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Dual Axis Solar Power Tracking System

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ABSTRACT

In the current world, electrical energy has surpassed all other important resources. However, it still hasn't been able to reach every corner of the globe, mainly rural places. Energy production has also come under threat from the quick depletion of fossil fuels and greenhouse gas emissions. As a result, finding other methods of energy generation is crucial. Solar energy is the greatest underutilized renewable energy source and has the potential to meet all of our energy needs entirely. Using solar photovoltaic panels allows for easy exercise. However, it has been noted that the majority of solar panels are positioned at fixed angles. The solar tracking device is used to keep the solar panel towards the sun throughout the day in order to capture as much incident solar energy as possible, increasing the system's performance ratio. The Dual Axis Solar Power Tracker, which combines software programming for the microcontroller unit with hardware design and implementation, can be used to accomplish this. To move two DC gear motors, which spin the solar panel in two axes, the system used an ATmega328P microcontroller. The microprocessor estimates rotating speed based on data collected from four light sensing sensors that are placed strategically close to a solar panel. As a result, solar panels are able to provide more output power.

Key words: Dual Axis, Photo sensors, Renewable energy Microcontroller, Solar photovoltaic panels.

1. INTRODUCTION

The unavoidable limitation of fossil fuel resources has made renewable energy sources a hot topic for researchers, technologists, investors, and decision-makers on global scale. One of the most readily available sources of these energy types is solar photovoltaic (PV) energy. In the majority of countries, it is generally accessible from sunrise to dusk. Despite the benefits, solar PV energy is still a long way from displacing existing conventional sources.

Maximizing the power output of PV systems in places with little solar radiation is still a challenge. Due to the sunlight's varying spatial distribution, the quantity of energy that quite possibly generated from solar sources, mainly utilizing solar panels which are fixed in nature, is constrained. It is essential to make sure that the solar panel's surface is always in direct contact with the incident sun's rays in order to maximize the quantity of electricity generated from solar energy. The need for a system which can track energy is to increase the use of solar energy during the day is obvious given that the electricity generated by solar energy systems is largely dependent on the quantity of solar energy caught by the solar Photo Voltaic modules.

By tracking the sun's path throughout the entire year, a solar tracker increases the. The photo sensors are in charge of differentiating the location of the sun and transmitting electrical impulses proportionate to the microcontroller's error, that activates the motors to follow the sun. The key goal is to keep the solar Photo Voltaic panel parallel to the sun the entire day for maximizing energy production. A dual axis solar tracking system can boost solar cell efficiency. It is possible to minimize the catastrophic issue of pollution that negatively impacts both the biotic and abiotic components of our home by employing solar energy as the main source of power generation.

Due to their higher efficiency and lower negative effects, dual axis solar tracking systems can be a smart choice for the intermediary future. Compared to stationary systems, solar tracking systems enhance electricity output by between 30% and 60%. They are mechanized to follow the position of the sun and align perpendicularly. The dual axis tracking system, which is specially designed on sensor-based technology, does away with periodic human programming.

2. RELATED WORKS

K.S. Madhu [1] indicate that a dual-axis tracker follows the daily east-to-west movement of the sun as well as the seasonal declination movement of the sun in their article submitted to the International Journal of Scientific & Engineering Research, vol. 3, 2229-5518, in 2012. The single-axis tracker tracks the sun's movement from east to west. In order to concentrate a huge region of sunlight into a small beam, concentrated solar power systems use lenses, mirrors, and tracking devices. PV uses the photoelectric phenomenon to transform light into electrical current. The action of converting sunlight into electricity is referred to as solar power. According to test data, tracking solar panels have an increased power efficiency of 26 to 38% during typical days compared to fixed solar panels. Additionally, it changes at any level on days that are gloomy or rainy.

Abdallah [2] (2008) developed a computerized system to track the sun's movement and rotate the solar still in accordance with it. The contrast between fixed and sun-tracked solar stills was displayed by the researcher. Because there was a 2% gain in efficiency, productivity improved by about 22% when sun monitoring was used. By employing the sun tracker, the water's thermal capacity decreases and its temperature rises. Both the evaporation rate and the distillation rate rise as a result.

Balabel [3] (2013) optimized the operational efficiency of a solar photovoltaic module using mathematical analysis. On control system design and testing, he concentrated. The study's calculations of the altitude angle at Taif, Saudi Arabia, served as its foundation. According to how it is managed, the researcher demonstrated that the sun tracking algorithm might be classified into closed-loop and open-loop systems.

Kancevica [4] (2012) pointed out the distinction between a stationary collector and a solar tracking device. The author highlighted how, in a solar tracking device, flat plate collectors were impacted perpendicularly by solar radiation as opposed to stationary collectors of the same size. On average, 1.4 times more heat energy was produced.

3. THE PROPOSED MODEL

LDRs (light dependent resistors) are mounted on a plate that also houses the solar panel. The value of the resistances of each LDR varies due to their inherent photoconductivity, which causes their resistance to decrease as incident light intensity rises. Each LDR transmits an equivalent signal to the microcontroller, which is programmed with necessary logic, based on resistance value of each device. By using a certain reference value from the LDR, the values are contrasted with one another. One of the two dc motors driving axles is spontaneously joined to the other's axle so that the latter can spin as the former travels.

The photovoltaic cell is driven by axle of the previous dc motor. The configuration of these two DC motors allows the photovoltaic cell to move to both the X and Y axes. Based on the input signals obtained from the LDRs, the microcontroller provides the proper actions to DC motors. The x-axis tracking is done with one dc motor, and the y-axis tracking is done with the other.

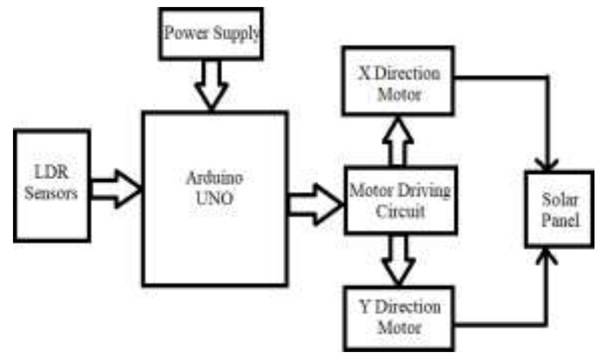

Figure 1: Block Diagram of Proposed system

Figure 1 shows block diagram of proposed system I which the project's primary parts are an Arduino Uno, DC Motors, Motor Driver, Solar Panel, Power Supply, Resistors, Bread Board, and LDR. Mechanical and electrical systems make up the system as a whole. The support, motor, and shaft each have a solar panel attached. As opposed to the sensors, microcontroller, and adapter that make up the electrical system.

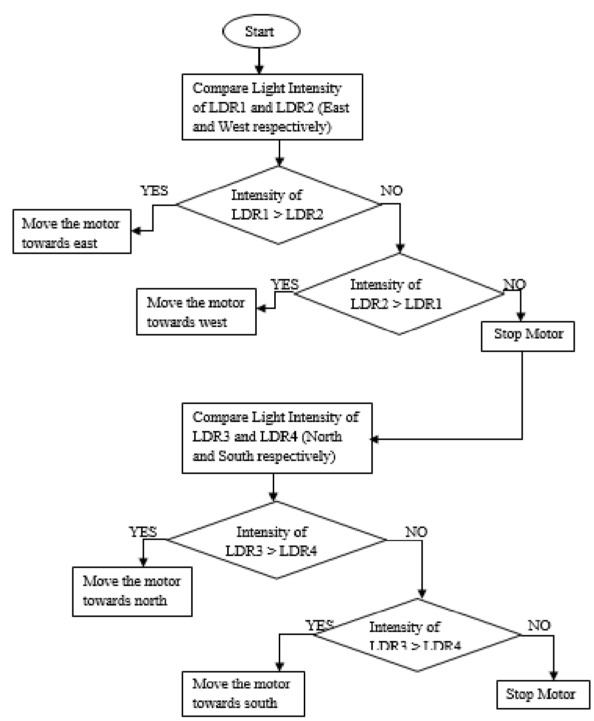

Figure 2: Flow Chart of Proposed system

Four sensors that are further coupled to the Arduino microcontroller monitor light intensity. The microprocessor then communicates the sun direction to the dc gear motors.

The PV panel is then rotated towards the sun using the motor and shaft combination system. Figure 2 shows the flow chart of proposed system in which the comparison is made between the North and South directions' LDR intensities. The panel will revolve towards the east if the North LDR intensity is greater, towards the south if it is not, and cease moving altogether if it is neither.

The sun moves from low in the winter sky to too high in the summer as the seasons change. As a result, two-axis tracking is required to accurately track the sun because its azimuth and altitude angles are always changing. LDR resistance fluctuates according to light intensity and is dependent on it. Low light intensity causes the LDR resistance to increase, increasing the output voltage. Conversely, when the light intensity is high, the LDR resistance is lower and a lower output voltage is obtained.

4. RESULTS

4.1 Analysis 1:

Table 1: Power Gain on a Sunny Day

Time	Static Power(W)	Dual Power(W)	Power Gain(%)
7 am	9.34	11.92	27.62
8 am	9.85	12.46	27.01
9 am	10.41	12.82	22.77
10 am	11.25	12.61	12.58
11 am	11.78	12.92	9.67
12 pm	12.82	13.11	2.10
1 pm	13.03	13.28	1.99
2 pm	13.12	13.45	2.13
3 pm	12.65	13.26	4.98
4 pm	11.62	12.54	8.01
5 pm	10.85	11.96	10.33
6 pm	9.92	10.44	5.39

In the table 1, the values of static and dual axis power obtained on a sunny day. Power gain is further calculated.

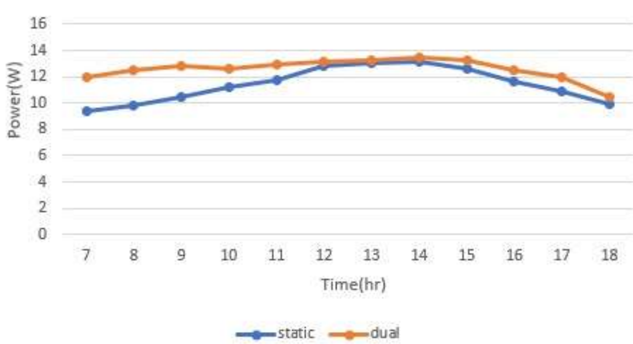

Figure 3: Time vs Power Graph for Analysis 1

From the figure 3, time vs power graph for analysis 1 can be observed.

4.2 Analysis 2

Table 2: Power Gain on a Rainy Day

Time	Static Power(W)	Dual Power(W)	Power Gain(%)
7 am	9.16	11.28	23.15
8 am	9.87	12.05	22.08
9 am	10.35	12.62	21.93
10 am	10.95	13.03	18.99
11 am	11.43	13.23	15.74
12 pm	12.92	13.19	2.08
1 pm	13.58	13.72	1.03
2 pm	10.27	11.15	8.56
3 pm	7.27	7.93	9.07
4 pm	6.83	6.91	1.17
5 pm	7.15	7.32	2.37
6 pm	6.57	7.21	9.74

In the table 2, the values of static and dual axis power obtained on a rainy day. Power gain is further calculated.

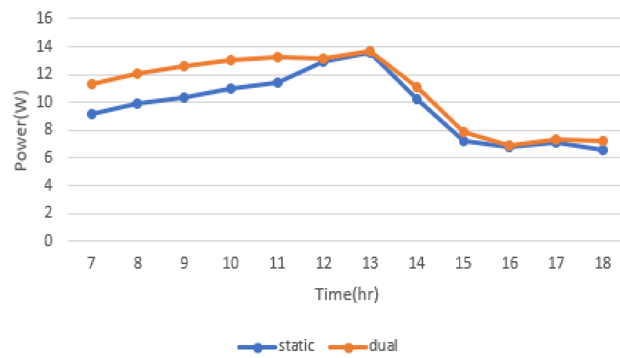

Figure 4: Time vs Power Gain Graph for Analysis 2

From the figure 4, time vs power graph for analysis 2 can be observed.

4.3 Analysis 3

Table 3: Power Gain on a Super Sunny Day

Time	Static Power(W)	Dual power(W)	Power Gain(%)
7 am	9.52	12.48	31.09
8 am	9.91	12.87	29.86
9 am	10.35	13.46	30.04
10 am	10.71	13.43	28.19
11 am	11.24	13.87	23.39
12 pm	12.81	13.15	2.65
1 pm	13.87	13.89	0.14
2pm	13.95	14.21	1.86
3 pm	13.47	13.65	1.32
4 pm	12.61	13.02	3.25
5 pm	11.74	12,37	5.36
6 pm	9.83	12.28	24.92

In the table 3, the values of static and dual axis power obtained on a super sunny day. Power gain is further calculated.

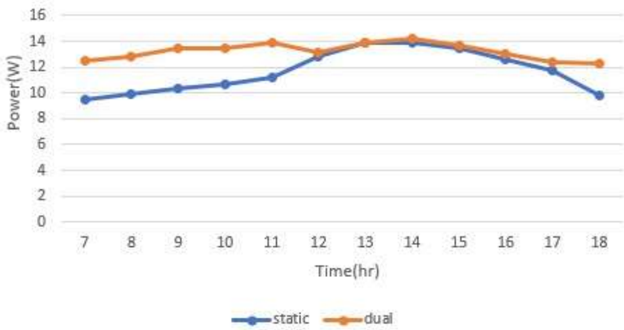

Figure 5: Time vs Power Gain Graph for Analysis 3

From the figure 5, time vs power graph for analysis 3 can be observed.

From the above mentioned 3 analyses, it is shown that during the afternoon i.e., from 12 pm to 2 pm, the power gain is less compared to the early morning or the evening time of the day. The power gain is less because the static solar panel and dual solar panel face the sun in the same direction, when it comes to the morning and evening times of the day, the power gain is more because the solar panel of dual axis solar tracker rotates accordingly with sun whereas static solar panel doesn't rotate accordingly with the sun.

Table 4:
Power and Efficiency in Different Weather Conditions

	Dual Axis Average Power(W)	Static panel Average Power(W)	Efficiency (%)
Super Sunny Day	12.56	11.36	11
Sunny Day	10.80	9.69	10
Rainy Day	13.23	11.66	12.05

From the table 4 we can see the power and efficiency calculated in the different weather conditions.

5. CONCLUSION

Using an Arduino UNO microcontroller and LDR sensors, the Dual Axis Solar Power Tracker is designed and developed. The main purpose in implementing of Dual axis Solar Power tracker is to increase the efficiency when compared to Static Solar panel.

The analysis is taken in different weather conditions, in which at every weather condition the efficiency is calculated. According to the analysis, it is observed that at higher temperatures the efficiency of dual axis solar tracker is way more than the efficiency at lower temperatures. On a super sunny day where the efficiency is observed highest, the efficiency of the dual axis solar tracker compared to the solar panel which is in static position is 12.05%, which is taken in the month of April. On a windy day where the efficiency is observed is lowest i.e., 7%.

On conclusion, it is observed that Dual axis Solar Power tracker gives efficient power when compared to Static Solar Power tracker either on a windy or a sunny day.

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