

AUTONOMOUS SOLAR TRACKING WITHOUT POWER CONSUMPTION

Submitted in partial fulfillment of the requirements for the award of

Bachelor of Engineering Degree in
Electrical and Electronics Engineering

by

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(DEEMED TO BE UNIVERSITY)
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **LOGESHWARAN J** (Reg. No. 39140026) and **GUNAL N** (Reg. No. 39140015) who carried out the project entitled "**AUTONOMOUS SOLAR TRACKING WITHOUT POWER CONSUMPTION** " under our supervision from February 2022 to April 2022.

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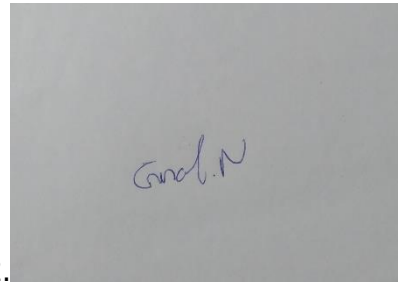
DECLARATION

LOGESHWARAN J (Reg. No. 39140026) and **GUNAL N** (Reg. No. 39140015) who hereby declare that the Project Report entitled “**AUTONOMOUS SOLAR TRACKING WITHOUT POWER CONSUMPTION**” done by us under the guidance of **Dr. M. Kavitha** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

1.



2.



DATE: 27.04.2022

PLACE: Chennai

SIGNATURE OF THE CANDIDATE

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ABSTRACT

Of all the renewable energies, solar energy is the only energy gained its popularity and importance quickly. Through the solar tracking system, we can produce an abundant amount of energy which makes the solar panel's workability much more efficient. Perpendicular proportionality of the solar panel with the sun rays is the reason lying behind its efficiency. peoples are compelled to purchase a number of panels in order to meet their energy demands or purchase single systems with large outputs. Availability of the solar cells types with higher efficiencies is on provided they are too costly to purchase. Ways to be accessed for increasing solar panel efficiencies are a plethora in number still one of the ways to be availed for accomplishing the said purpose while reducing costs, is tracking. Tracking helps in the wider projection of the panel to the Sun with increased power output. It could be dual or single axis tracker.

The main challenge in the solar field is the less amount of solar energy captured by photovoltaic (PV) systems. To increase the efficiency of the solar power generation system we need to get maximum output from the panel. This can be done by using a moving solar power generation system instead of a standing one. According to the researches done, it can increase the generation from 25% to 38%. In this project, we have developed an autonomous tracking system which will get aligned with the sun without any computer control, GPS information, Batteries or power supply and thus ensures the maximum power generation from the Solar Panels.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL BACKGROUND

Energy day by day is put to use at its best to fulfil the desires and ambition of the peoples at large. Each and every corner of our life is caged with various layers of impediment and in this response, energy is becoming an indispensable factor. Therefore, the source of energy needs to be endless/ perpetual in order to carry this colossal population ahead. Human beings being evolutionary in nature are perhaps the best ever creation of nature is always in the race of envisaging the probable and available comforts and benefits in every possible angle in this perilous world.

Taking a look at the present scenario it is evident that conventional sources of energy such as coal, natural gas, oil, etc. are at the edge of extinction. Being in mortal combat with time itself to fulfil every demand for energy the demand for these resources for energy has escalated to its zenith. The conventional use of energies due to the burning of fossil fuels like coal, oil and natural gas, the whole environment is getting polluted. The present project, therefore, is orchestrated with components like DC Motor, Photovoltaic array etc. according to which while the functioning of, unlike other use of the conventional energies, would not emit any pollution and in turn act as a reservoir of energy taken from the Sun itself. As adumbrated no other energy is more abundant than solar energy as per as its availability and freeness are concerned, utilization of which, compounded with rest of the fact of its conversion into electrical energy. Historically if counted, in the year 1881 for the first time ever solar panel was invented. Later on, all through the hands of Russell Ohl in the year, 1941 concept of the solar cell was conceived and subsequently workability of a solar panel has also advanced in comparison with the earlier span. Though it is improbable still it is not impossible as per as tracking of the mother energy is concerned in furtherance to which attempt has been taken through this project to confine every drop of energy from being left

out. The DC Motor adjacent with the system with the help of LDR module by measuring the intensity of the sun rays fixed on the upper edge of the solar panel will help the solar panel to revolve around proportionately with the movement of the Sun itself in order to grab and store the maximum amount of energy as it can. In pursuance of such objectivity, this project comes forth into existence.

When heat is the source of every creation, Sun produces the biggest ever energy in this solar system to produce and transcend life from one organism to the other. In this response, the project called "Automatic Solar Tracking System" serves the purpose of utilizing the maximum amount of energy taken from the Sun and to convert such energy into some other production. The basic is crooned to scoop out from this project in making this system an economically convenient subject, accessibility of which is easy and functioning of which is optimum in the end. In the wake of technological advancement when the pace of time is at its best to pass by, this system is a time worthy production, produced to create the best of its kind. In a stretch, it could be signified that this project which is an extension of solar energy, is a renewable source of energy, never-ending phenomena. It's only 10 to 20 per cent of the solar cells that are being used commercially out of which the best potential of the cells gets reflected and therefore scope for better use of the solar cells exist.

In the world of pollution, this system is an eco-friendly alternative, hence a valuable asset. When the ocean of pollution is encumbering every corner of life, this system would be able to create ripples of hope in the midst of this bustling civilization. The survivability of this system lies upon its workability. In the trend of comparison with other mind-boggling systems, it could be a trailblazer.

1.2 LITERATURE SURVEY

A design built by NASA for the new Parker Solar Probe that protects the probe from solar radiation if one of these sensors detects sunlight it means that the probe has rotated away from the Sun in such a way that the heat shield is no longer protecting everything behind it and the computer is sent a signal to adjust the rotation of the craft so that all of the light sensors once again find themselves in the shade in this way the Parker Solar Probe can automatically adjust to keep his heat shield facing the Sun without requiring any communication from Earth this solution that NASA used for their probe we realized could be simplified even further .



Figure 1.1: Parker solar probe

1.3 SCOPE OF THE PROJECT

In this project we have proposed different method for tracking the sun, While comparing this with our existing model, The proposed model Works autonomously work without any external power supply for rotating the solar panel, This type of system can be used in the area where there is minimum or no External power supply.

1.4 ADVANTAGES

- High efficiency
- Maximum power output
- Less Maintenance
- No communication required

CHAPTER 2

THEORITICAL BACKGROUND OF SOLAR TRACKER

2.1 THE EARTH ROTATION AND REVOLUTION

The position of the sun changes continuously throughout the day. It is due to the motion of earth that we experience sun at different angles in the sky. Earth exhibit two types of motion. One is the motion of earth along its own axis, and the other is the earth revolving around the sun. the motion of the earth along its own axis, known as rotation, results in the phenomenon of days and nights. One rotation of the earth takes 23 hours and 56 minutes. On its own axis, the motion of the earth is west to east

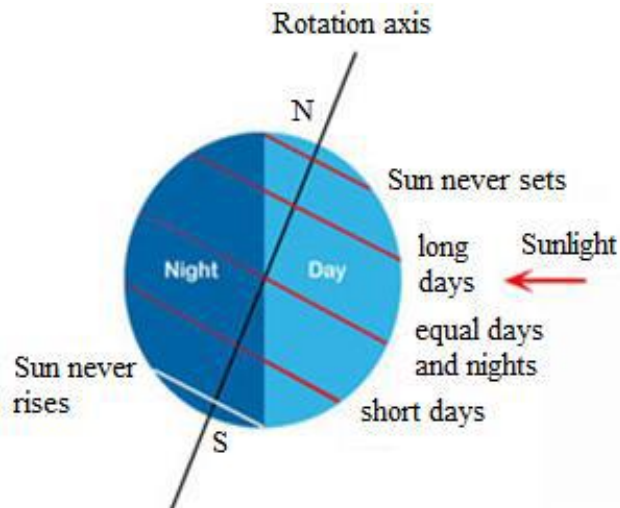


Figure 2.1: Earth Rotation

Revolution, that is the motion of the earth around the sun is responsible for the different seasons in the year. The earth takes 365 days to revolve around the sun. Earth revolves around the sun in an elliptical orbit and the plane covered by the earth during the revolution is known as an ellipsis. The axis of rotation and ellipsis makes an angle of 66.5 degrees between themselves. This is the explanation behind the summer/winter solaces and spring

autumn equinoxes. Due to these motions of the earth, the amount of sunlight received throughout the year varies.

Sunlight is the electromagnetic radiation from the sun expropriated by the earth. The total power given off by the sun into space is much more than that intercepted by the earth

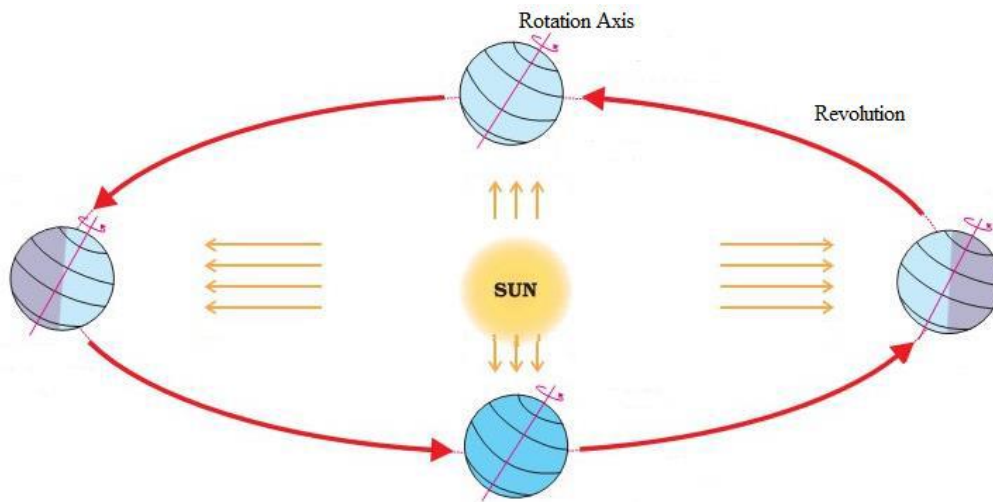


Figure 2.2: Earth Rotation and Revolution

Within a given period of time, the emission of solar radiation is somewhat constant and the intensity this radiation hitting a unit area of the earth's crust is also constant, known as solar constant. The value of this solar constant can be expressed as: -

$$GSC = \sigma \cdot T^4 \left(\frac{4\pi R}{4\pi D} \right)^2 = 1367 \text{ W/m}^2$$

In the above expression, σ is termed as Stefan Boltzmann Constant with a value of $5.67 \times 10^{-8} \text{ W/m}^2, \text{ K}^4$, R is known as the radius of the Sun, $696 \cdot 10^6 \text{ m}$ and D is $150 \cdot 10^9 \text{ m}$, the average distance between the Sun and the earth.

The absorption of solar radiation on the surface of the earth also varies with different parameters. Latitude and longitude are one of the prescribed parameters. Latitude the horizontal imaginary line, parallel to the equator, is the angle suspended by the arc linearly join a person's position and the equator, at the center of the earth. On the contrary longitudes are the vertical imaginary lines, where longitude is the angle suspended by the

arc joining the north-pole and south-pole as well as passing through the given location, linearly with the Greenwich meridian, at the center of the earth. The latitude and longitude express north-south and east-west directions respectively on the earth.

The sunlight is observed at different angles depending on the place on the earth and the angles of the sun. The sun's angle can be classified into the following: -

- Elevation Angle
- Zenith Angle
- Azimuth Angle

The elevation angle is the angle made by the sun with the horizon. The elevation angle is 0 degree at sunrise and 90 degrees around noontime, at the equator. The elevation angle is different at a different time of the day and different for different latitudes. The depicted formula can be used to determine the elevation angle.

$$\alpha = 90 + \varphi - \delta$$

When the equation above gives a number greater than 90° then subtract the result from 180°. It means the sun at solar noon is coming from the south as is typical the northern hemisphere.

φ is the latitude of the location of interest (positive for the northern hemisphere and negative for the southern hemisphere).

δ is the declination angle, which depends on the day of the year.

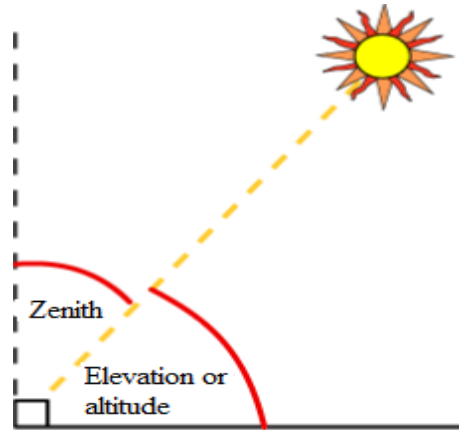


Figure 2.3: Angle of elevation and zenith angle

Zenith angle is akin with elevation angle. The only difference being it is measured along the vertical. Therefore, it's the angle between the sun and the vertical i.e Zenith Angle = $90^\circ - \text{elevation angle}$.

$$\zeta = 90^\circ - \alpha$$

Azimuthal Angle, this is the compass direction from which the sunlight is coming. At solar noon, the sun is directly south in the northern hemisphere and directly north in the southern hemisphere. The azimuth angle varies throughout the day. At the equinoxes, the sun rises directly east and sets directly west regardless of the latitude. Therefore, the azimuth angles are 90 degrees at sunrise and 270 degrees at sunset

Sunrise and Sunset time can be formulated by the following formulas-

$$\text{Sunrise} = 12 - 115^\circ \cos^{-1}(-\tan \phi \tan \delta) - TC60$$

$$\text{Sunset} = 12 + 115^\circ \cos^{-1}(-\tan \phi \tan \delta) - TC60$$

Where ϕ being the latitude of the place, δ being the declination angle and TC is the Time Correction.

2.2 TYPES OF TRACKERS

Table 2.1 Types of Solar Trackers

Types	Specification
Active Solar Tracker	• It uses motors and gear trains or direct drive actuators, to follow the movement of the sun. • Directed by a controller. • Deactivates during darkness based on the design of the system. • It uses a light sensor to locate the angle at which maximum sunlight can be absorbed. • The MCU directs the solar panel to change the angle.
Passive Solar Tracker	• It uses a liquid, easily compressible and boiled. • It is driven by the solar heat. • The fluid moves when heated, like a teeter-totter and hence the solar panel moves.
Chronological Solar Tracker	• Works with the rotation of the earth. • Have no sensors. • Depends on the geographical location. • Uses a controller to calculate the moment and position of the earth with respect to the sun at a given time and location.
Single Axis Tracker	• Tracks in a single cardinal direction. • It has a single row tracking configuration. • More reliable. • It has a longer lifespan. The common categories in which single axis trackers can be classified holds: • Horizontal single axis trackers (HSAT). • Horizontal single axis tracker with tilted modules (HTSAT). • Vertical single axis tracker (VSAT).

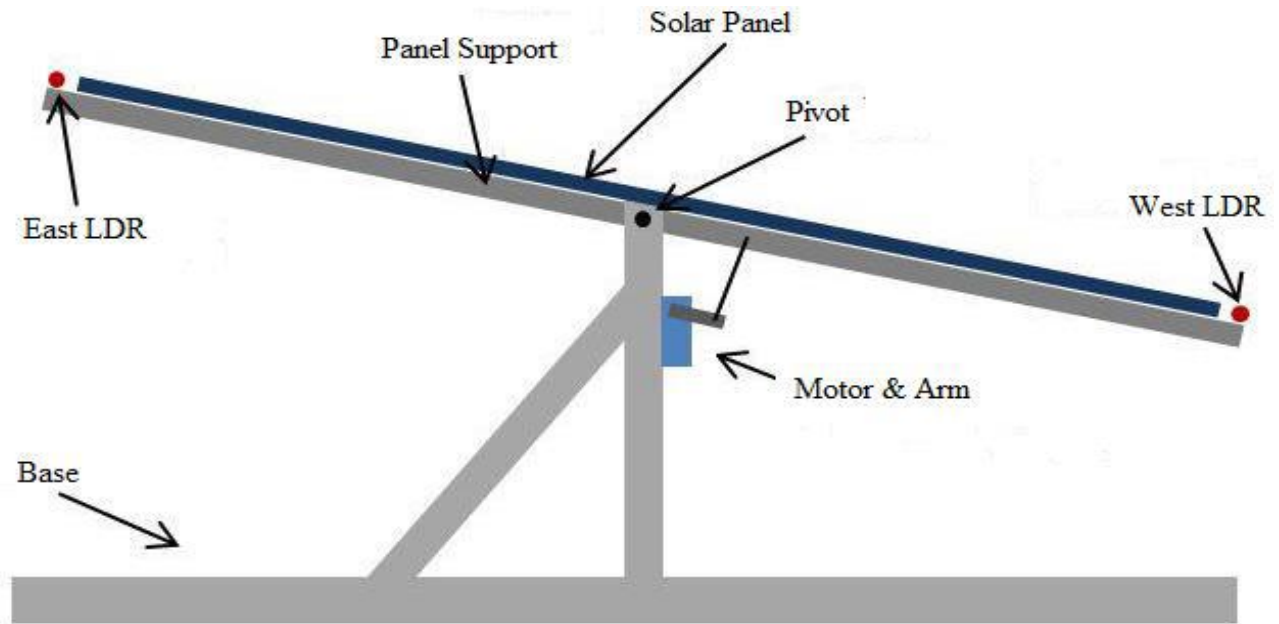


Figure 2.4: Single Axis Tracker

Table 2.2 Dual Axis Tracker

Dual Axis Tracker	• It moves along two cardinal directions (Horizontal & Vertical). • The axes are traditionally orthogonal. • Its efficiency is much more than any single Axis Tracker. • It conventionally follows the movement of the sun and hence captivates maximum solar radiations.
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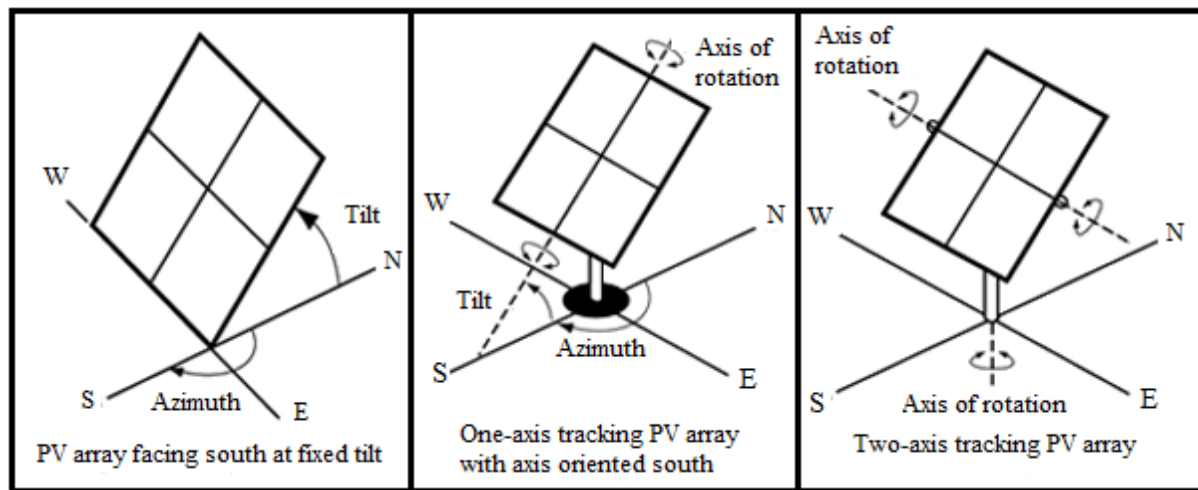


Figure 2.5: Dual Axis Tracker

2.3 ADVANTAGES OF SOLAR ENERGY

- The process of attaining solar energy is unsoiled.
- It is a renewable source of energy.
- The investment is done only during the installation of solar panels, the expenses of acquired solar energy after installation is little.
- Solar energy is a perennial source of energy.
- There is no adulteration in the process of acquiring solar energy.
- The yield rate is very high, using solar panels.
- It requires the least maintenance, once the setup is installed.
- Solar energy is very useful and can be easily drawn into applications in rural areas where the extraction of electricity is difficult.
- Solar energy does not create noises compared to the noises created by the machinery in the extraction of other natural resources.

CHAPTER 3

PROJECT DESCRIPTION

3.1 BLOCK DIAGRAM

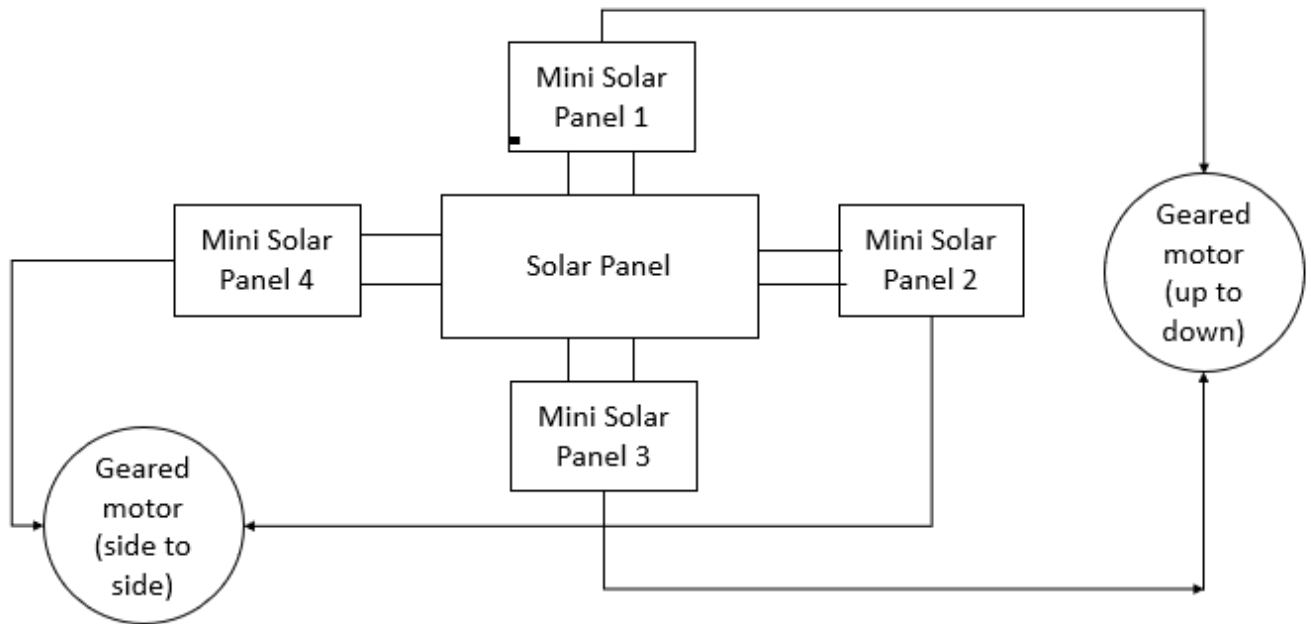


Figure 3.1: Block diagram of proposed model

3.2 PROJECT CONCEPT EXPLANATION

We are built an autonomous solar tracking device this is a device that follows the Sun without any computer control or GPS information it doesn't need batteries or power supply.

- ▶ A sunflower anticipates daybreak, much like a rooster does before starting to crow. At sunrise, sunflowers face east to greet the first rays and continue to move with the sun until it sets in the west. Overnight, the sunflower head swings back around so it faces east at dawn.
- ▶ The stems of young sunflowers grow more during the night, but only on the west side which allows the sunflower head to bend eastward. During the day, the stem's east side grows, resulting in a swaying motion to the west with the sun. As the sunflower matures, that overall growth starts to slow down. Essentially, the older plants settle on facing east as it reacts more strongly to light early in the day than later on, so it gradually stops moving.
- ▶ Heliotropism, also called phototropism, is most apparent in immature sunflower buds. As the flowers develop, they lose their flexibility of movement. A flexible segment of the stem just below the flower responds to pressure within the motor cells, causing the sunflower to turn toward light. The plant tracks light to enhance photosynthesis, the process of creating food from light. Heliotropism also increases the flower temperature, which attracts bees and other pollinators. The rise in temperature increases the rate of pollen germination. Mature sunflowers with stiffer stems become stationary, facing the rising eastern sun. Similar to a sunflower, solar tracking results in more efficient way of producing green energy

PRINCIPLE IDEA

When the sun moves from east to west solar panels are always pointing towards the direction of the sunrays normal to the panel. This results in producing more electron

flow and generate more electricity. This can be achieved by placing the solar panel on a frame and constraining its motion along x, y, z linear motions and allowing to move to rotate about x, y axis.

3.3 EXISTING MODEL

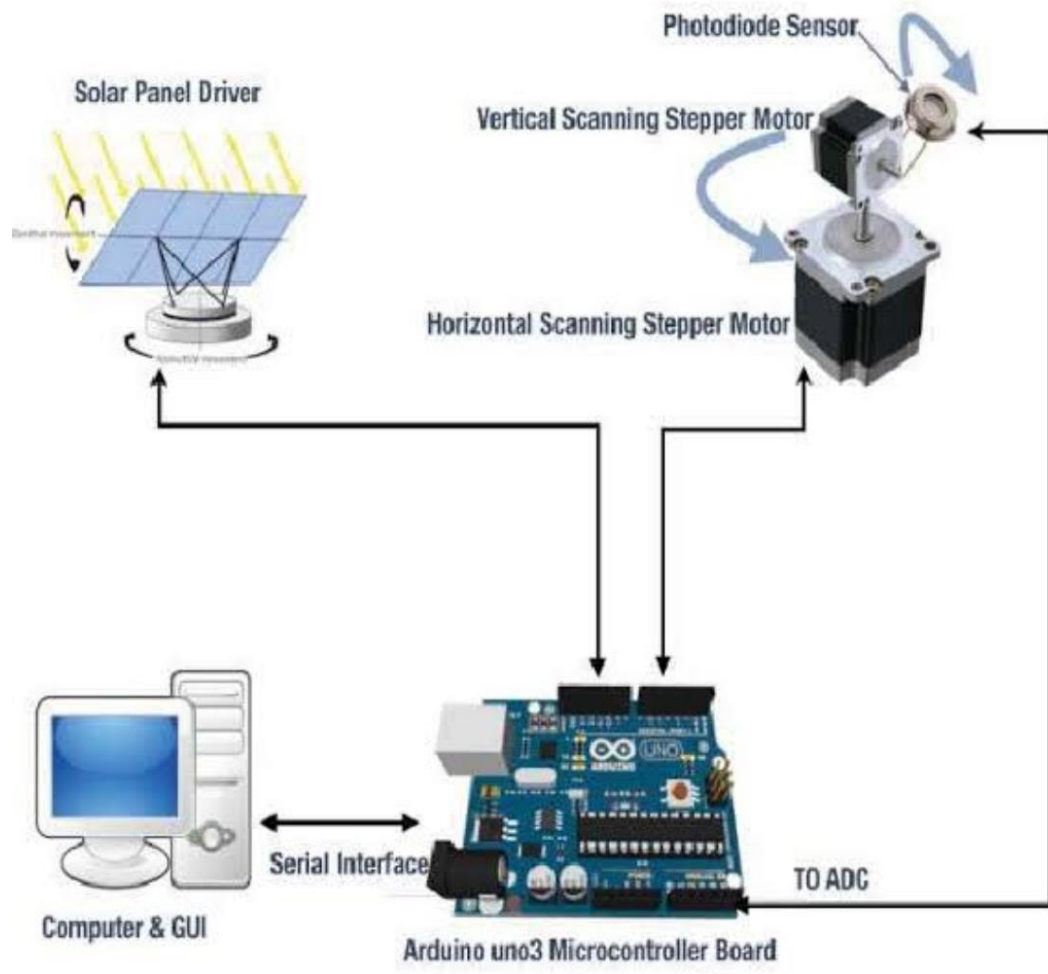


Figure 3.2 Existing solar tracker model

CHAPTER 4

PROPOSED SYSTEM

4.1 OUR PROJECT DESIGN

we are built an autonomous solar tracking device this is a device that follows the Sun without any computer control or GPS information it doesn't need batteries or power supply.

A solar tracker is useful for any sort of solar energy project if you have solar panels they'll be much more effective at producing electricity if we can make them follow the Sun as it moves through the sky likewise if we're using something like a parabolic mirror to heat water it's essential that the mirror tracks with the Sun so that the focal point doesn't move off of your target with this solar tracker all we have to do is take it outside and it does the rest presuming the Sun ever comes out from behind the trees which should happen to any minute now. up until now the only solar trackers we've seen require astrological or GPS information to be processed by a computer to know where in the sky the Sun will be on certain dates and times and then the computer tells a series of motors which direction they should point the panel for a long time we've been trying to come up with a simpler way to do this.

For example: The leaves and flowers on many plants follow the Sun throughout the day without any way to process information plants don't have a brain but somehow they accomplish this task simply by detecting where the light is and moving accordingly, the elegance of this natural function is something that have thought about many times but we couldn't figure out a simple way to translate it into a mechanical design

instead of using light sensors and a computer to process sensor information we realized we could use tiny solar panels to run small electric motors directly if one of the solar panels on this design is exposed to sunlight it generates enough electricity to power up one of these tiny geared motors which rotates to the swiveling mount until the solar panel is back

in the shade causing the motor to turn off there are two motors one for panning the mount side to side and one for tilting it up and down each motor is connected to two solar panels with the wiring in opposite configurations so that the motor spins in one direction when this panel is exposed in the opposite direction when this panel is exposed for this prototype we just using a piece of cardboard instead of a real solar panel or parabolic mirror on the front but it doesn't matter the tracking function works the same with anything that casts a shadow

These solar panels should be spaced such that whatever we have in front of this tracker covers them in its shadow when it's properly aligned with the Sun but as soon as the Sun moves a certain distance out of alignment the shadow moves with it a solar panel gets exposed and the tracker will adjust the further back these panels are from the object in front of them the more accurately this tracker will follow the Sun because they will become exposed to sunlight at a shallower angle the limiting factor to moving the panel's very far back is that once the Sun sets and then Rises again on the next day on the opposite horizon it will be shining at such an obtuse angle compared to where the solar tracker was facing at sunset that none of the panels will be in the shade and the motors won't know how to adjust this can be mitigated by making the whole setup larger in diameter so that the detection panels are further apart and it's harder for the Sun to find an angle where it would shine on all of them because of this this design should work even better.

To put a vertical Sun Shade between them this is an easy enough modification that maybe it's worth doing to this design by default what I've made here is a pretty rough model having pieced it together with wood and rubber bands but we think the design is a good one something like this we are really hope is useful to a lot of people in producing alternative energies.

4.2 COMPONENTS

1. Geared Motor



Figure 4.1: Picture of Geared motor

2. Four Mini Solar Panel

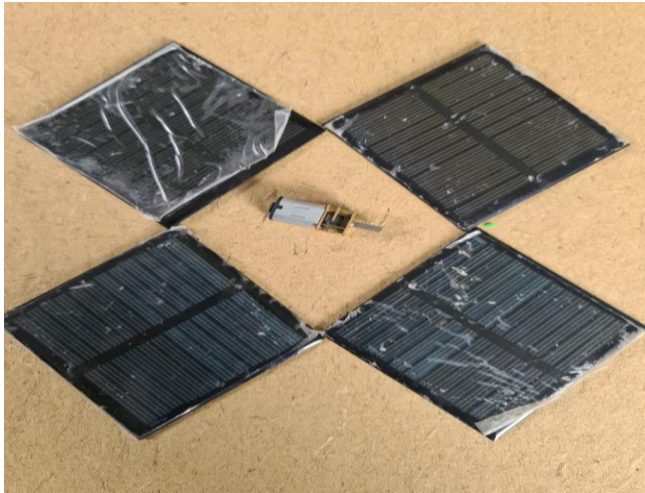


Figure 4.2: Picture of Solar panels

- ▶ Main solar panel is placed on a rotating mount. Below the main panel 4 mini solar panels are placed in a plus pattern
- ▶ These panels are placed at a distance from main panel in such a way that when the sun is normal incident to the main panel no mini solar panels are exposed to sun. All the mini panels should be under zero exposure by the shadow cast by the main panel.
- ▶ 2 geared motors are placed below the mini solar panels in which one of them is placed in a top facing manner and the other sideways.
- ▶ The top facing geared motor is connected to top and bottom mini solar panels with opposite polarity. This motor controls the y-axis rotation (i.e. xz plane) of the main panel
- ▶ The side facing geared motor is connected to left and right side mini solar panel. This motor controls the x-axis rotation (yz plane) of the main panel

- ▶ The geared motor is connected to disc type attachment of the frame by belt drive. This helps the frame to rotate along the corresponding axis.
- ▶ The frame is designed with several hinges to support the rotational movement.
- ▶ The hinge frame and solar panel has 2 Degrees of freedom(Dual-axis tracking).
- ▶ Prototype Components:
 - * 0.6w,5V Mini solar panels (4 numbers)
 - * gear motor electric 6v dc ,30 rpm(2 nos.)

4.3 PROJECT PROTOTYPE

4.3.1 WORKING:

- ▶ When any one of mini panel is exposed to the light it will generate a small volt of electricity which is enough to run the geared motor. The rotational motion of geared is transferred to the disc type attachment of the frame.
- ▶ The design is in such a way that when one mini panel is exposed to light the other mini panels should be under zero exposure because of the shadow cast by main panel. This prevents the misguided tracking.
- ▶ The connections are in such a way that when lights is incident on a right mini panel the stepper motor corresponding to it rotates clockwise then when light exposes left mini panel the motor rotates anti clockwise.
- ▶ Similarly when light hits top panel motor rotates clockwise and when on bottom panel motor rotates anti clockwise.
- ▶ When the main solar panel is normal to the Sun the motor stops rotating as there will be no mini panels exposed to the sunlight.

Prototype Fabrication



Figure 4.3: Front view of Prototype

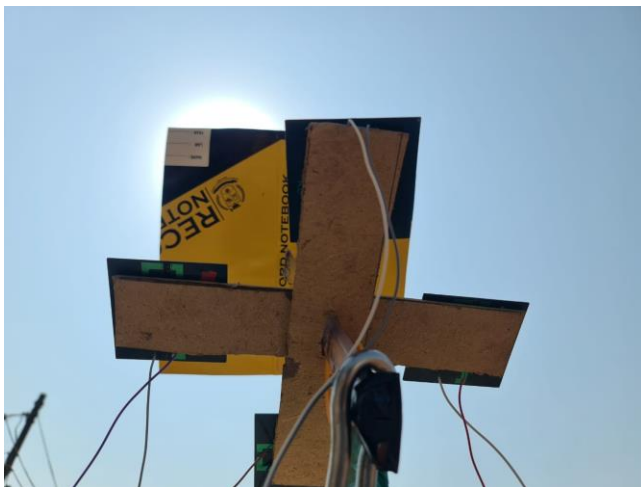


Figure 4.4: Back view of Prototype

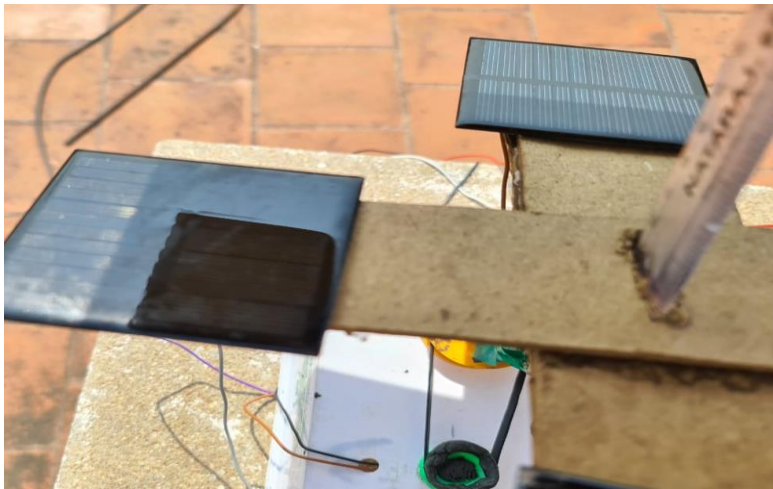


Figure 4.5: Lateral view of Prototype

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 SUMMARY

- We have designed a Autonomous solar tracking system which can collect maximum amount of sunlight on the solar panel. It will that follows the Sun without any computer control or GPS information and with the use of mechanical drives and we eliminated the need of electronics like sensor and battery as power source for solar tracking. By using this autonomous solar tracker, we can produce an abundant amount of energy which makes the solar panel's workability much more efficient than normal solar trackers. The proposed method is scalable to full size system and also avoids usage of the main solar panel's power output for tracking which decreases efficiency of main panel

5.2 FUTURE SCOPE

In our Project, for a time being we have completed up to single axis tracking and Dual axis will be carried out in Future to increase the efficiency higher than the current state.



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