Automatic Solar Tracking System: An Overview of Design and Fabrication

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Abstract: The major problem associated with the solar panel is its efficiency. Most of solar panels are less efficient because it is not able to convert the maximum of the sun's energy. The issue is there with the non-movement of solar panel with the sun's direction. This can be achieved by a solar tracking device that moves the panel with the direction of the sun. The tracker consists of the physical components such as Servo motor and frame. Second is the Control panel that consists of Light Dependent Resistor (LDR), a comparator and an Arduino UNO. This paper presents the design and Fabrication of the automatic solar tracking device. The model is based on the principle that when sunlight falls on LDR installed on the panel, the input is given to the Aurdino and then it gives a command to the servomotor to align its position where the intensity is maximum so that maximum efficiency is achieved.

Keywords: Arduino, Light Dependent Resistors, Servo Motors and Dual Axes Motion.

I. INTRODUCTION

In the recent past, research has been conducted on generating clean energy from the resources available. The forms of energy shall replace non-renewable resources. The main reason for this change shall be the drying of the carbon soon and this type of energy is responsible for global warming. One of the renewable energy sources on which the focus of the researchers is concentrated is solar energy. Enormous research is being carried out on improving the efficiency of the solar cells. The major concerns about the efficiency improvements are that it is still lagging on its part. The main issue is the current rate which is approximately 35% [1] and another aspect is the positioning of the solar panel. To have a relaxation from these issues, the idea is to orient the solar panels towards the sun. Most of the published papers reveal that the solar panel must be able to follow the sun's direction. This is achieved using the tracker system that maintains the panel position with the light source. The design of the system consists of the solar panel with the LDR placed on the panel and to give it a movement, two servo motors are used that provides the dual axes motion to the panel.

II. LITERATURE REVIEW

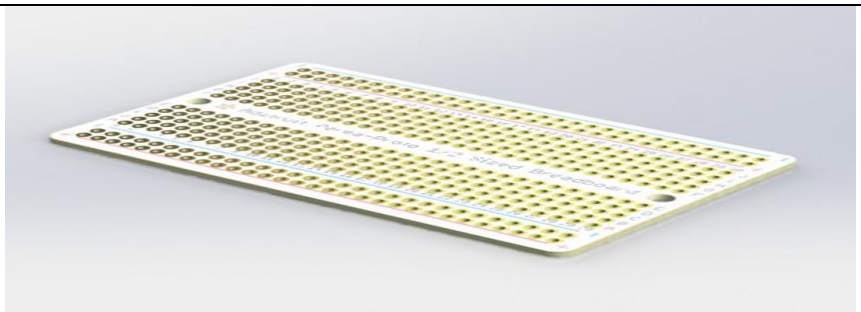
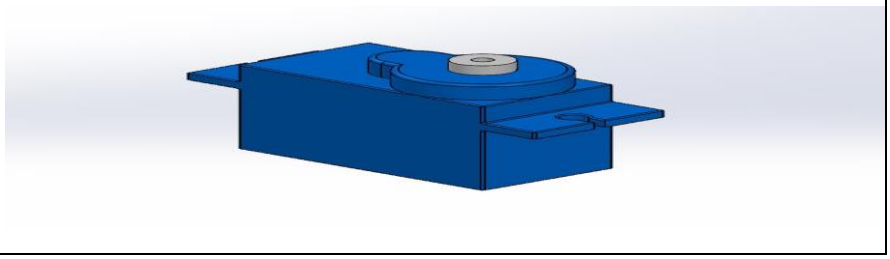
Abhishak Sharma et al [1] designed and fabricated a model that minimizes the angle of incoming light. The model consists of a mechanism that will tilt the flat solar panel towards the sun that is controlled by LDR. DC Motor having a high reduction ratio is used for the movement. The model does not have any microprocessor or Arduino. Hemant Kumar Nayak et al [2] designed and fabricated a dual-axis solar tracking system. The model does consist of sensors and microcontroller

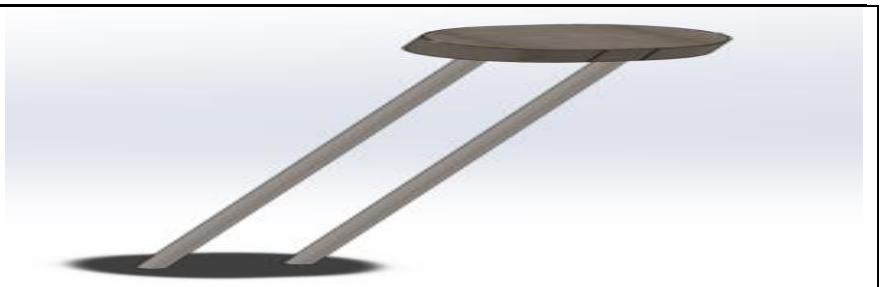
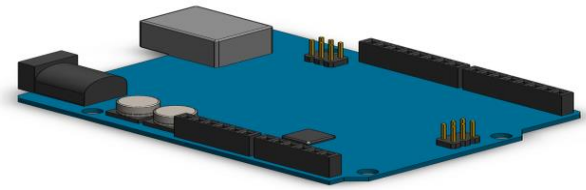
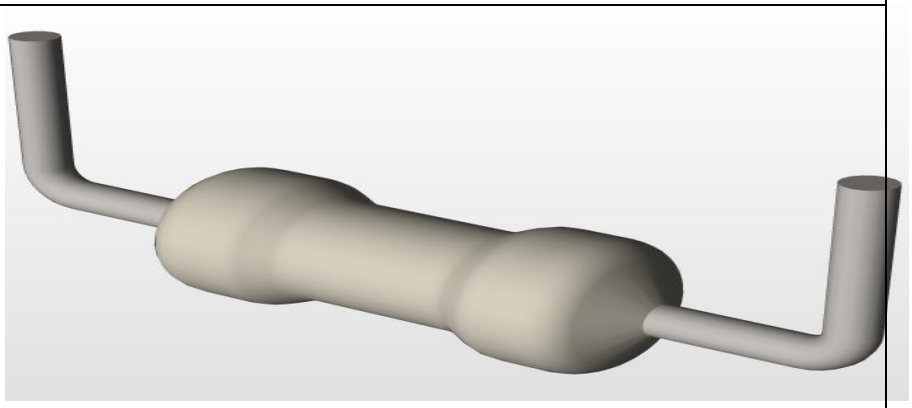
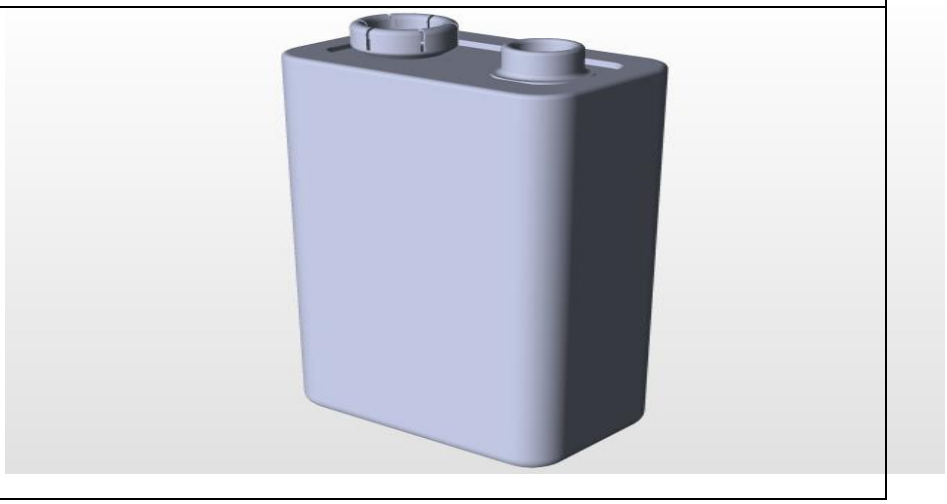
[1]. Two stepper motors were used in the model to keep sun's beam intact with the solar panel. This model shows a 40-45% increase in the output energy as compared to a normal solar panel aligned in a fixed direction. Bhupendra Gupta et al [3] demonstrated a solar tracking system having three degrees of freedom. The author had used LDR sensors, microcontroller, solar panel, two stepper motors. The main objective of this model is to catch maximum sun's intensity on the solar panel. The enormous amount of energy is utilized in this model due to the 3D movement. Md. Tanvir Arafat Khan et al [4] presented a model in which the three ways of controlling has been discussed. LDR was used in the model that offers accurate movements. Ahmad Imran bin Ibrahim et al [5] improved the efficiency of the panel by 60 percent with the help of dual solar tacker. The system incorporated the use of LDR connected to the potentiometer. Deekshith K et al [6] proposed a model in which the dual-axis tracking device was used with the microcontrollers. Imam Abadi et al [7] made a model in which the author presented the optimal energy conversion process by changing the inclination of the panel. Peter Amaize et al [8] constructed a model of Automatic solar tracker system that includes incorporates Arduino within the system. LDR was used in the model to check the intensity of sunlight, also the servomotor is used to control the movement of the solar panel. The paper concluded that the movable panel produces more energy as compared to a fixed panel.

III. DESIGN OF COMPONENTS

These components are firstly designed on solid works. This designing provides us with a brief layout of the dimensions to be taken. This designing helps make the model. Reverse Engineering is followed in this model.

TABLE 1: DESIGN OF THE COMPONENTS

S.No.	Component used	Solid works model
1.	Breadboard	
2.	Servo motor	

3.	LDR	
4.	Arduino	
5.	1Kohm	
6.	9 Volt battery	

IV. SOLID WORKS ASSEMBLY OF THE MODEL

This solid works model represents the design of the automatic solar tracker system. This model is accomplished by doing the assembly of the subparts. This solid works model briefly describes the positioning of LDRs, solar panels, battery, breadboard, servo motors. These components are assembled on the wooden structure. Fig: 2 indicates the final assembly of the Automatic solar tracker.

V. FABRICATION

a. Specifications of components

A brief description of the components is mentioned in Table 2. These components are firstly designed on solid works. This designing provides us with a brief layout of the dimensions to be taken. This designing helps make the model. Reverse Engineering is followed in this model.

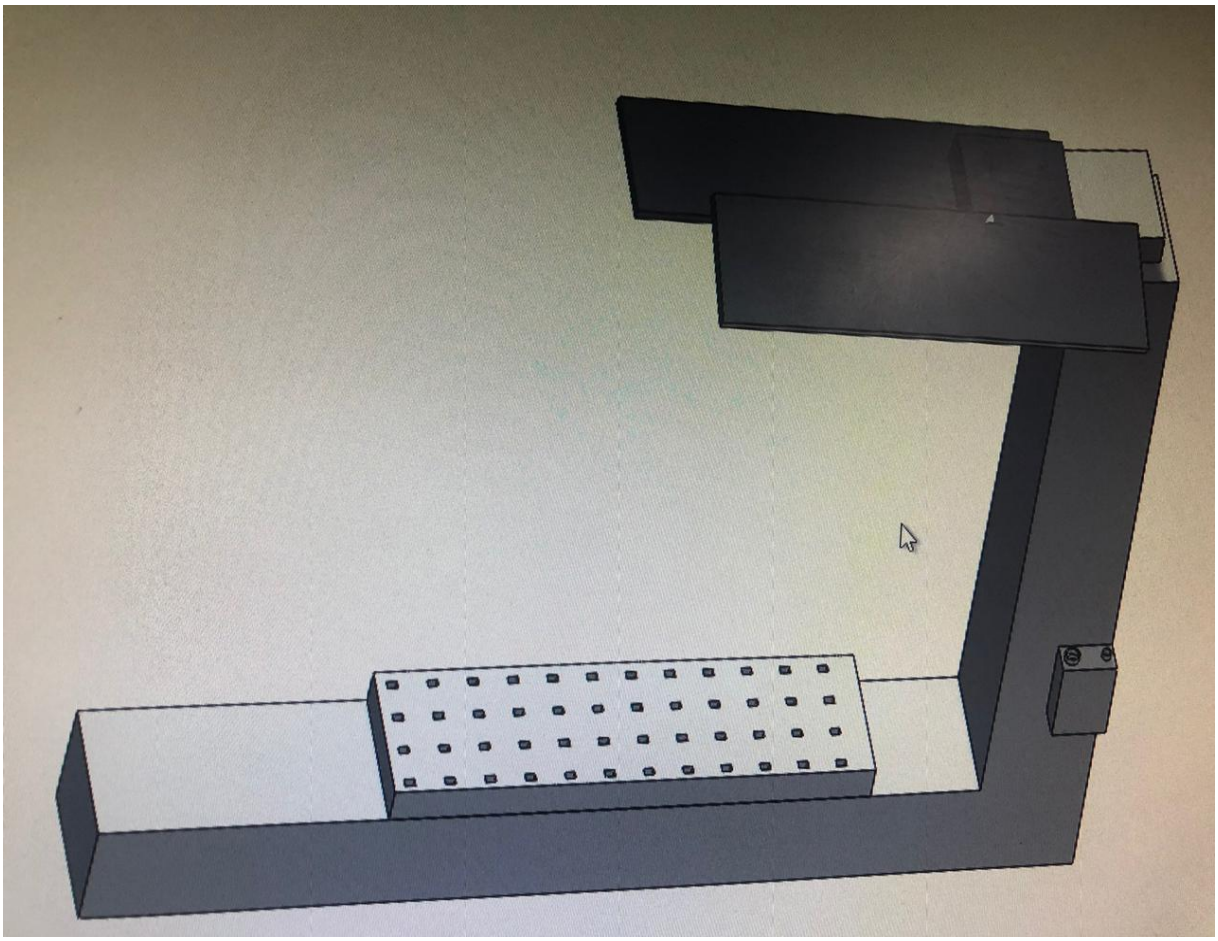


Fig. 2: Final assembly of the model

Table 2: Specifications of Components

S.NO	Component used	Picture	Specifications
1.	Arduino		Arduino UNO is used having ATELMEGA-3 microprocessor unit.

2.	LDR		LDRs having 5V of stability are used.
3.	1Kohm resistor		Tolerance level Is +_ 5ohms.
4.	Servo motor		SG-90 servo motors are used.
5.	Bread board		Bread board of 830 points is used.

6.	Battery		9V battery of hi watt company is used

b. Fabrication & connections

Fig.3 Describes all the connections of the model with the sub-components. Motor 1 and 2 are the servo motors having three terminals which are connected as shown in the fig 3. Four LDRs are connected in a parallel way and Four 1Kohm resistors are connected in series with the LDRs to protect LDRs from high currents.

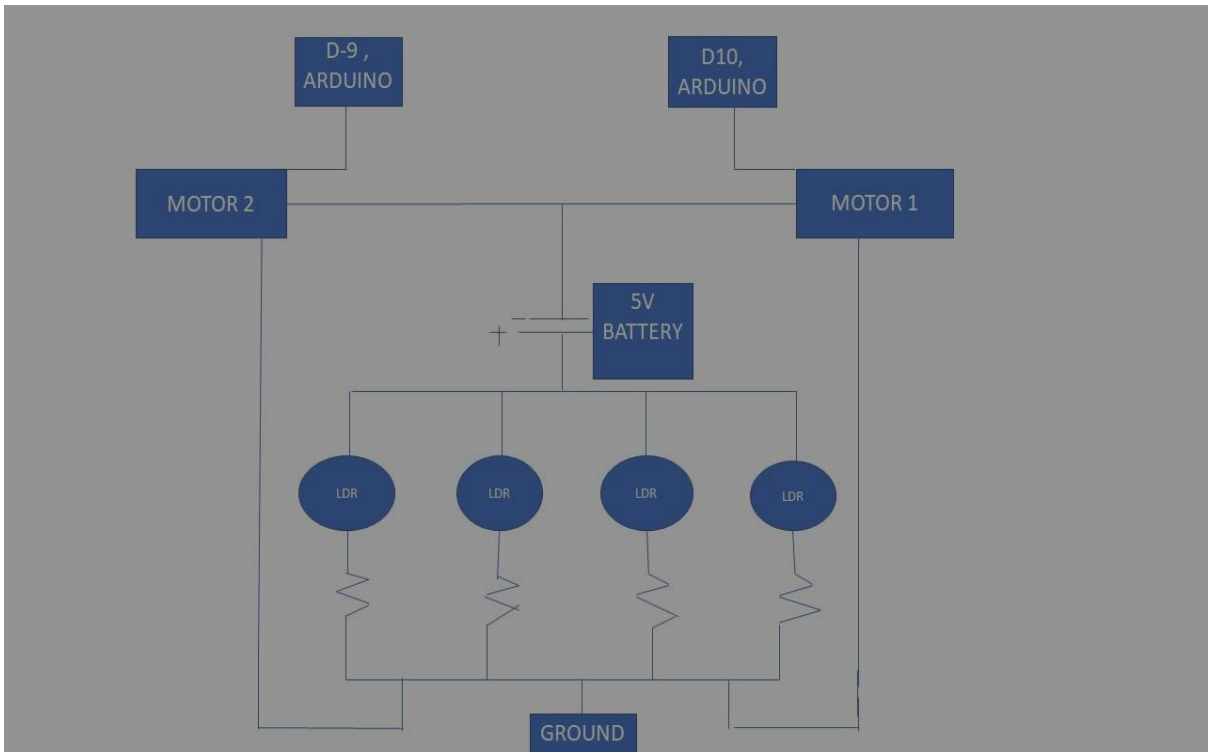


Fig. 3: Connections involved

VI. TESTING OF MODEL

In this model, testing is done by continuously changing the direction and intensity of the light source. By changing the direction of the light source, the solar panel can orient itself in that

direction. We had measured the angle on which light beam is incident on the panel and we had also measured the orientation of the panels accordingly.

Table-3 Testing

S.No.	Sun inclination(degree)	The orientation of panel (in degrees)
1.	45	43
2.	60	55
3.	90	88
4.	120	110
5.	150	143
6.	180	180

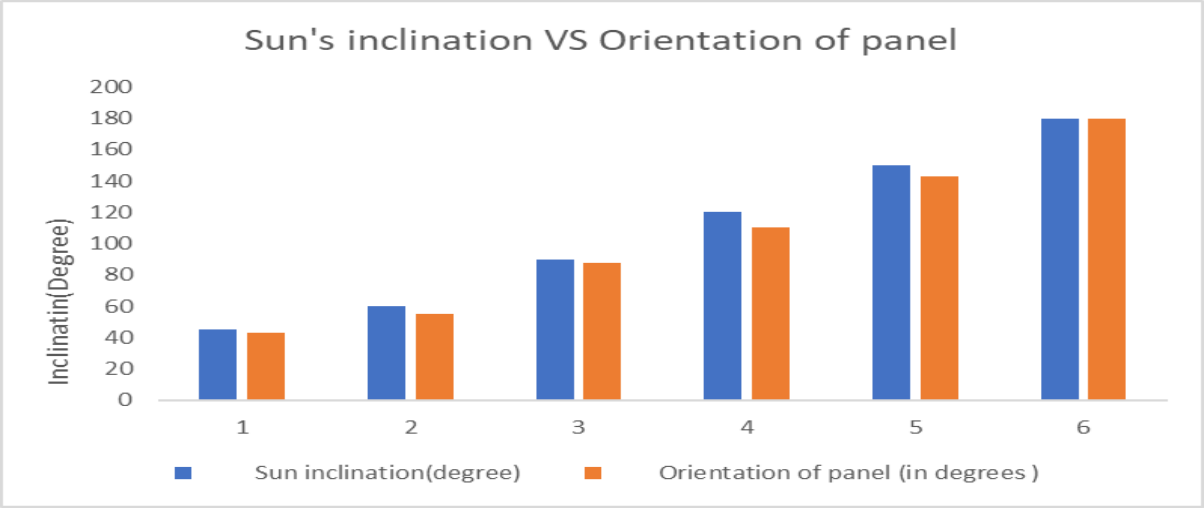


Fig-4 Comparison between the sun's inclination and the panel's orientation

This graph clearly states that the sun's orientation and the panel's orientation lies in the acceptable limits for the orientation of the panels.

VII. CONCLUSION

The paper gave a brief overview of the solar tracking system based on Arduino and describes the simple and attractive features of the tracking system. Here the use of servo motor in solar trackers enables accurate tracking of the sun and light dependent resistor are used to determine the solar light intensity. As the solar tracker is directly exposed to solar rays, they can generate more electricity compared to their stationary panels. This type of model is most efficiently used where there are low horizons and locations. As per the latitude, installation, weather requirements, the tracker will work efficiently as per the required conditions.

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Conflict of interest: The authors declare that they have no conflict of interest.

Ethical statement: The authors declare that they have followed ethical responsibilities

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