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# AUTOMATIC DUAL-AXIS SOLAR TRACKER WITH SOLAR PANEL

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## ABSTRACT

Solar energy is clean source of energy that has a much lower environmental impact than conventional energy. Solar energy has been increasing in a wide range of applications. Even though the wide usages of solar energy, the efficiency is not up to mark. Upon scheffler dish principle in practical the solar panel is parabolic in shape. This paper focuses on low cost dual axis solar tracking system to magnify the use of solar energy. To enhance the efficiency, combination of two types of solar tracking designs are implemented. LDR and servo motor is selected as the driving mechanism of the model. Dual axis is more acceptable as it's efficiency is more. The four active sensors present constantly monitor the sun and rotates the panel towards the direction of maximum intensity obtained. With the implementation the proposed configuration the additional energy generated is around 25% to 30%.there is very less consumption of energy by the system itself. The system have increased efficiency and reduced cost so that it can be implemented mainly in rural area.

**KEYWORDS:** Conventional, Dual-Axis, LDR, Panel, Scheffler.

## I. INTRODUCTION AND LITERATURE REVIEW

The craze of renewable sources of energy increased, after the innovation in design and development of photoelectric cells. It's main mechanism is the conversion of light energy into direct current.[2] Apart from single- axis or fixed mount the best possible configuration of the solar tracker is the dual-axis solar tracker where the energy conversion increases by elevating the panels in the direction where the intensity of light energy is maximum. The tracking efficiency is further dependent upon the embedded microprocessor system.[13,14]

Considering all other renewable energy it has been perceived that solar energy is the cheapest source of energy in rural areas so currently lots of researches have been done to exploit the opportunity. The productivity of solar cells depends upon two factors the amount of radiation from the source and the storage techniques.[1,3] To increase the harvest of the solar radiation two methods are used sun tracking and maximum power point tracking(MPPT),or combination of both the methods. Gn 1 KW/m2 is the amount of maximum solar energy which is the average availability on the sea level of the earth.[2] For achieve energy efficiency at its maximal level, a PV panel must be equipped with solar tracking system.[3] There are three types of solar trackers. In fixed axis the solar panel is mounted fix which does not move on any axis. Where-as power efficiency of single axis solar tracking is more than fixed mount. Single axis trackers are designed to track the sun in only one direction. A dual axis tracker is capable of holding maximum radiant energy per area as it works in both directions.[4]

Guangyu Liu designed a, hybrid controller based on sub controllers for dual axes sun tracker. They built this system to work under different circumstances where the operational modes can be classified in two modes, the normal tracking mode and the protection mode. The normal tracking mode consists of open-loop and closed loop sub-controllers which switches between them according to the tracking error which is achieved by logic supervision. The protection mode employs the wind and the rain stow sub-controller, which replaces the normal tracking mode when the rain or the wind exceed the set point for each sub-controller.[1]

Nikesh and Rakesh designed a prototype in which they have used ASTS hardware and software to operate a feasible solar panel. They also used algorithm and control system in radar. The software based control incorporates a GUI with the database which fastens with Microsoft Access. The database of the system can be kept for keeping records.[5] J.Rizk's way is to increase the efficiency of solar power conversion by increasing the amount of time to which it is vertical to the sunlight.[6]

Chih-Wei Chien proposed a micro-concentrator framework based on origami concentrators, photovoltaic applications to minimise the cost of electricity. The fabrication of the concentrators involves the origami technique, which allows the use of thin-film processing technologies. The concentrators are lightweight, flexible, and requiring only one dimensional translational motion for solar tracking.[7] Engin M dealt with the movement and the accuracy of the tracker rely on the accuracy and configurations of the sensors. Normal controllers can be easily influence by the weather conditions such as cloud, dust and wind. Hybrid controllers combine the open-loop and the closed- loop control method. The hybrid controller improves the reliability and performance of the sun tracking by utilizing the advantages of both control tactics.[8]

Saxena and V.Dutta proposed a hybrid controller based on two control loops for dual axis tracker. The main idea of the system is to switch between the two controllers. Where there are two working modes, the auto and the manual mode where the closed and the open loop controllers are employed respectively. When the tracker employs the open loop controller, a large variation in sun position can be occurred in some days.[9] Yeh H Y designed a hybrid sun tracking controller based on logic-based switching. The tracker controller employs the open loop and the closed loop controller and switch between the two controllers. The tracker showed that system can efficiently achieve the stability, but the controller system does not take the protection feature into account.[10]

Using the vector process to track the direction and path of the sun through out the day, Armstrong derived the angle of incidence. He conferred the results for the efficiency of MPPT under stationary solar panel.[11] Yingxue Yao depicted the use of multifunctional dual axis solar tracker which can be applicable real time industrially. His proposed system suggests declination of mounting system upon east-west axis direction, where the normal-daily adjustment methods are developed for PV and CSP configurations.[15]

M.H.M. Sidek focuses upon the configuration upon open loop solar tracking system. The system was designed with the help of hollow aluminium cylinder, encoder, sensor, microcontroller and polyuthrene which increases the efficiency of the device by 26.9% and 12.8% compared to the traditional fixed mount solar trackers.[16]

Thus, concludes the Introduction and Literature Review section of this paper. Block Diagram and Description is listed in the upcoming section. The Results are projected in section III of the manuscript followed by Conclusion and References.

## II. Block Diagram and Description

### A. Block Diagram

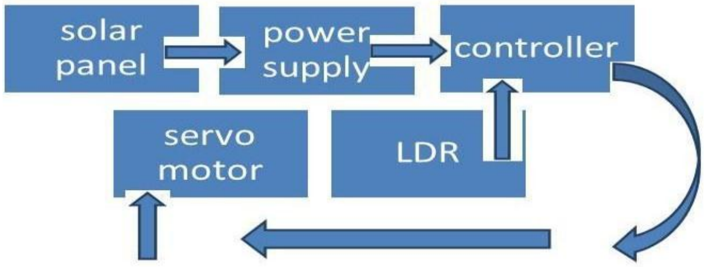


**Figure 1: Block diagram of the system**

### B. Material Inventory List

The components used to make a low cost dual axis solar tracking system are :

Arduino uno board: The UNO is the most used robust and documented board of the entire arduino family. It is a microcontroller board based on the ATmega328P which requires an AC to DC adapter or battery to get started. It consists of 14 digital input output pins of which 6 can be used as PWM outputs, 6 analog inputs, a 16MHz quartz crystal ,a USB connection, a power jack, an ICSP header and a reset button.

Software: The source code written for arduino is called sketch. Arduino has its own coding editor where we can write programs in C/C++ languages. Arduino IDE is the software which is used for development of sketches. The IDE contains the following tools: Text editor, message area, text and console tool bar.

Servo Motor: To have control over angular or linear position, velocity and acceleration, a linear actuator is required. It consists of a suitable motor coupled to a sensor for position feedback.

LDR: It is named as light dependent resistor. It is generally used for light tracking purposes. This equipment functions when An LDR is a component that has variable resistance which changes with the intensity of light falling upon it. When intensity of light increases, its resistance decreases and vice-versa.

LED: A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode that emits light when activated.

Solar powered panel: For lesser power consumption, high utility and better longivity, amorphous silicon has been used as photovoltaic cell. To generate electricity ,solar panel allows photon, a particle of light to drive electron free from its orbit. These flow of electron generates electricity as output of photovoltaic cell.

### C. Working Topology

In this proposed model, the LDR's work as photo detectors. It is a light receptive device. The resistance value decreases when the intensity of light increases and vice-versa. Here four LDR's are used which are placed in the base plate in such a way that they are adjacent to each other. One of the servo motor moves the base plate in North to South direction where as another base plate moves the base plate in East to West direction. The working is to track maximum intensity received from the source object as referred in Figure 1. The setup is made such that a panel is fixed at the center of the base plate along with an led connected across the panel. If there is same amount of light falling on both pairs of the LDR, then the servo does not displace from its mean position but the led glows brightly.

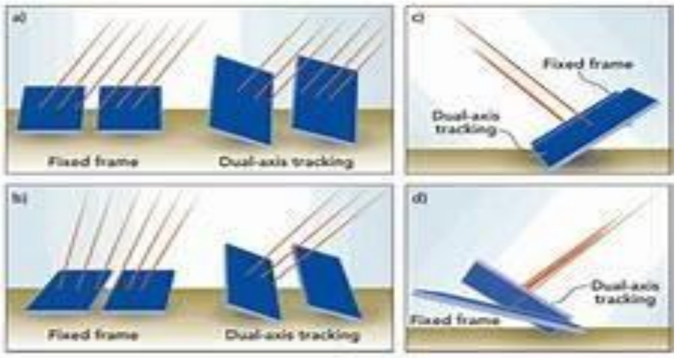


**Figure 2[12]: Depicts how dual-axis solar tracker system is superior compared to single axis or fixed axis solar tracker.**

### D. Algorithm

**Control Variable**

**Avgtop, avgbot: for calibrating average intensity of light as sensed by photo-resistors servov, servoh: for the movement along the axis N-S and E-W**

**Avgleft:** for calibration of average intensity of light along N-S

**Avgright:** for calibration of average intensity of light along E-W

```
if(avgtop<avgbot)
        then
if(servo>servoLimitHigh)
        then
servov <-servovLimitHigh
            endif
endif
elseif (avgbot<avgtop)
        then
if(servov<servovLimitLow)
        then
servo<-servovLimitLow
            endif
endif
if (avgleft > avgright)
        then
if (servoh > servohLimitHigh)
        then
servoh <- servohLimitHigh;
            endif
endif
else if (avgright > avgleft)
        then
if (servoh < servohLimitLow)
        then
servoh <- servohLimitLow;
             endif
endif
```

### E. Proposed Prototype

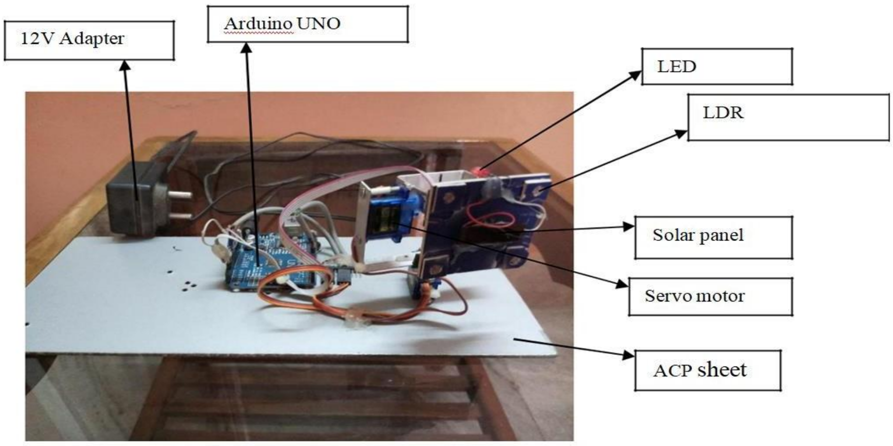


**Figure 3: Dual-Axis Solar Tracker Setup.**

## III. RESULTS AND ANALYSIS

The Simulated data is obtained real time and verified from the experimental results.

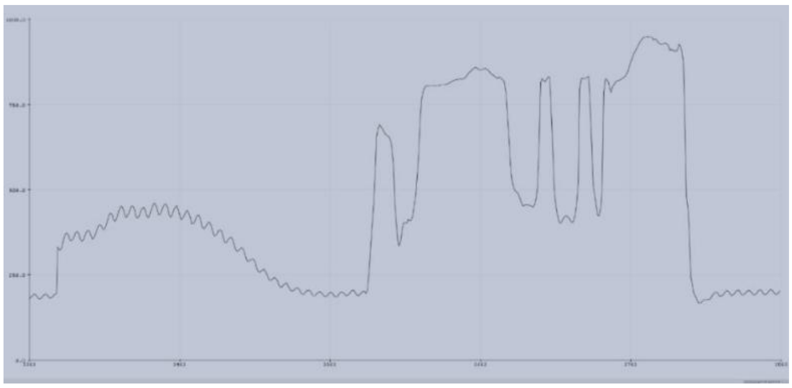

**Figure 4: Simulated data graph-1.**

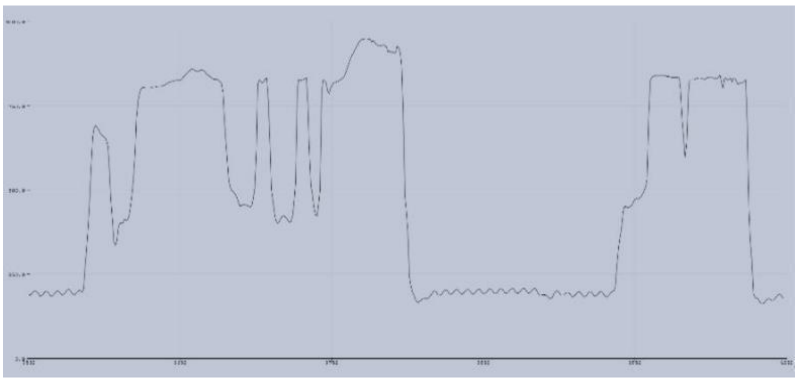

**Figure 5: Simulated data graph -2.**

From the above graph obtained we can conclude that the rate of tracking is directly proportional to that of the intensity of light sensed by photo-resistor. Where more intensity of light is being sensed the tracker shows its movements and moves in that direction.

## IV. CONCLUSION

A hybrid controller for dual axes is designed .The controller is responsible for tracking and stow positions. The tracking controller is capable of working under different weather conditions by adding protections and stow features. After creating a solar tracking system, we found out that our hypothesis was partially correct, but in-correct as well as we discussed more the general ideas, than the efficiency of servo motors, LDR's, resistor, code and other important parameters. The placement of the servo motors should be placed properly and made sure that the resistance value is neither too low, nor too high. It is light to an idea to build Solar tracking models in practical world. For practical uses we need more powerful solar panels as well as LDR's.

Other Benefits for using dual axis solar tracking are: less global warming, improved public health, inexhaustible energy, economic benefits. The proposed model can be applied in the rural and urban areas as an alternative electricity generation especially for those devices which consumes less power and energy.

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