement in the panel. But the position of the sun changes during rising and setting (The sun rises in the east and sets in the west). Due to this reason, a single-axis solar tracker is developed for the rotation of solar panels in the east and west direction. But due to the rotation and revolution of the earth, we cannot get an equal amount of sun rays throughout the year. So that we adopted a dual -axis solar tracker to utilize the solar energy effectively and efficiently by rotating the panel in both horizontal and vertical directions. The main objective of the dual-axis solar tracker is to increase the efficiency of the solar panel by 30-45% when compared to the static and single-axis solar tracker. The literature survey clearly shows the different methods of solar tracking for maximum utilization of solar power [1-15].
The single-axis tracker can rotate only on horizontal (or) vertical. But this dual-axis tracker can rotate on both horizontal and vertical movement. This dual-axis solar tracker was implemented by using an Arduino board [2].

The Low cost of implementation by Arduino is the reason behind choosing Arduino for this project [3]. This was achieved even by using a microcontroller [4].

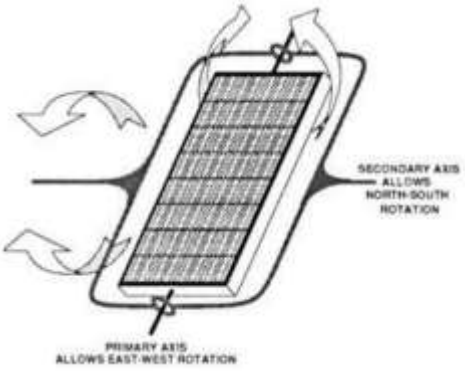

Figure.1 Mechanism of dual axis tracker

The above figure.1 shows the basic operating mechanism of the dual-axis solar tracker. It is an Azimuth-Altitude dual-axis solar tracker [5]. Altitude refers to the elevation of the angle between a substance and the observer's location. It is basically between the angles of 0-90◦. Zenith distance can also be used instead of altitude. Then azimuth is usually analyzed from the north and increases towards the east [6]. This is mainly employed to get the maximum efficiency when compared to the static and single-axis solar tracking system [7]. To achieve this, we used Arduino UNO, LDRs, DC motor, LCD, and solar panel. In [8] automatic solar tracking and two-axis, solar tracking is proposed in [9] for better solar tracking based on the position of the sun.

2. DUAL AXIS SOLAR TRACKER

The flow chart of our dual-axis solar tracker system is shown in Figure.2. It consists of PV Panel, LDR, DC motor, a Driver circuit, Arduino, and voltage source.

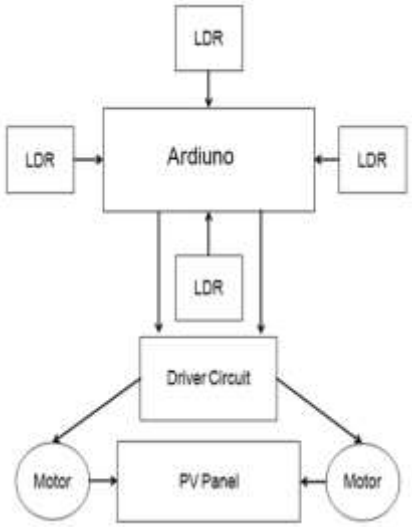

Figure.2. Block diagram of dual axis solar tracker

An input command is given to the Arduino board. Four LDRs are connected to the Solar Panel, which gives signals to the Arduino. The Arduino then gives a command to the driver circuit to rotate the solar panel in a vertical and horizontal direction.

3. WORKING

In our project, four LDRs used for sensing the intensity of light (Two for Azimuth position and the rest two for Altitude positive sensor). The analog signal from the sensors is given to the in-built ADC (Analog to Digital Converter) and light comparison unit. This output is given as an input to the Arduino board along with the input command. The output of the Arduino is given to the motor driving circuit. Two DC motors are connected with the driving circuit, one for vertical and another one for horizontal movement. The motor rotates the solar panel perpendicular to the position of the sun's rays. Then finally the output power is displayed on the LCD. In this project, the LDR combination plays an important role. The combination of signals is fed to the Arduino and this bit pattern is shown in table 1.

Table.1 Desired Bit Pattern

LDR 1	LDR 2	LDR 3	LDR 4
1	1	0	0
0	1	1	0
0	0	1	1
1	0	0	1

When the motor gets the last bit pattern in the table 1, the motor will move the panel to its initial position and again follow these steps, when sun starts rising in the next day. Even a load is taken from the solar panel by connecting the panel with battery and inverter. The battery is used to store and give the DC supply to the inverter, which is taken from the solar panel. Then the output DC supply was given to the inverter which converts DC to AC. Then a load is connected along with it. This function is represented in the Figure.3 which is shown below.

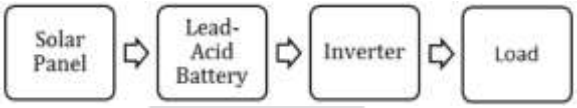

Figure.3 Block diagram of Output side of solar panel

The major components which are used in dual axis solar tracking system are:

1. Solar panel
2. Arduino board
3. LDRs
4. Motor driver
5. DC motor
6. Lead Acid battery
7. Inverter

3.1 Solar Panel

The solar panel works based on the principle of photovoltaic effect which converts the solar energy into electrical energy [10]. There are various types of panels are available like monocrystalline, polycrystalline, amorphous, and hybrid. In this project we use 40W 12V amorphous solar panel is considered.

The Amorphous solar panel was shown in above Figure.4. The cost and silicon requirement of amorphous panel is low when compared with the other types of solar panel.

Figure.4 Solar Panel

3.2 ARDUINO

We presented an Arduino-based Dual Axis Solar Tracker [11] in our project. The Arduino board unit controls the rotation of a solar panel that follows the sun's path [12]. A number of microcontrollers and controllers are used on the Arduino board. Both analogue and digital input/output are available. There are 14 digital input/output pins (six of which are utilised as PWM outputs), six analogue inputs, a 16 MHz crystal oscillator, a USB connection, a power button, and a reset button. Using the Integrated Development Environment platform, the input command was sent to the Arduino. Because it does not employ the FTDI USB-to-serial driver chip, the Arduino Uno differs from all previous boards. Instead, it uses an ATmega8U2 that has been coded as a USB-to-serial converter.

The Arduino board was shown in Figure.5:

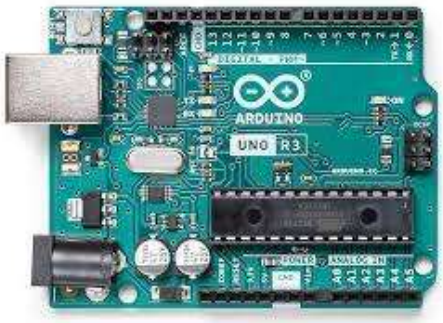

Figure.5. Arduino Board

The specifications of Arduino board are listed in table.2 below:

Table.2 Arduino Uno specifications

Parameters of microcontroller	ATmega328
Operating Voltage	5V
Supply Voltage	7-12V
Maximum supply Voltage	20 V
Digital I/O pins	14
Analog Input Pins	6
DC Current per I/O Pin	40mA
DC Current for 3.3V Pin	50mA
Flash Memory	32KB of which 0.5KB used by boot loader
SRAM	2KB
EEPROM	1KB
Clock Speed	16MHz

3.3 ADVANTAGES

The advantages of tracking solar energy among various sources are:

- ❖ Dual-axis trackers follow the Sun continually and provide constant power output throughout the day.
- ❖ These solar trackers provide a reasonable solution in cases of the limited power capacity of the connection to the grid.
- ❖ Dual-axis trackers need smaller space and provide an opportunity to use the remaining area around for other additional purposes such as car parking, gardening, and others.
- ❖ These trackers generate 45-50% higher power output per year, as compared to a static station of the same installed capacity.

4. Result and Discussion

This section presents and discuss the performance of different tracking system and proposed system concerning a different period time in a day.

Table.3 Output power obtained in Fixed Mount, single-axis and dual axis

Hours	Power for Fixed Mount in W	Power for Single-Axis in W	Power for Dual-Axis in W
07.00	0.09	0.35	0.68
08.00	0.25	0.47	0.87
09.00	0.75	1.02	1.55
10.00	0.98	1.23	1.78
11.00	1.58	2.24	2.86
12.00	2.5	3.1	3.15
13.00	2.22	2.54	2.98
14.00	1.88	2.11	2.44
15.00	1.58	1.86	2.30
16.00	1.56	1.57	2.01
17.00	0.78	0.98	1.56
18.00	0.44	0.65	0.78
Sum=12hrs	Sum=14.61W	Sum=18.25W	Sum=22.96W
All Day Solar Energy Output	**0.6087 W/hr**	**0.7604 W/hr**	**0.9566 W/hr**

The power tracking of solar panel with different positions are tabulated above in table 3. It is evident that the proposed dual-axis tracker perfectly aligns with the sun's direction and tracks the sun's movement more efficiently and has a tremendous performance improvement. The experimental results clearly show that dual-axis tracker is superior to single-axis tracker and fixed systems. Power Captured by the dual-axis solar tracker is high during the whole observation period and it maximizes the conversion of solar irradiance into electrical energy output as shown in the table.3. As a result, it creates a solution for the effective utilization of solar energy and thus helps in creating smart houses.

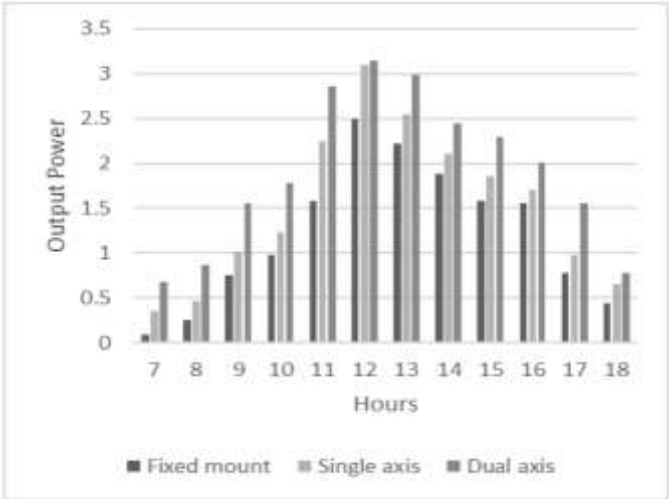

Figure.6 Bar Chart comparison for different tracking system

A bar chart comparison of solar power with different tracking methods is shown above in figure.6. It is clearly showing that the proposed method yields better output power compared to an existing method.

5. CONCLUSION

The Arduino-based dual-axis solar tracking-based solar panel is designed and successfully implemented to increase the efficiency of the solar panel. The proposed dual-axis solar tracker is more effective than the existing single-axis solar tracker and fixed mount. The proposed solar tracker which automatically tracks the sun to grab maximum solar power with the help of the Arduino board was effectively achieved. The implementation cost of the Arduino board for tracking solar power is low and it is implementation is simple. Finally, the experimental system reveals that the proposed system effectively tracks the sun in both good and bad weather conditions. During different periods in a day compared with the existing system and efficiency of a solar panel is effectively improved.

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