Design and Fabrication of 180° Solar Panel Air Cooler

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Abstract: **This study has been undertaken to in everyday life we come across high temperature around in the room, hence there is a need of cooling mechanism to feel comfortable. In today's world we have different media of cooling air i.e., Room Air Conditioner, Water Coolers and Fans etc. the dependency on them is so high that the energy consumption are far beyond control. The need for cooling device which consumed less power was the reason to initiate the project. The main aim of the project is to design a "SOLAR AIR COOLER". Which work on evaporating cooling phenomenon. An evaporative cooler produces effective cooling by combining a natural process-with a simple, reliable air moving system. Fresh outside air is pulled through moist pads where it is cooled by evaporation and circulated through a house or building by a large blower. As this happens, the temperature of the outside air can be lowered as much as 10 degrees. Design of the apparatus was based upon theoretical calculations that were done on the grounds of certain basic principles of refrigeration, air-conditioning and heat and mass transfer. The whole project was concentrated in making it suitable for a small sized room with effective cooling. During the course of the project, we tried various alternatives and finally made it a DC powered device. The effective operation of the device is worth a start considering the energy saving it shows. And the need of the day is to save energy hence it shows a high prospect in modern world.**

Keywords: **air cooler, solar energy, Arduino, solar panel.**

I. INTRODUCTION

Energy is the primary and most universal measure of all kinds of work by human beings and nature. Energy is a crucial input in the process of economic, social and industrial development. Day by day the energy consumption is increasing very rapidly. The rate of energy consumption is increasing. Supply is depleting resulting in inflation and energy shortage. This is called the energy crisis. According to law of conservation of energy "energy can neither be created nor be destroyed but can be transformed from one form to another form. Energy can be transported from one place to another place". Alternative or non-conventional or renewable energy resources are very essential to develop for future energy requirements. The energy demand increases day by day because of population increasing industrialization increases and transportation increases etc. Evaporative cooling is a physical phenomenon in which evaporation of a liquid, typically into surrounding air, cools an object or a liquid in contact with it. An evaporative cooler is an air-cooling system known as a cost-effective and energy-efficient alternative to air conditioners. It efficiently provides cool air in dry-climate areas.

II. EXPERIMENTAL SET UP

- **Position of sun relative to earth**

In addition to estimating the amount of energy coming from the sun, the solar designer must also be able to predict the position of the sun. The sun's position must be known to predict the amount of energy falling on tilted surfaces, and to determine the direction toward which a tracking mechanism must point a collector. Chapter 3 discusses the computation of the position of the sun with respect to any given point on the face of the earth. Using only four parameters (latitude, longitude, date and local time), equations are derived to determine the location of the sun in the sky.

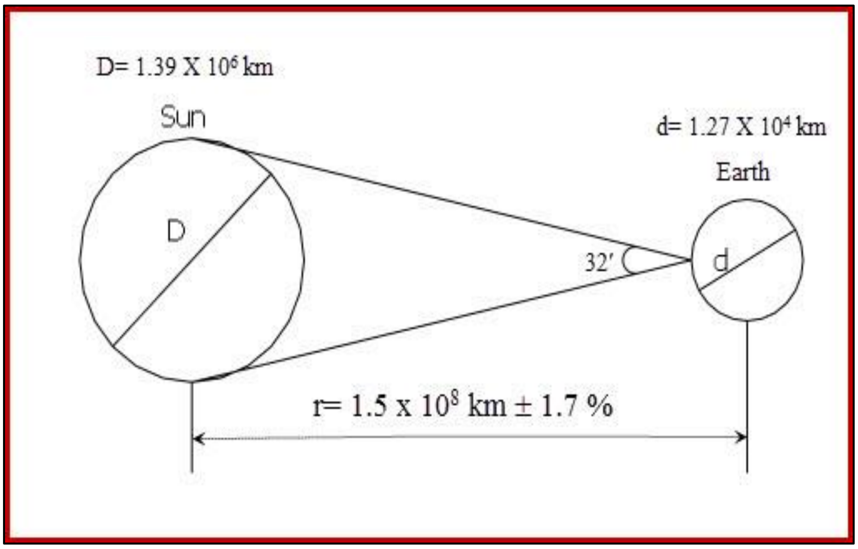


Fig.1 - Position of Earth relative to Sun

The sun is sphere of intensely hot gaseous matter with a diameter of 1.3×10 m and is about 1.5x10 m away from the earth, the sun rotates on its axis once about every four weeks. However, it does not rotate as a solid body, the equator takes about 27 days and the Polar Regions take about 30 days for each rotation. The sun has effective black body temperature of 762 K. The earth axis of rotation is tilted 23.5° with respect to its orbit about the sun in its orbital movement the earth keeps its axis oriented in the same direction. This tilted position of earth along with the earth daily rotation and yearly revolution, Accounts for the varying distribution of solar radiation over the earth's surface, the changing lent of hours of day light and darkness, and the changing of seasons. Figure schematically shows the effect of the earth's tilted axis at various times of the year, and in second figure shows the position of the earth relative to the sun's rays at the time of the winter solstice and the summer solstice at the solstice (December 21), the North Pole is inclined 23.5" away from the sun. All points on the earth's surface north of 66.5° north latitude are in total darkness for 24 hours while all regions within 23,5" of the South Pole receive continuous sunlight. At the time of the summer solstice (June 21), the situation is reversed. At the time of the two equinoxes (March 21 and September 21 approximately), both the poles are equidistant from the sun and all points on the earth's surface have 12 hours of daylight and 12 hours of darkness.

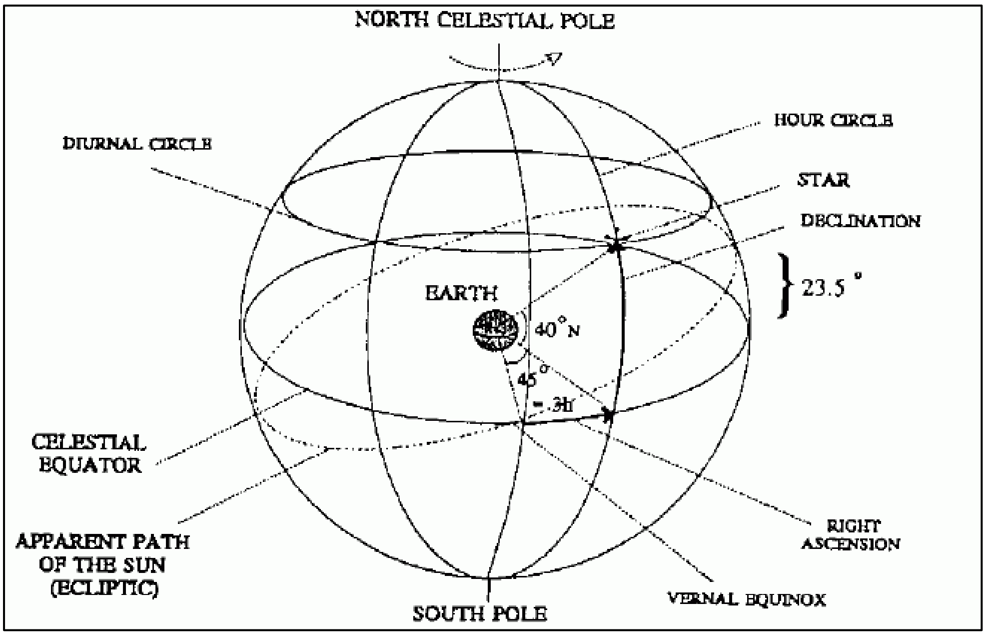


Fig.2 - The celestial sphere.

The position of the earth's surface with respect to the sun's rays can be determined at any instant if the latitude of the place, hour angle and the sun's declination & are known. Point P represents a place in the northern hemisphere. The hour angle is the angle through which the earth must turn to bring the meridian of P directly in line with the sun's rays. At solar noon the hour angle is zero. The solar noon is defined as the time at which the sun is highest in the sky. The hour angle expresses the time of day with respect to solar noon. One hour of time equals 15° of hour angle.

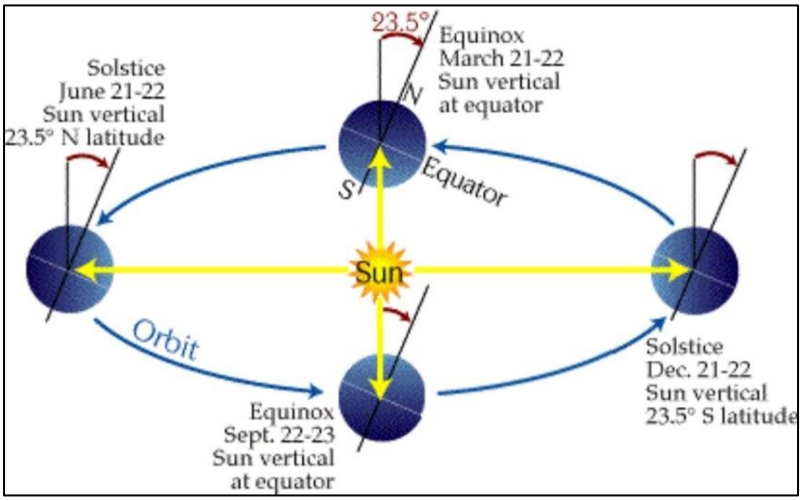


Fig.3 - Position of the earth with respect to sun at solstice and equinox

The angular displacement of the sun from the plane of the earth's equator s termed as the declination of the sun, 8. This angle varies between +23.5° and -23.5° as the earths performs its yearly circumnavigation around the sun. The latitude at 23.5°, the Tropics of Cancer and Capricorn enclose the only region on earth where the sun's rays strike normal to its surface at some time during the year. The shortest day of the year occurs in the northern hemisphere when the sun lies time during the year. The shortest day of the year occurs in the northern hemisphere when the sun lies vertically above the tropic of Capricorn at the latitude 23.5°.

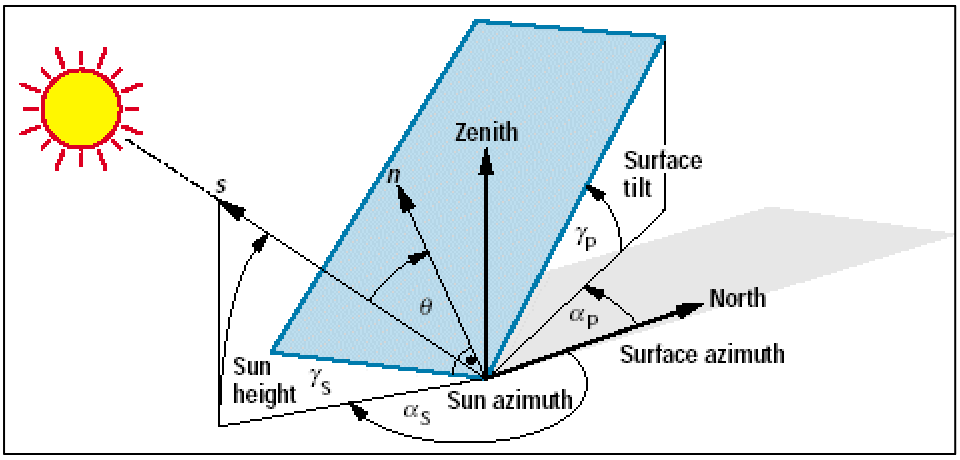


Fig.4 - Solar zenith, altitude and azimuth angles.

A characteristic fundamental to the capture of solar energy is that the amount of energy incident on a collector is reduced by a fraction equal to the cosine of the angle between the collector surface and the sun's rays. Knowing the position of the collector and the position of the sun equations may be used to predict the fraction of incoming solar energy that falls on the collector. These include situations where the collector is fixed or is tracked about a single axis, no matter what the orientation, oxide layer to a semiconductor.

- **Design requirements**

Designing of this concept involved several steps. It will include the motor selection, reduction of rpm of motor to desired limit for the specific operation. Designing the timing circuit for the operation. Design of shaft, bearing and all related article like support, base etc. material selection is also very important aspect which is going to be consider during the design.

- **Construction and working**

The solar track indexing mechanism consist of the following main components:

A) Solar panel and battery

B) Drive

C) Structure

D) Operating electronic circuit

A. Solar panel and battery:

Battery and solar panel are common project components. Battery and 10 W 12 V DC solar panel specs are provided. The battery circuit uses an electronic circuit to separate battery charging from output from the battery.

B. Drive:

The drive mechanism consists of following main components:

1. MG996R Servo Motor
2. Arduino Sensor
3. Panel mounting stand
4. Panel 10 W 12V DC
5. Cooler body

Wooden triangle that serves as the basis for the solar panel, which is installed on a motor called the MG996R. The other side of the panel is fastened to a nut and bolt system, which gives the solar panel stability and enables it to spin 180 degrees horizontally.

C. Structure:

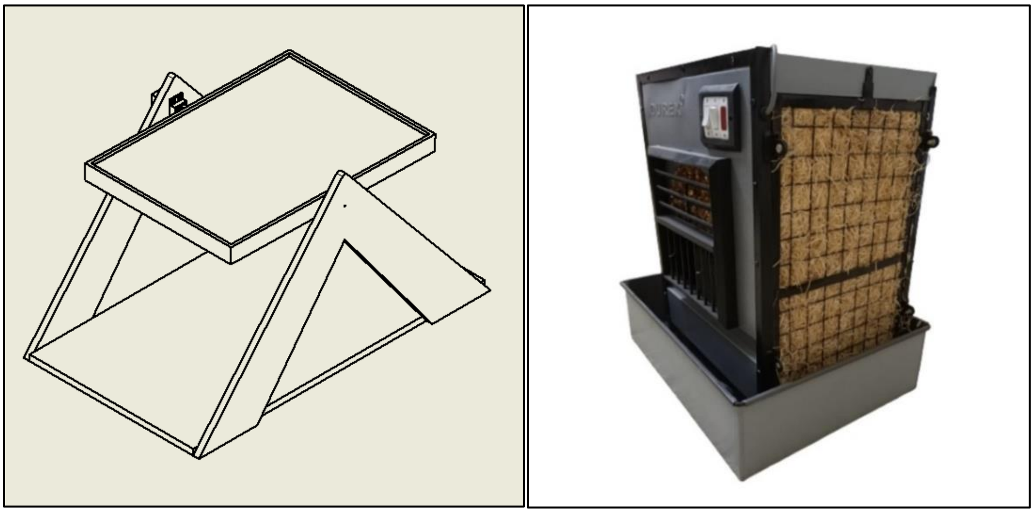


Fig.5 - Proposed assembly of indexing and cooler mechanism

D. Operating electronic circuit:

The functioning electrical circuit is used to verify the solar panel's angle on a regular basis. The full 180° angle can be divided roughly into 12 pieces, or 12 indexing deviations, or 15° each. An Arduino sensor mounted on a wooden frame allowed for this. A 5V DC battery serves as the direct source of the 5V DC input voltage.

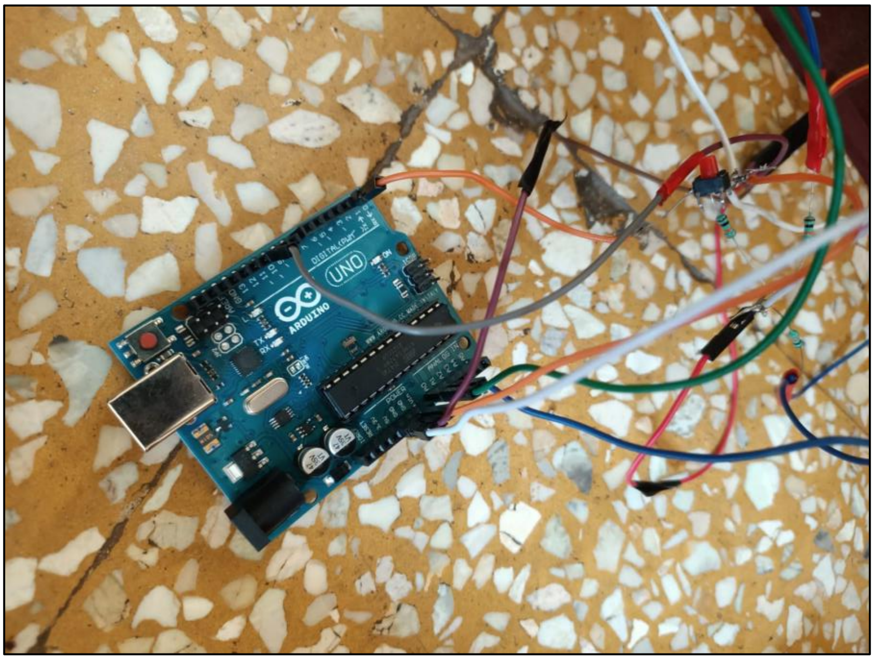
Components:

1. Arduino kit
2. Operating Electronic Circuit

3. LDR Sensor
4. MG996R Servo Motor
5. Charge Controller
6. 12 V DC battery
7. 12V Submersible Pump
8. RS-555-12V Fan Motor
9. Toggle switch

Battery must be connected to the Arduino kit with USB port in order to start the circuit. The Arduino kit is complete with the provided code; as a result, it turns on immediately after receiving a power supply, and the two LDR sensors mounted on the solar panel detect solar radiation and shift to the side that is receiving the most of it.

The sunrise position LDR sensor operates at startup time and provides the electrical circuit with a beginning pulse. The LDR sensor for the location of the sun at sunset operates at the conclusion of the day and resets the electrical circuit. Both of these LDR sensors are controlled by the driving mechanism.



Photograph.1 - Operating Circuit

III. DISCUSSION

1. After taking an hourly average reading of both, it was discovered that the solar panel with the tracking mechanism had a higher average power production than the stationary one.

2. From there, the efficiency increase was computed.

3. It was possible to achieve a constant angle of the sun's beams between 80° and 100°.

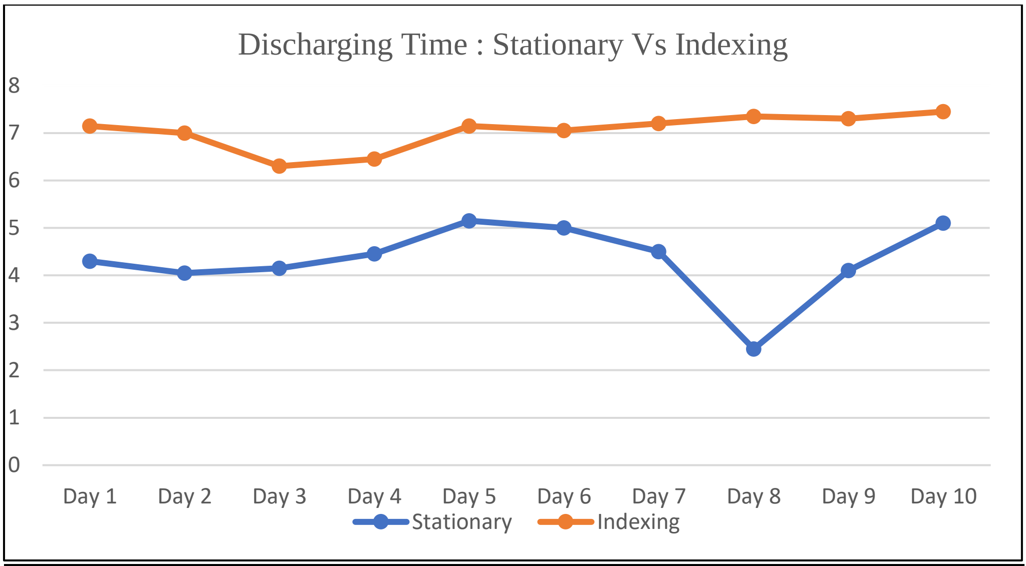
4. A solar tracker was suggested, created, and built. The final design was successful because it increased the overall efficiency of power gathering from only 30% for a fixed panel to over 60% for the identical panel on the tracking device.

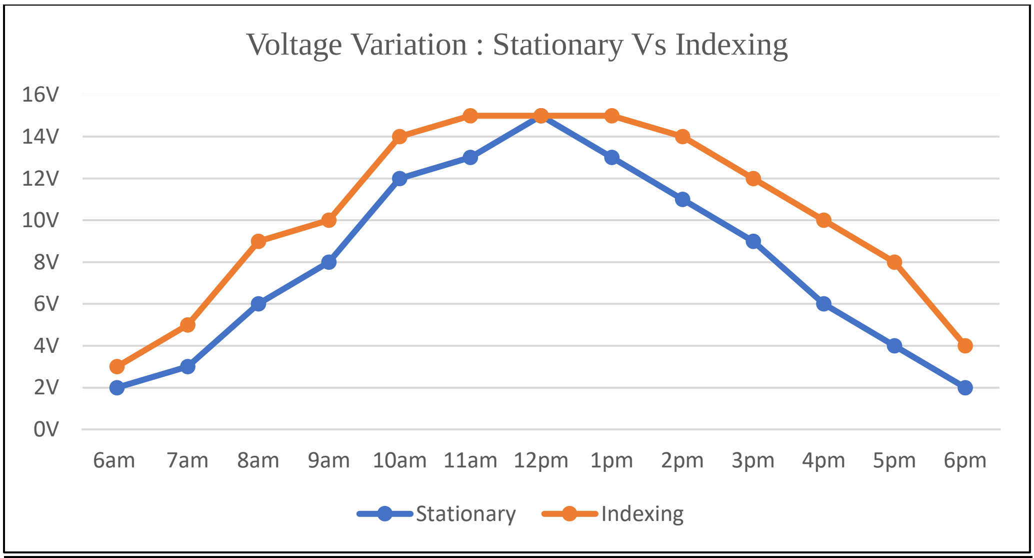
5. Considering that much more electricity can be delivered by the solar array coupled to a solar tracking device, this means that the overall cost of a system can be significantly decreased.

6. Solar electricity is now considerably more cost-effective than it was when it was produced using stationary solar panels since more energy can be extracted from a single solar panel while lowering the cost per watt.

7. While a two-axis tracker would still provide more electricity, a single axis tracker like the one created delivers a significant power gain over a fixed solar panel. This might be a topic that merits more exploration.

8. The easiest way to boost a solar power system's overall effectiveness for household or business users is by using solar tracking.





IV. CONCLUSION

The solar tracker prototype was tested when it was finished to make sure it adhered to design parameters. It worked as intended and according to the design specs. A test revealed that the power gained by precisely tracking the sun is less than the power utilised by the tracker system. The most significant finding of this study is how inexpensive it is overall to build a tracker system. This indicates that the system can be mass produced for less money and at a price that many communities in developing nations can afford.

1. After creating the solar plate indexing system, we came to the conclusion that, when taking into account mechanism losses, it is possible to raise the efficiency of the current solar power systems.

2. Expensive at first but a one-time purchase that requires no upkeep.

3. Because of its straightforward and efficient use of space, it may be replaced with modern power systems.

4.Can be used for domestic purpose and it can charge battery more in less amount of time.

5. As a result, the prototype was successful because it increased efficiency.

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