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# Model For Dual Axis Solar Tracking System

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## ABSTRACT

*The Solar panels are those gadgets that take in solar radiation and turn it into either heat or power. In essence, a solar panel is an assembly of solar cells, also known as photovoltaic cells, which can produce energy through the process of photovoltaiceffect. solar collector, reflector, or photovoltaic panel can be oriented towards thesun using a technique called solar tracking.Tracking device ensures that the solar collector automatically tracks the sun's path across the sky and maintains the ideal angle to maximise solar radiation. This paper reported the developed a laboratory prototype of a solar tracking system to enhance the performance of the photovoltaic modules in a solar energy system. The designed principle of the device is to keep the photovoltaic modules constantly aligned with the sun beams to maximizes the exposure of solar panel to the Sun. This is aimed to increase the output power from the solar panel.*

*KEYWORDS: Dual Axis Solar Tracker, Photovoltaic Cells, modelling.*

## 1. INTRODUCTION

About 90% of solar energy is carried by the "direct beam" of sunlight, and the remaining portion is carried by the "diffuse sunlight"—which on clear days is primarily the blue sky and on cloudy days makes up a bigger portion of the total. The Sun must remain visible to the panels for the longest amount of time in order to maximize collection, since the most of the energy is in the direct beam. On cloudier days, though, the proportion of diffuse to direct light can drop to 60:40 or even lower. The cosine of the angle formed by the incoming light and the panel is the point at which the energy delivered by the direct beam decreases. Furthermore, the reflectance is roughly constant when averaged over all polarizations.

A solar tracker is a device that positions solar panels or photovoltaic cells in thedirection of the sun to maximize the amount of solar energy received. A dual- axis solar tracker is a type of solar tracker that moves solar panels or cells in wo different directions, both azimuth (East-West) and elevation (North-South),to track the sun's movement throughout the day and year.

Dual-axis solar trackers are more efficient than single-axis solar trackers or fixed solar panels since they can follow the sun's movement more precisely and generate up to40% more electricity. They are especially useful in regions where the sun's angle changes significantly throughout the year, such as high latitudes or areaswith long daylight hours in summer. Dual-axis solar trackers use sensors and control systems to detect the positionof the sun and adjust the angle of the solar panels accordingly. The control system may be mechanical, electrical, or a combination of both, and it can beprogrammed to optimize the tracking accuracy, speed, and energy output. However, dual-axis solar trackers are more complex and expensive than othersolar tracking systems, and their maintenance and installation require professional expertise.

Some of the light that is intercepted is reflected at the panel's surface rather than being sent into it entirely. The refractive index of the surface material and the angle at which the incoming light strikes its source determine how much is reflected. Additionally, the amount reflected varies with the polarization of the incoming light. All polarizations are mixed together in identical proportions when sunshine enters the room from direct sunlight. Reflective losses, when averaged over all polarizations, are roughly constant at incidence angles up to about 50°, after which they rapidly increase. Take a look at the accompanying graph, which is suitable for glass.

The Dual-axis solar trackers are used tomaximize the energy output of large-scale solar farms, reducing the number of solar panels required to produce the same amount of electricity. Dual-axis solar trackerscan be used in residential and commercial rooftop solar systems to increase energy efficiency and reduce energy costs. Dual-axis solar trackers can be usedin off-grid and remote areas where electricity is not available or unreliable. They can help to improve energy independence and reducethe need for backup generators or batteries. These trackers can beused in solar-powered water pumping systems to increase the efficiencyof the pumping process and reduce the energy required.

**2. LITERATURE SURVEY**

The most significant outcome of industrialization, technological advancement, and population growth is energy consumption. The world's need for energy is rising daily as it develops and grows. But as people started using clean, sustainable energy sources to live in a cleaner environment, the proportion of fossil fuels in the energy supply is declining. Because they are clean, sustainable, and friendly to the environment, renewable energy sources are crucial for meeting future energy needs. Furthermore, the use of renewable energy sources has led to a rapid increase in energy production globally in recent years. Researchers have performed many theoretical and experimental studies on solar tracking systems analysis.

Hossein Mousazadeh et al, [[1] in his investigation has built a sun tracking system and assessed on a movable structure using four light-dependent resistive sensors. Thirty percent more energy was captured using the sun-tracking system than with the horizontally fixed mode, according to experimental studies.

The direct sun rays were detected using four LDR sensors. To act as a shade device, an obstacle was placed between each pair of LDRs. The interface between the hardware and the software was an electronic drive board with a microcontroller. Each motor was driven by a power MOSFET, which managed the actuators. The outcomes of the trial showed that the system was extremely

Balabel et al. [2] optimized the operational efficiency of solar photovoltaic modules through mathematical analysis. He concentrated on the control system's design and testing. The study's foundation was the altitude angle computation at Taif, Saudi Arabia. The study demonstrated that, depending on how it is controlled, the sun tracking algorithm can be split into closed-loop and open-loop systems. Rhif et al. (2010) reviewed the literature on the tracking procedure for the dual axis sun tracker using a sliding mode control law. This autonomic dual axis sun tracker can increase power production by up to 40%. The outcome demonstrated the strength, value, and excellent quality of the sliding mode control in the tracking process.

According to Madhu et al. [3], a single axis tracker tracks the sun's eastward movement, while a two-axis tracker tracks the sun's daily eastward movement and the seasonal declination movement. Through the use of mirrors or lenses, a broad area of sunlight is concentrated into a narrow beam. PV uses the photoelectric current to convert sunlight into electric current. According to test results, monitoring solar plates have a 26–38% higher electricity efficiency than fixed plates on a daily basis. Additionally, it varies to some extent on overcast or wet days. In general, solar panels do not move in response to changes in the sun. This project uses a solar tracker gadget that monitors

A. Aktaş et al. [4] has developed single-axis solar tracking devices move in a single direction, either vertically or horizontally, to track the sun. Typically, the inclination angle is manually changed at specific times throughout the year, and there is automatic east-west movement. While single-axis systems are less expensive than two-axis systems, their efficiency yields are lower. Depending on the solar trajectory and the meteorological conditions, single-axis solar tracking systems move on either the vertical or horizontal axis.

C. J. Nwanyanwu [5] explained that it is critical to align PV modules or solar collectors with the daily variations in solar irradiation for the best possible solar radiation harvesting. In Kumasi, Ghana, a photo sensor-based solar tracking system was designed and tested. A quadrate array of sensors, comprising four Light Dependent Resistors, a Potentiometer, Servo motors, and a Microcontroller, is part of the solar tracking system. The system's maximum angle of tolerance is two degrees in case the system exhibits any discernible reaction to the sun's movement. To illustrate the functionality of the design, an experiment was run on the operational system. Issues and potential fixes were also discussed.

One of the main problems that dual-axis solar trackers aim to solve is the inefficient use of solar energy due to the fixed position and orientation of solar panels. Fixed solar panels have a limited energy output because they can only capture a portion of the sun's energy depending on their orientation and the angle of the sun., Additionally, the angle of the sun changes throughout the day and year, resulting in further energy losses. Single-axis solar trackers can improve energy output by rotating solar panels in one direction, but they cannot compensate for the changes in the sun's elevation.

Therefore, the problem statement that dual-axis solar trackers aim to address is the need to maximize the energy output of solar panels by following the sun's movement in both azimuth and elevation directions. By adjusting the position and orientation of solar panels to face the sun directly, dual-axis solar trackers can increase energy output and reduce energy costs for users, making solar energy more accessible and cost-effective.

## 3. SIMULATION MODEL

The three Light Dependent Resistors (LDRs) are placed on a common plate with solar panel. Light from a source strikes on it by different amounts. Due to their inherent property of decreasing resistance with increasing incident light intensity, i.e photo conductivity, the value of resistances of all the LDRs is not always same.

Each LDR sends equivalent signal of their respective resistance value to the Microcontroller which is configured by required programming logic. The values are compared with each other by considering a particular LDR value as reference. One of the two dc servo motors is mechanically attached with the driving axle of the other one so that the former will move with rotation of the axle of latter one.

The axle of the former servo motor is used to drive a solar panel. These two-servo motors are arranged in such a way that the solar panel can move along X-axis as well as Y-axis. The microcontroller sends appropriate signals to the servo motors based on the input signals received from the LDRs. One servo motor is used for tracking along x-axis and the other is for y-axis tracking. In this way the solar tracking system is designed.

Solar panels, made up of photovoltaic (PV) cells, capture sunlight particles or photons. Using a semiconducting material such as silicon, the PV cells convert the sunlight into useable direct current (DC) electricity. An inverter connected by wires to the solar panels turns those direct currents (DC) into alternating current (AC) electricity on a much grander scale than the AC/DC plug on your small appliance. The AC goes to the electrical or breaker box panel in your home or business to power the lights, computers and other appliances

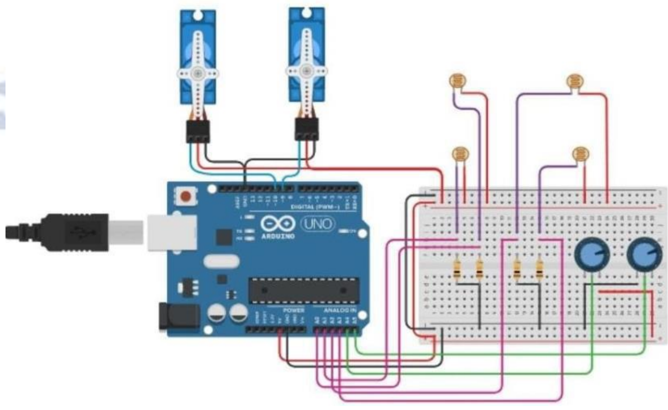

Figure.1-Aurdino circuit of the panel

The utility company meter at your home or business will measure how much energy is used, and how much is generated by the solar panels. This will tell you whether your system is generating enough energy from solar power to fully meet your needs or whether you are still taking some power from the electric grid. “Grid-tie” solar power customers tie their solar system into the local utility’s power grid, which allows them to sell any excess energy they generate into the grid for others to use. Others prefer to set up a stand-alone solar power system, keeping their homes “off-grid” and generating power solely for their own use. The panel layout is as shown in Figure-2

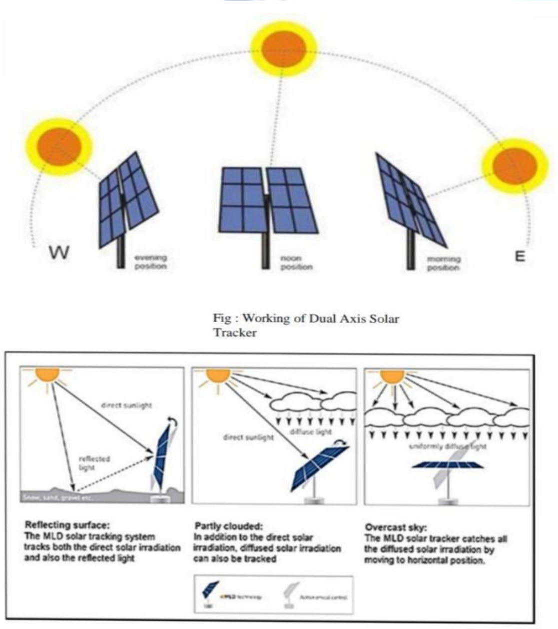

Fig : Working of Dual Axis Solar Tracker

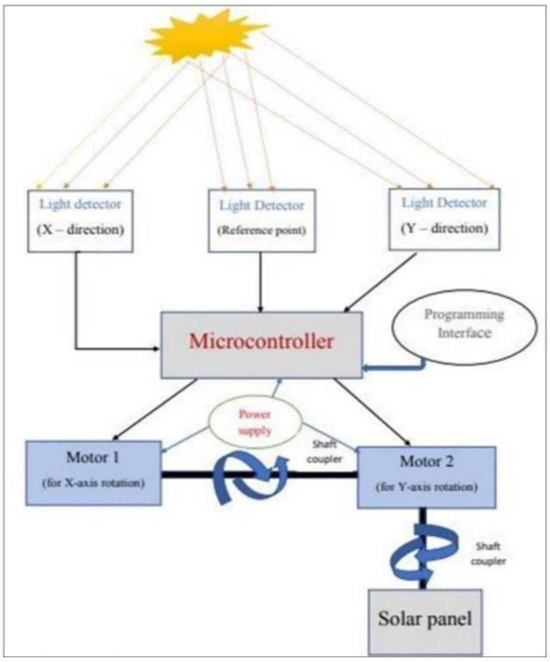


Fig.2- Panel Layout

## 4. SYSTEM PROGRAMMING

Program Code :-

```
#include
Servo myservo;
Servo ourservo;
int posx = 90;
// initial position is top int posy = 90;
int sens1 = A0; // (x,0)
LDR int sens2 = A1; // (0,0)
LDR int sens3 = A2; // (0,y)
LDR int tolerance = 2;
void setup()
{
myservo.attach(9);
// pin9 ourservo.attach(10);
// pin10 pinMode(sens1, INPUT)
; pinMode(sens2, INPUT);
pinMode(sens3, INPUT);
myservo.write(posx);
delay(1000);
// buffer delay
ourservo.write(posy);
delay(1000)
; }
```

## 5. RESULTS

Dual axis solar tracking systems can increase the efficiency of solar panels by up to 40% compared to fixed solar panels, leading to higher energy output and cost savings over time.The system can be used in various locations and environments, including areas with low sunlight, variable weather conditions, and high latitudes.

The cost and complexity of the system are higher than fixed solar panel systems, but the increased efficiency and energy output can provide a better return on investment in the long run.The space requirements of the system can be higher due to the moving components of the mechanism, which can limit the areas where it can be installed.

Dual axis solar tracking systems can reduce greenhouse gas emissions and promote a more sustainable energy future.Overall, the results of a dual axis solar tracking system project depend on several factors, including the design, materials used, location, and environment. However, the general advantages and disadvantages of the system can provide insight into its potential benefits and limitations for renewable energy applications.

The Time wise intensity is shown in Figure-3.

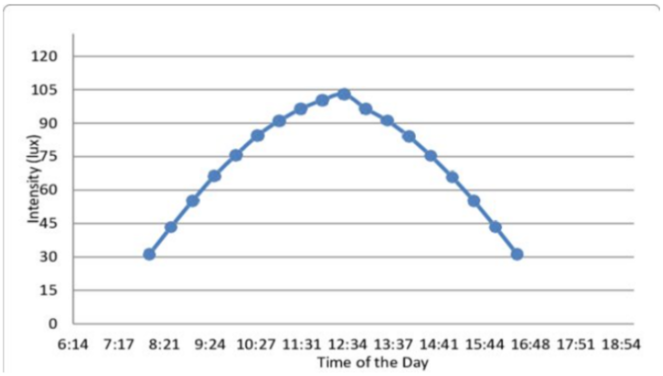


Figure 3. Day time wise intensity observed

## 6. CONCLUSION

In conclusion, the dual axis solar tracking system project is a promising solution to improve the efficiency of solar panels and generate more energy from sunlight. The system is designed to track the movement of the sun in two axes and adjust the position of the panels accordingly, maximizing their exposure to sunlight and increasing the amount of energy they generate.

While the system has several advantages, such as increased energy efficiency and versatility in different locations and environments, it also has some drawbacks, including increased cost and complexity and additional space requirements. These factors must be carefully considered before deciding to implement a dual axis solar tracking system.

Overall, the future of dual axis solar tracking systems looks promising, with potential future scopes such as optimization of the tracking algorithm, integration of advanced sensors and control systems, and exploration of alternative materials and designs. These advancements could further improve the performance and reliability of the system and make it more accessible and cost-effective for a wider range of applications.

In summary, the dual axis solar tracking system project is a valuable innovation in the field of renewable energy, and with continued research and development, it holds great potential for a more sustainable future

**Conflict of interest statement**

Authors declare that they do not have any conflict of interest.

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