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AN OVERVIEW OF SINGLE AXIS SOLAR TRACKER

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ABSTRACT
In this paper, we have given an overview of Single-Axis solar tracker. Since there is a severe energy crisis right now, and we know that solar tracker is one the biggest invention of mankind in which single axis solar tracker plays a very important role. With limited amount of time left for non-renewable energy sources, people are moving towards renewable energy sources and energy from the core of the sun is the safest yet economical method till discovered. The main goal of this project is to increase the power we are drawing from the sun. The project consists of a servo motor, LDR sensor, a PCB (Printed circuit board); capacitor, resistance of 1 kilohm and 10kilohm, heat sink and a mini-Arduino, two batteries of 3.4 volts each and two solar panel of 3 volts each. What solar tracker do is it rotates the solar panel in a fixed direction in which it is fixed and then it stops at the maximum intensity position with the help of LDR sensor and the solar panel utilizes the sunrays with full capacity and give better results than the stationary or fixed solar panel. The project is compared with stationary solar panel and the results shows that the solar panel fixed with solar tracker provides more energy than fixed solar panel.

Keywords:
Renewable Energy, Fossil fuels, Mini-Arduino, Tracker, Servo motor, LDR sensor, Batteries, Efficiency

I. INTRODUCTION

Since the industrial revolution, fossil fuels are the only energy source dominating every other source across the globe. This has major implications for the global climate, as well as for human health [3]. Renewable energy sources were only the answers to these fatal ones. The amount of sunlight that strikes earth surface in an hour, out of which only half part of that energy is enough to handle overall world's energy consumption. The photovoltaic solar cells convert sunlight directly into electricity with the help of an effect called photovoltaic effect. Need of solar power is increasing day by day and why not. Today it provides light; it provides sustainable energy system that allows development without risking nature and future generations. But is it that much reliable? If it is, then, why people are not focused on this

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method more and why we won't see solar panels in each and every household. The answer to these questions is based on the fact that the overall picture is not as good as it seems to be, the economics of generating solar power is a severe drawback and till now the efficiency levels is not quite satisfactory. Till now scientists have hold their attention only onsingle-crystalsilicon cells, the efficiency of which is very low. Extensive research based on non-silicon-basedcells need of the hour as fossil fuels like petrol will be exhausted soon [19]. So, what could be done to possibly increase the efficiency of silicon based solar panels? This is the case where Solar tracker enters the discussion, it is proven that to maximum the efficiency of solar panel it is necessary to hold the perpendicular position to the sun rays.

There are mainly two types of Solar Tracker:

1. Single Axis Solar Tracker (SAST): SAST only rotates in one direction and requires only one servo motor. A single axis solar tracker as shown in Fig.1 improves the solar power 25% from the fixed solar panel. It is adjusted every month or so seasonal changes for sun's position.

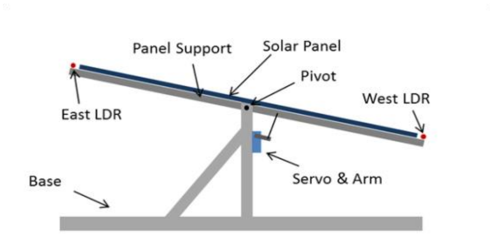

Figure 1: Single Axis Solar Tracker

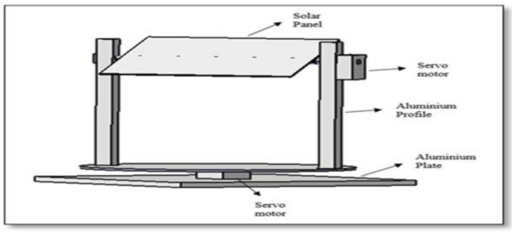

Figure 2: Dual Axis Solar Tracker

2. Dual Axis Solar Tracker: Double Axis solar tracker tracks the sunlight in all four directions shown in Fig. 2. It improves the solar power by 40% than the fixed one. DAST eliminate the need of adjustment which we are required to do in Single axis, in dual axis solar tracker one motor tracks the position of sunlight and other one tracks the seasonal changes.

II. LITERATURE SURVEY

In [1], an efficient and low power PSoC based sun tracker had been designed. One microcontroller can be used to control many solar panels; only the correct information needs to be sent. Efficiency is increased almost by the factor of 2. Hence reliable, economical, compact and efficient system of solar energy conversion had been made possible with this design. But in the experiment, there is a limitation that it can't retrace back its path. Returning back to its original position after the sunset, is done by rotating the panel fully 180 degrees. This consumes more space than the systems which retrace back their path.

The author in [2] discussed MPP tracking method, the purpose of this method is to improve the performance of the classical P&O under an abrupt change in solar isolation is proposed. The proposed technique is meant to offer the following 3 features: (a) Precisely recognize the MPP under static weather condition, (b) enables the fast dynamic response when the solar isolation undergoes the enormous change, and (c) offers a variable perturbation to diminish the steady-state oscillation in the neighbourhood of the MPP.

In [3] the paper mainly focuses on the design of the system because as the name it suggests that the system works automatically. The constructed system has been tested and some data from hardware measurement have been collected and discussed. Typical solar panel has been used and the purpose only to prove the designed system is able to operate accordingly. Therefore, the surrounding effects, for instance, weather condition are not seriously considered during hardware testing.

The conclusion of this paper [4] is that the systems have no significant difference in between them while considering all the factors what affect the output power of solar panel. According to comparison, the electrical output is quite little of single-axis sun tracking solar panel system and has no significance over dual-axis sun tracking solar panel system's electrical output. In terms of cost effectiveness, single-axis sun tracking solar panel system is more preferable over dual-axis sun tracking solar panel system. The values would have diverged more between dual and single axis if the location is different.

MAIN COMPONENTS

1. *Mini-Arduino*

Figure 3: Mini Arduino

Arduino nano is one type of microcontroller board, and it is designed by arduino.cc. It is a small sized board, flexible too with a wide range of other applications as shown in Fig.3. It is mainly used in project to give instruction to start and stop the servo motor with the help of LDR sensor.

2. *zLDR sensor*

Figure 4: LDR

LDR sensor or also known as light dependent resistor shown in Fig. 4 works on the principle of photoconductivity, which is optical phenomenon. The sensor used in the experiment is of diameter 5mm, 2 pins with maximum operating temperature +800 degrees Celsius. It is used in automatic street lightning, cameras, alarm clocks and in conveyor belts too.

3. Servo Motor

Figure 5: Servo Motor

Servo motor as represented in Fig. 5 consists of a DC motor, a gear system, a position sensor and a control circuit. The dc motor gets powered from a battery and runs at high speed with low torque. They are used in RC planes, robots, DVDS, radio-controlled toys and automobiles to maintain their speed. The rating of servo motor is shown in Table 2.

Table 1: Servo Motor Rating

Parameters	Input	Output
Voltage	120/240 Vac	0-240 Vac
Frequency	50/60 Hz	0-1000 Hz
Phase	1ph/3 ph	3 ph
FL Current	9.9/4.6 Arms	6 Arms
Power @ 240 Vac	2.38KVA	-

4. Rechargeable Batteries

Fig. 6 Rechargeable Batteries

Rechargeable batteries are used as a source to run the Arduino and as a load too. The use of batteries is explained further in the working principle.

5. Solar Panel

Figure 7: Solar panel

Solar Panel is the most vital piece in this experiment. The solar panel used in the experiment is of 6.5 watts and 20 volts. The main function of solar tracker is to sun's energy into electricity.

III. WORKING

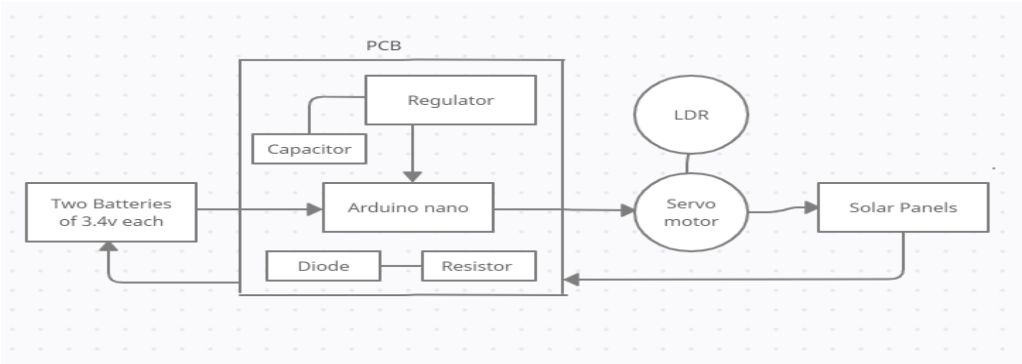

Figure 8: Circuit Diagram

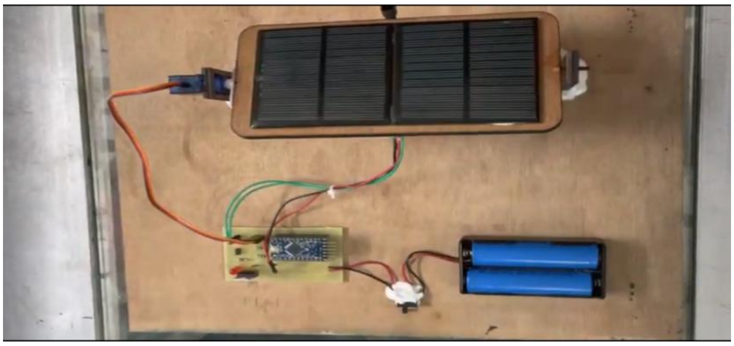

Figure 9: Snapshot of miniature solar tracker

The circuit diagram for the solar tracker made is shown in Fig.8. The snapshot of miniature solar tracker is shown in Fig. 9. Two batteries each of 3.7 volts are connected to a switch and then to a PCB (Printed Circuit board) in which Arduino mini, a regulator, a 104 Ceramic Capacitor, a Diode, a resistance of 1 kilohm, 10 kilohm and an LED is connected. Basically, an Arduino requires only 5 volts to operate and the batteries are providing more than enough, so a regulator connected in PCB is converting the required amount of voltage to Arduino to start working. Since, the batteries are providing a total of7.4 voltsand an Arduino requirement is only 5 volts so a voltage drop of 2.4 volts can be seen, the remaining 2.4 volts is removed using the heat sink attached to the regulator. Output of PCB is connected to LDR which is connected to the circuit board with 10 kilohm resistors in series and a servo motor is connected to the arms of the panel. Arduino nano is connected in such a way that as soon as the switch is on, the panel gives instruction to the servo motor to start rotating and stops the motor when the LDR detect the highest intensity of sunlight and then gradually move the panel in the same direction in which sun is rotating. Solar panel of 3 volts each is connected to a diode present in the PCB circuit and the output of diode are connected back to battery so that the load of solar plates charges the battery itself forming an energy cycle.

IV. RESULT

Table 2 Tracked Vs untracked observation table

Time (hrs.)	Voltage (Without Tracking)	Current (Without Tracking)	Power (Without Tracking)	Voltage (With Tracking)	Current (With Tracking)	Power (With Tracking)
9 am	5.4	0.11	0.61	12.2	0.22	2.9
10 am	9	0.20	1.71	13.5	0.25	3.4
11 am	10.5	0.2	2.1	14	0.28	3.92
12 pm	12.5	0.30	3.5	14	0.28	4
1 pm	14	0.32	4.48	17	0.3	5.1
2pm	13.5	0.3	4.05	14	0.3	4.2
3pm	11	0.26	2.86	13	0.26	3.38
4pm	8	0.16	1.28	10	0.25	2.5
5 pm	6	0.12	0.72	7	0.2	1.4
6 pm	2.5	0.05	0.125	5	0.1	0.5

The above Table 2 shows the statistical data for voltage, current and power at every 1 duration in a day. It is obvious that tracked solar energy is more efficient and generates more power than untracked solar energy. At 1 pm stationary solar axis achieved a total power generation of 4.48 watts, while tracked power dissipation was 5.1 in summer season. The efficiency of the prototype is quite promising and it can also power higher ratings devices if installed in larger scale. The load of the miniature solar tracker is battery itself powering the mini-Arduino and an LED keeping the cycle running is very good example of energy conserving model. Graphical representation shown below tells more accurately that the curve representing the tracked energy is much higher than that of untracked one. The results obtained are shown in Fig. 8 and Fig. 9.

The voltage value is higher as compared to stationary solar tracker because the servo motor rotates the panel perpendicularly directed towards the direction of sun. However, the value of voltage will decrease in rainy and cloudy days because of shading effect but still solar tracker will help the panel to absorb as much as sunlight it can. In Fig. 8 as we can see graph of tracked energy vs untracked energy, the green area shows the exponential growth of the energy dissipation from the sun, this area is not visible on daily basis because it is exponential but if we compare both the graphs it can be seen clearly. Since, we used only single axis solar tracker there is only 20 – 25 % growth produced but in dual axis solar tracker the growth percentage marks up to 40% to 50%. In second bar graph, Fig. 9 same results can be notice and it clearly shows how only single axis solar tracker can enhance the daily power consumption.

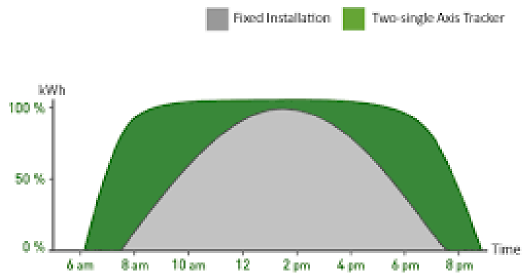

Figure 8: Tracked V/s untracked graph

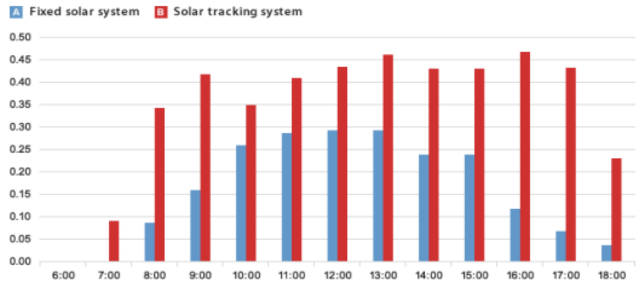

Figure 9: Bar graph based on observation table

V. CONCLUSION

Single Axis Solar Tracker perfectly aligns with the Sun's direction and tracks the movement in an efficient way and provides major improvement than stationary solar panel. Experimental results shows that single axis solar tracker is superior to stationary solar panel but not for more efficient tracking dual axis is required [2]. Power captured by single axis solar tracker is high during the whole observation time period and it maximizes the conversion of solar irradiance into electrical energy output.

FUTURE SCOPE

In future this whole mechanism of power cycle or we can say energy cycle can be replicated into large scale and can be applied into future project to conserve energy. This same mechanism can be applied to solar cooker, ovens, driers and thermal solar heater. We can use woods in some area instead of mild steel thus further reducing the cost of making tracker. A spring of appropriate stiffness can be used to avoid sudden jerks [10]. To improve sun tracking more efficiently using an 18 series PIC microcontroller can make this job done. In that microcontroller, the data will be stored periodically. Real time clock (RTC) can be interfaced in the PIC board rather than sensors for seasonal tracking here [4]. Solar tracker whether it is dual axis or single axis will only help to utilize the sun's energy from its core and today's era it seems very fair to use them instead of stationary solar plates.

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