



DUAL AXIS SOLAR TRACKING SYSTEM

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ABSTRACT

This paper presents the design and construction of a dual axis solar tracker based on the PIC18F2620 microcontroller. The tracker makes use of four LDRs separated by an opaque object to read the intensity of the sun. Depending on the values of the LDRs, the microcontroller controls two geared DC motors to provide rotational movement. One of the motors moves the PV panel from east to west while the other moves along the north- south plane. When the intensity of the sun is higher on one LDR when compared to the rest, it moves towards the direction. Also, when the light intensity is very low in all the LDRs, it would move back to the east. The output power of the tracker was measured and compared with that of a fixed system. Its result showed that there was a significant increase in the efficiency when the solar tracker was used.

1. INTRODUCTION

With the unavoidable reduction of fossil fuel sources in Nigeria and around the world, renewable types of energy have become a topic of interest for researchers, technicians, investors and decision makers. Various types of energy sources that are getting attention include bioenergy, hydroelectricity, solar, geothermal, wind energy, tidal power and wave power. Their renewability has made them a favorable replacement for fossil fuel sources. Among these types of energy sources, solar photovoltaic (PV) energy is the most available. Nowadays, this technology has been adopted more widely for residential use, as more research and development activities are going on to improve solar cells' performance and lower the cost.

The world capacity for PV has grown at 49% per year on average since early 2000s (iea.org,

2017). Although its deployment in some countries is quite low and not sustaining, solar PV energy is expected to become a major source of power in the future. Despite the advantages, solar PV energy is still far from changing the traditional sources in the market. It is still a challenge to maximize power output of PV systems in areas that do not receive large amount of solar radiation. Solar tracking is a possible approach to make solar PV power further efficient, thus being a dependable choice for customers. This paper shows the development of such promising technology. One method of increasing the efficiency of a PV cell is to maximize the duration of exposure to sunlight. Tracking systems are usually used to achieve this by keeping PV solar panels aligned at an appropriate angle with the sun rays at any given time. This method can be used for any solar energy system in practice.

In a calendar year, the position of the sun with

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respect to that of the earth changes in a cyclic manner. The main purpose of a solar tracking system is to track the position of the sun in order to expose PV solar panel to maximum radiation at any given time (Chaiko, 2008).

Over the years, various energy companies and research institutions have been carrying out solar tracking for improving the efficiency of PV solar energy production. For the fixed PV system, it cannot track the movement of the sun and hence low power output, the single axis can only track the sun west-east, whereas the dual axis tracks both east-west and north-south.

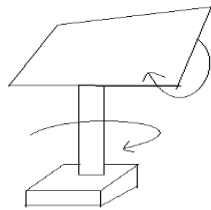


Figure 1: A Dual Axis Solar Tracker

Energy production from PV systems increase by up to 40% when trackers are employed. The cost of such tracking systems are however still very expensive for the average consumer or for a small-scale application. This current work shows that a similar system can be designed at a much lower cost. In addition, the solar trackers currently available are generally not programmable for location flexibility. Moving a system from the northern hemisphere to the southern hemisphere, coupled with the latitudinal and longitudinal position changes, can result in considerable design changes to the trackers control circuitry.

1.1 Components

The underlisted components were used in the

construction of the dual axis solar tracker.

- Solar panel
- Battery
- Charge controller
- Dc motor
- Light dependent resistor
- Microcontroller
- Motor driver

2. EXPERIMENTAL SETUP

The dual axes solar tracker is meant to move in all directions (both vertical and horizontal axes). Four LDRs are used as the sensors, an opaque object is used to separate these sensors and is placed on the solar panel.

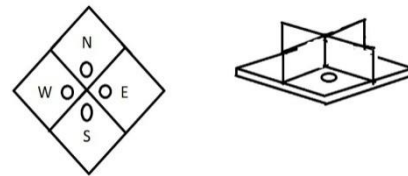


Figure 2: LDR Placements

The microcontroller being the brainbox communicates and receives signals from the system. Since the sensors respond to intensity of light and give out analog readings, they have to be converted to digital. The 10-bit ADC present in the PIC18F2620 IC carries out this conversion. Figure 3 and Figure 4 shows the block diagram and flow chart of the system respectively.

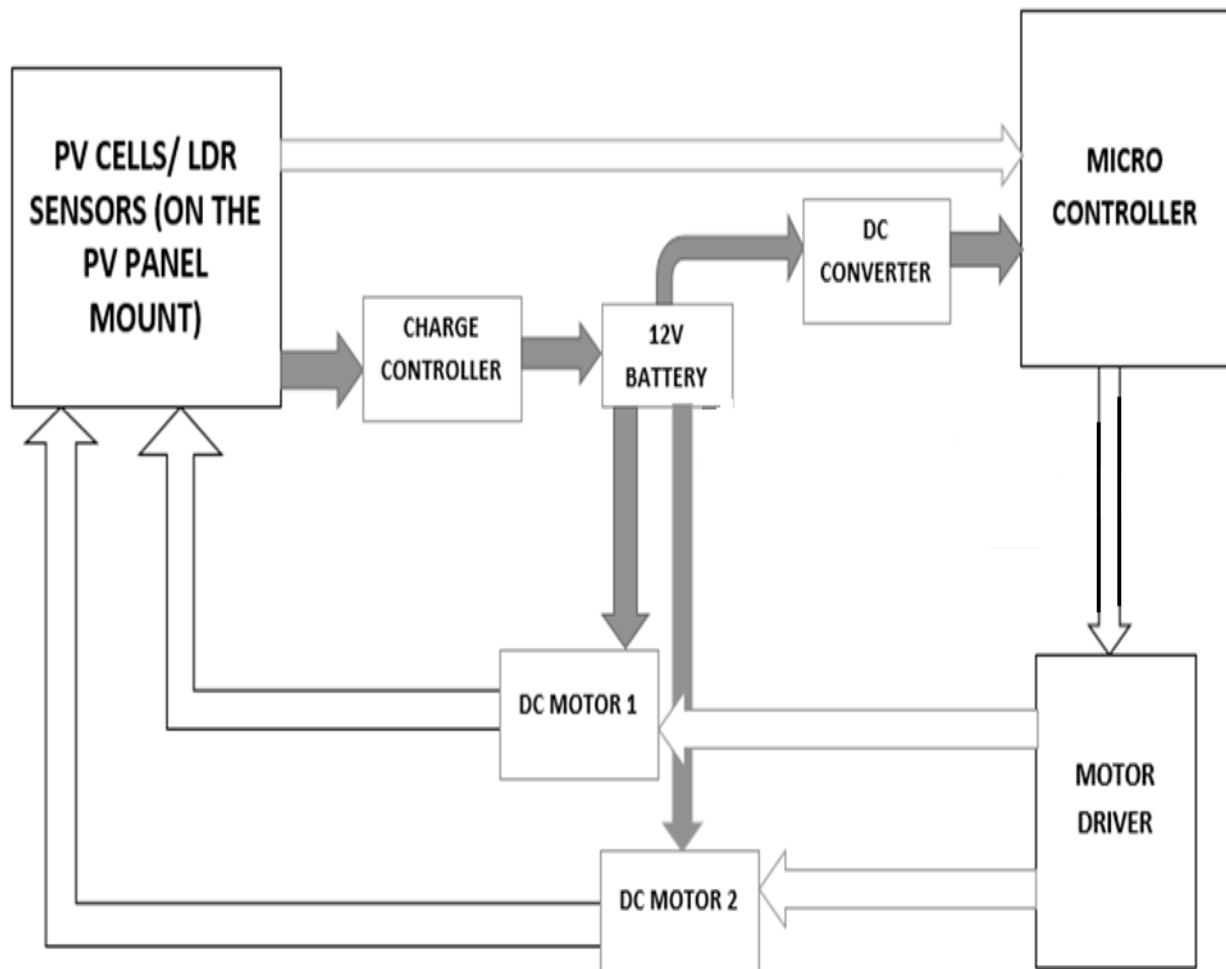


Figure 3: Block Diagram

The two comparators present in the microcontroller compare the converted signals of the four sensors. The motors, depending on the readings from the sensors and the existing algorithm, are then powered by the relay driver to achieve its tilt and rotate adjustment for optimum sunlight. Since it is dual axis, for every comparison done, adjustment is made

vertically before it is horizontally adjusted. This process continues until it is inclined in a way that each perpendicular LDRs receive similar amount of sunlight. Figure 5 shows the circuitry diagram of the system. The proposed model for the dual axis solar tracker is shown in figure 6.

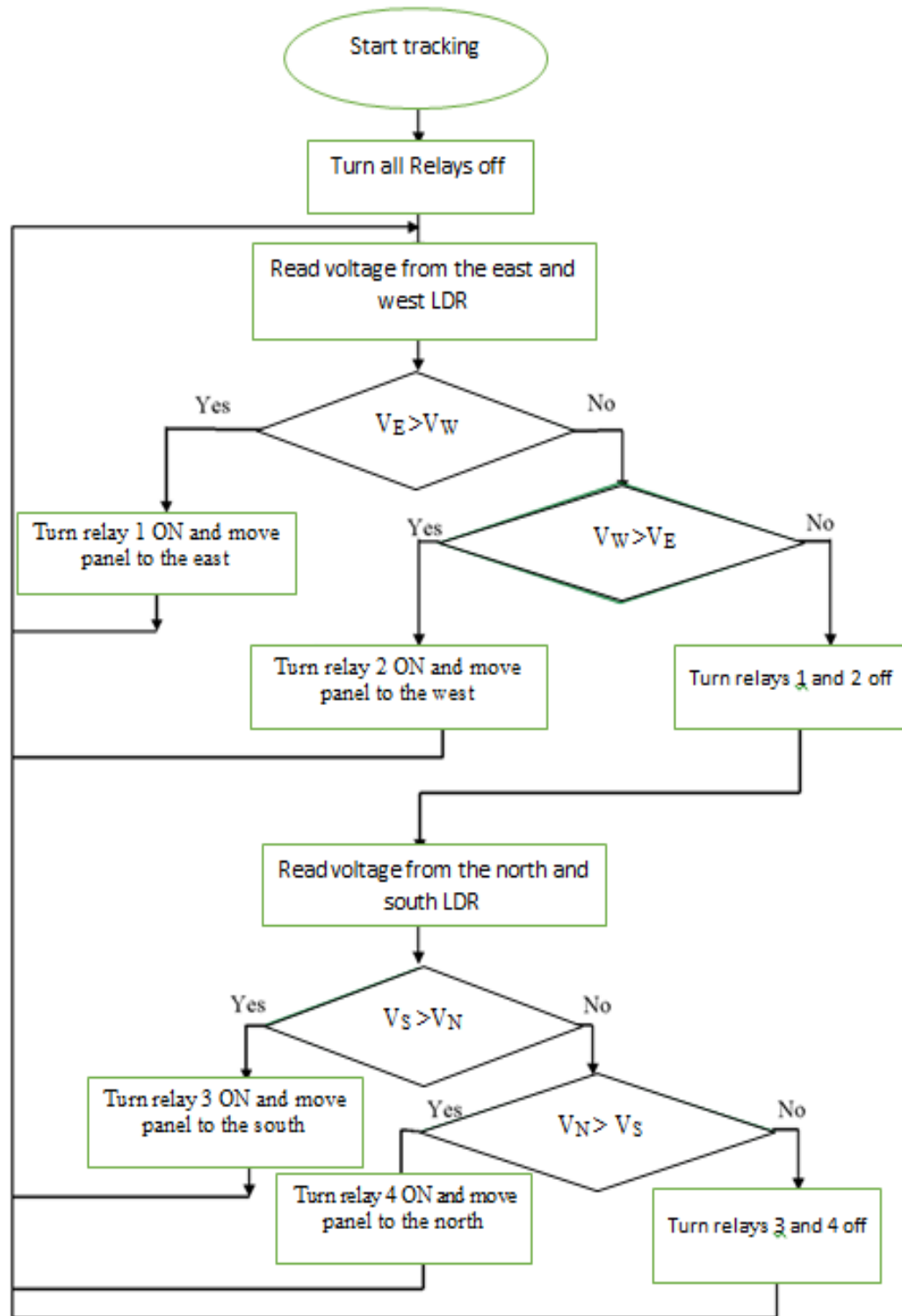


Figure 4: Flow Chart

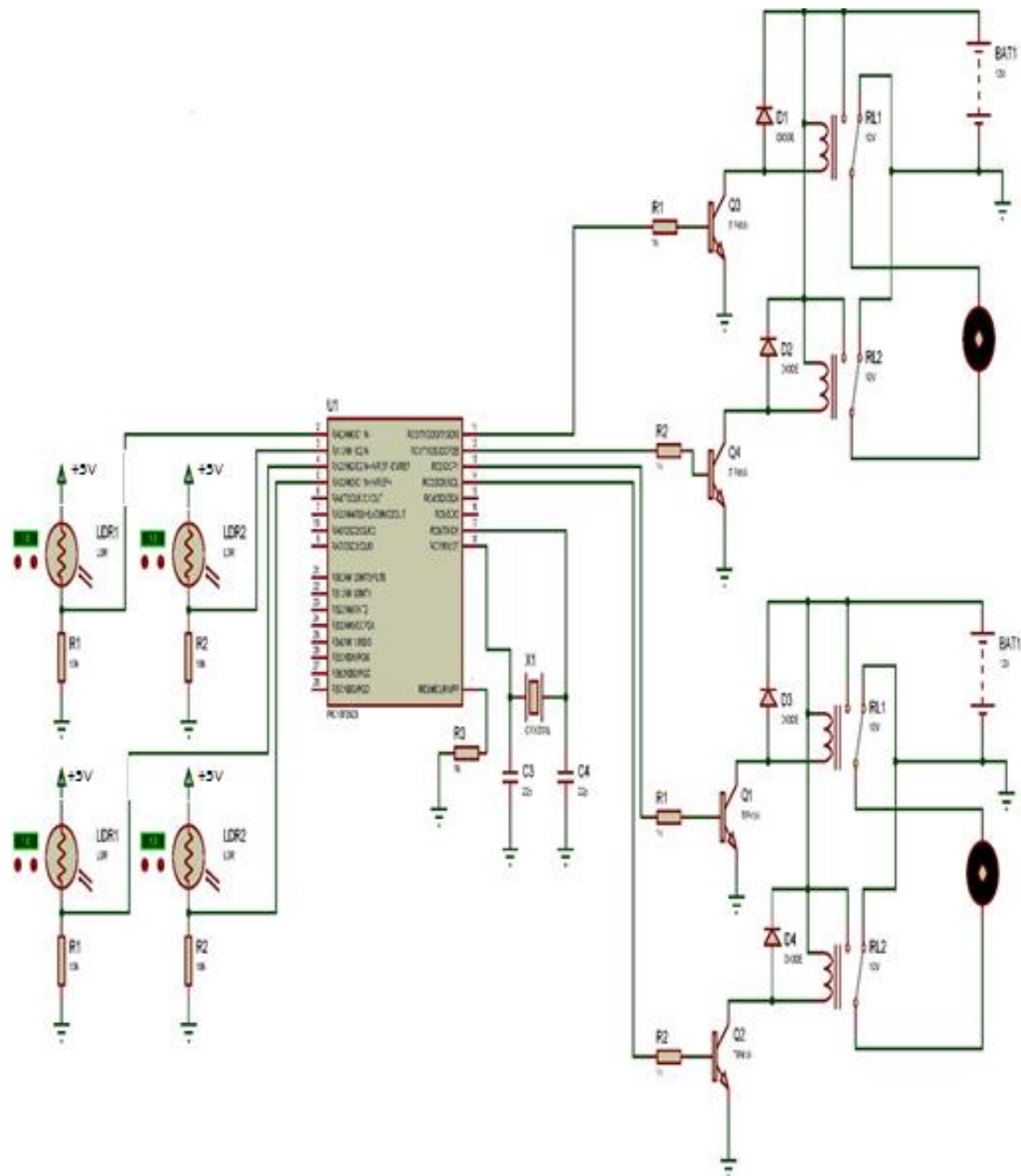




Figure 6: The Proposed model

3. EXPERIMENTAL RESULTS

The device was able to detect and follow the movement of an observable light source. This applied for both indoor light (from a lamp) and outdoor light (sunlight). The wiper motors were able to move the array so well, which enabled a wide range of rotation for the PV panel as expected. With the help of the dual axis solar tracker, there was noticeable increase in the efficiency of the system.

Two solar PV panels having the same specification were used to collect data. One was fixed and other was with the solar tracker.

Table 1 shows the power output comparison from a fixed solar panel and a dual axis solar tracker. Figure 7 is a graph comparing the output power of a fixed panel and dual axis solar tracker.

In November 2018, another set of values were

taken, showing the output power from the dual axis solar tracker two consecutive days. The results obtained are showed in Table 2 and Table 3.

The tracker system excelled over fixed mount system as the testing time shifted to the end of the day. While the fixed mount system had losses due to its misalignment, the dual axis solar tracker system still was able to convert a considerable amount of solar energy.

Table 1: Output power comparison between a fixed panel and dual axis solar tracker

Time	Power From Fixed Panel(W)	Power From Dual Axis Solar Tracker(W)
11:00	35.89	47.83
12:00	72.73	113.3
13:00	28.75	34.81
14:00	75.50	76.43
15:00	59.50	62.71
16:00	48.77	54.36
17:00	36.96	41.82
18:00	27.72	32.79

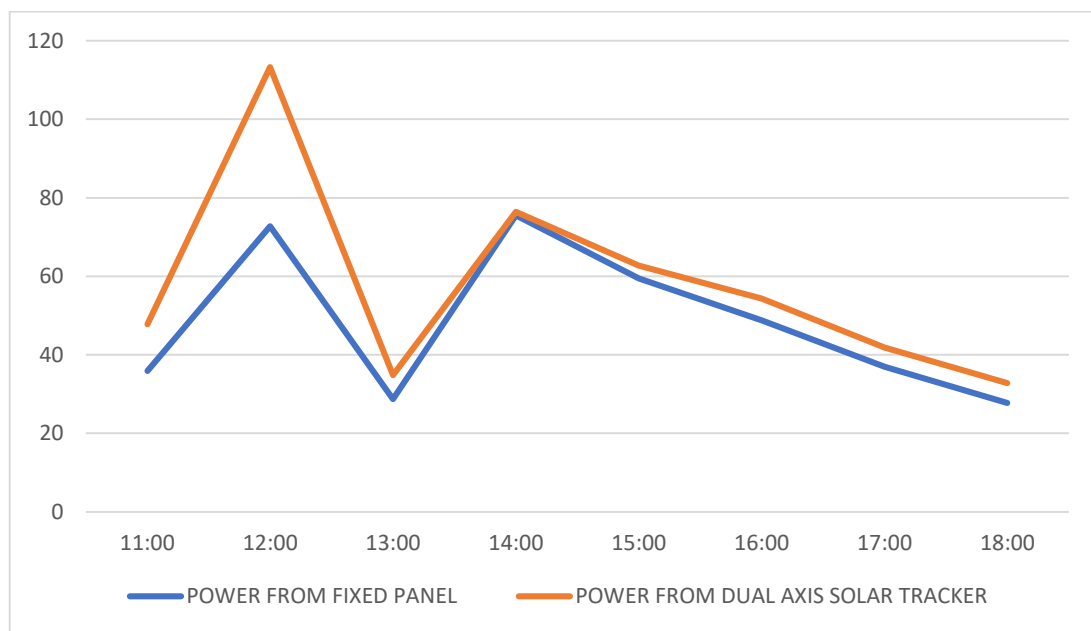


Figure 7 Output Comparison of Solar Tracker Configurations

Table 2: Result obtained on the 12/11/2018.

Time	Voltage (V)	Current (A)
10:00	15.60	5.46
11:00	13.46	3.30
12:00	16.79	5.90
13:00	017.88	6.61
14:00	14.21	5.41
15:00	13.20	2.89
16:00	13.33	3.01

Table 3: Results obtained on the 13/11/2018.

Time	Voltage (V)	Current (A)
10:00	16.81	6.14
11:00	18.06	7.20
12:00	18.00	7.04
13:00	17.81	6.50
14:00	17.90	6.67
15:00	13.41	3.12
16:00	12.80	2.42

4. CONCLUSION

This research work was geared towards the design and implementation of a self-sustaining tilt and rotate dual-axis solar tracker with basic tracking functions. From the results obtained as presented in Table 1, it is clear that the conceptualized dual axis solar tracker was achievable and obvious that the dual axis solar tracker is more efficient than the fixed solar system.

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