FABRICATION OF DUAL AXIS SOLAR TRACKING SYSTEM

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ABSTRACT: Solar energy is coming up as a major source of energy. The need of the hour is renewable energy resources with cheap running costs. With the current systems for solar energy harvesting, we have high production only at fixed times mostly noon. This project proposes a dual axis solar tracker system that increases the productivity by a significant margin.

KEYWORDS
1. ***Solar energy***
2. ***Photovoltaic cells***
3. ***Solar Tracking system***
4. ***Dual axis***
5. ***Storage and conversion***
6. ***Utilization***

1 INTRODUCTION

During the last few years the renewable energy sources like solar energy have gained much importance in all over the world. Different types of renewable or green energy resources like hydropower, wind power, and biomass energy are currently being utilized for the supply of energy demand. Among the conventional renewable energy sources, solar energy is the most essential and prerequisite resource of sustainable energy.

Solar energy refers to the conversion of the sun's rays into useful forms of energy, such as electricity or heat. A photovoltaic cell, commonly called a solar cell or PV, is the technology used to convert solar energy directly into electrical power. The physics of the PV cell (solar cell) is very similar to the classical p-n junction diode. Sunlight is composed of photons or particles of solar energy. Semiconductor materials within the PV cell absorb sunlight which knocks electrons from their atoms, allowing electrons to flow through the material to produce electricity. Because of its cleanliness, ubiquity, abundance, and sustainability, solar energy has become well recognized and widely utilized.

Dual axis trackers are more efficient and increase the power output when compared to fixed trackers and single axis trackers.

1.1 SOLAR TRACING SYSTEM

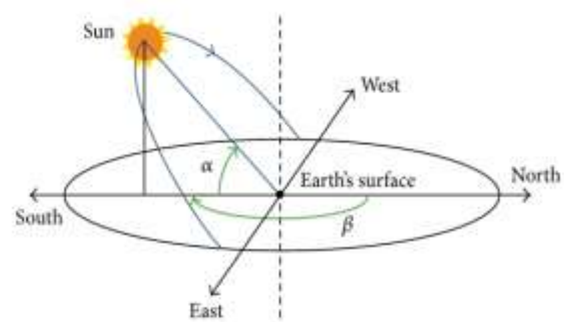
A Solar tracker is an automated solar panel which actually follows the sun to get maximum power. Even though a fixed flat-panel can be set to collect a high proportion of available noon-time energy, significant power is also available in the early mornings and late afternoons when the misalignment with a fixed panel becomes excessive to collect a reasonable proportion of the available energy. For example, even when the Sun is only 10° above the horizon the available energy can be around half the noon-time energy levels (or even greater depending on latitude, season, and atmospheric conditions). Thus the primary benefit of a tracking system is to collect solar energy for the longest period of the day, and with the most accurate alignment as the Sun's position shifts with the seasons.

1.2 TYPES OF SOLAR TRACKERS

Solar trackers are grouped under two basic categories: the single axis trackers and the dual axis trackers. The single tracker rotates east to west following the sun's movement, and the dual trackers include vertical and horizontal movements i.e. they can incline or tilt to account for winter and summer sun angles. Single Axis Trackers are trackers with only one degree through which they rotate or use as axis of rotation. This axis is usually aligned following the North meridian. They rotate azimuthally from east to west following the path of a sun. Double or Dual Axis Tracker have two different degrees through which they use as axis of rotation. The dual axis are usually at a normal of each rotate both east to west (zenithal) and north to south (azimuthally) .

1.3 SOLAR ANGLE

Illustration of the solar angles: (a) altitude angle, α; (b) azimuthal angle,β . The solar path corresponds to a day in the early fall or late winter seasons in the northern hemisphere, that is, just prior to the spring equinox or just after the fall equinox. Solar noon is the time of day when degree,α= 180,that is, the sun is directly at south and is halfway between sunrise and sunset.



1.4 CALCULATION METHOD

The optimum tilt angle is calculated by adding 15 degrees to your latitude during your latitude during summer.
For instance, if your latitude is 34°, the optimum tilt angle for your solar panels during winter will be 34 + 15 = 49°.
The summer optimum tilt winter, and subtracting 15 degrees from angle on the other hand will be 34 – 15 = 19°

2 LITERATURE REVIEW

Saravanan,C., Panneerselvam , M.A.; Christopher, I.W. A novel low cost automatic solar tracking system. *Int. J. Computer Appl.* **2011**. A PV system uses a PV module/panel/array to convert solar energy into electric energy. To extract the maximum output power from the PV module, a sun tracker can be used to track the sun direction. In fact about 20%–50% more solar energy can be captured depending on the geographic position by adding a sun tracker to a PV system. Sun trackers are divided into two types: single-axis and dual-axis. The sole axis of a single-axis sun tracker is aligned along the local north meridian ;it has only one freedom degree, so it can only track the sun in one direction which is the daily path of the sun. Dual-axis type has two freedom degrees, so it can track the sun path in the two directions which are daily and seasonal motions of the sun .A single-axis sun tracker increases the daily output power of a PV module up-to about 20% compared to a fixed PV module. A dual-axis sun tracker is more accurate to track the sun direction compared to a single-axis type .The output power of the PV module can be increased up to about 33% compared to a fixed PV module by utilizing a dual-axis sun tracker. Dual-axis trackers are classified into two types: sensor-based and sensor less sun trackers. A sensor-based sun tracker acts as a closed-loop system in which photo sensors are used to provide appropriate feedback signals for tracking the sun direction. The correct angles of the sun position obtained by the sensors are used by the sun tracker to orient the PV module face toward the sun. In fact, two independent dual-axis mechanical systems are needed; one for carrying the sensors, and another for carrying the PV module. It is clear that the reference points of the two mechanical systems should be identical, and this increases the complication of the sun tracker.

A multipurpose dual-axis solar tracker with two tracking strategies Yingxue Yao, Yeguang Hu, Shengdong Gao, Gang Yang, Jinguang Du described as follows. As a kind of clean and renewable energy source, solar energy has been drawing more and more attention, especially in the field of electricity generation, due to the shortage and pollution of fossil fuels. The process of converting solar energy to electric energy is realized mainly through flat PV systems or CSP systems. The power output that these systems could produce depends on various factors, including the amount of the energy they receive from the solar radiation. Some researchers have studied the optimal angle of solar collector to increase the power output. As the sun's position changes throughout the day, the solar tracker is a more efficient method of increasing the energy production. So the solar tracker is being studied by more and more researchers .Currently, there are mainly two types of solar trackers based on movement capability: single-axis tracker and dual-axis tracker. Different single-axis and dual-axis trackers have been presented by the previous studies. Clifford and Eastwood presented a passive solar tracker activated by aluminium/ steel bimetallic strips and controlled by a viscous damper. Poulek and Libra designed a simple single-axis solar tracker based on a new arrangement of auxiliary bifacial solar cell connected directly to DC motor. Kim et al. proposed a single polar axis tracker with the solar collector rotating at a speed of 15/h round the polar axis. Roth et al. proposed an altitude-azimuth dual-axis tracker which, guided by a closed loop serve system, could operate automatically.Batayneh et al. proposed a dual-axis sun tracking system with altitude-azimuth mounting controlled by the designed fuzzy controller. Mavromatakis and Franghiadakis presented a novel single-axis azimuthal tracker with the ability to move the collector's plane in two directions through a special support structure. According to the previous studies, solar trackers have been used in different solar collector systems. C.S. Chin et al. presented an active single-axis solar tracker used in flat PV systems. The experimental test showed that the efficiency over the fixed solar panel was around 20%. Chang tested the flat PV system mounted on a single-axis tracker and found that the gain of the single-axis tracking panel installed with the yearly optimal angle was 17.5%, compared to a traditional fixed panel. Kimet a. applied the single polar axis tracker to CPC solar collector. The study of Kacira et al. Showed a daily average of 34.6% gain ingenerated power with two-axis solar tracking compared to a fixed PV panel on a particular day in July in Sanliurfa, Turkey. Abdallahand Nijmeh designed a two axes sun tracking system for PV

2.1 MAIN COMPONENTS OF THE FABRICATION OF DUAL AXIS SOLAR TRACKING SYSTEM

The main components that are used in the fabrication of our project is listed in below,

1. Photovoltaic cells
2. Solar panel
3. Dual axis Tracking system
4. Light dependent resistor
5. Dc motor
6. Battery
7. Inverter.

2.2 PHOTOVOLTAIC CELLS

Photovoltaic simply means they convert sunlight into electricity.

Solar panel works by allowing photons, or particles of light, to knock electrons free from atoms, generating a flow of electricity. Solar panels actually comprise many, smaller units called **photovoltaic cells**.

2.3 SOLAR CELLS

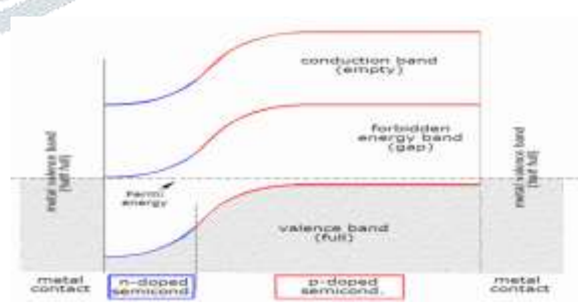
A solar cell, made from a mono crystalline silicon wafer

The most commonly known solar cell is configured as a large-area p-n junction made from silicon. As a simplification, one can imagine bringing a layer of n-type silicon into direct contact with a layer of p-type silicon. In practice, p-n junctions of silicon solar cells are not made in this way, but rather, by diffusing an n-type dopant into one side of a p-type wafer (or vice versa).

2.4 SOLAR PANEL

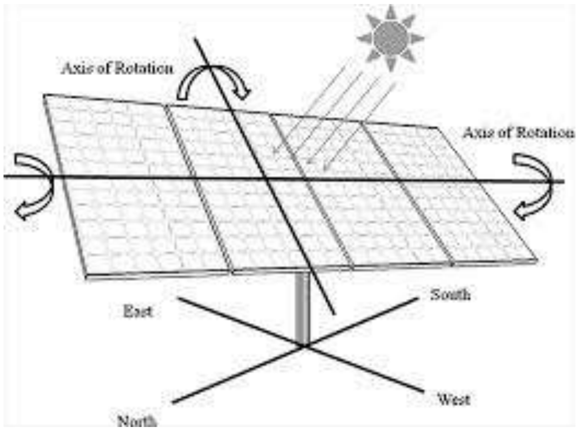
A solar panel is a collection of solar cells. Lots of small solar cells spread over a large area can work together to provide enough power to be useful. The more light that hits a cell, the more electricity produces.

2.5 DESIGN



2.6 DUAL AXIS TRACKING SYSTEM

Tracking Process. DC motor movement will follow the condition of the LDR. In dual axis solar tracking system, there are 2 DC motors. One motor is used to control elevation axis and another motor is used to control azimuth axis.



2.7 LIGHT DEPENDENT RESISTOR

A photo resistor (or light-dependent resistor, LDR, or photo-conductive cell) is a light-controlled variable resistor. The resistance of a photo resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity.

2.8 BATTERY

Despite having a very low energy-to- weight ratio and a low energy to volume ratio, their ability to supply high surge currents means that the cells maintain a relatively large power to weight ratio.

2.9 BATTERY RATING

12V Lead acid battery are used which are connected in series. They could deliver 7Amps.(sealed lead acid battery)

2.10 DC MOTOR

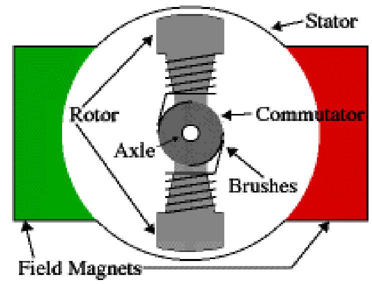
In DC motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

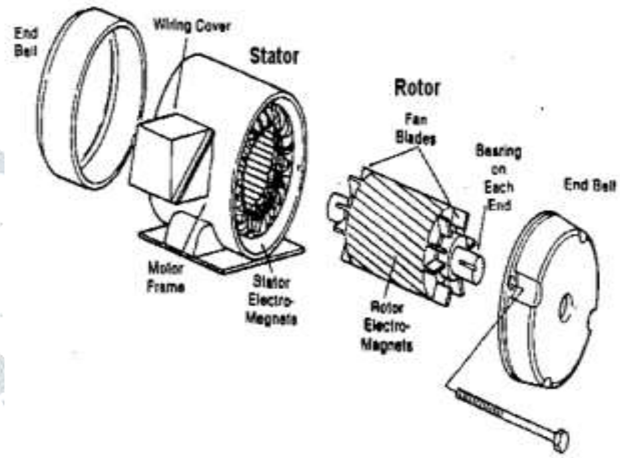
2.11 WORKING PRINCIPLE

A D.C. Motor is a machine which converts electrical energy into mechanical energy. Its location is based on the principal that when a current carrying conductor is placed in the magnetic field, it experiences a mechanical force whose direction is given by Fleming's left hand rule.

Every DC motor has six basic parts -- axle, rotor (armature), stator, commutator, field magnet(s), and brushes. In most common DC motors the external magnetic field is produced by high-strength permanent magnets[1]. The stator is the stationary part of the motor -- this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotors (together with the axle and attached commutator) rotate with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator. The above diagram shows a common motor layout -- with the rotor inside the stator (field) magnets.

2.12 DC MOTOR DESIGN





2.13 INVERTER

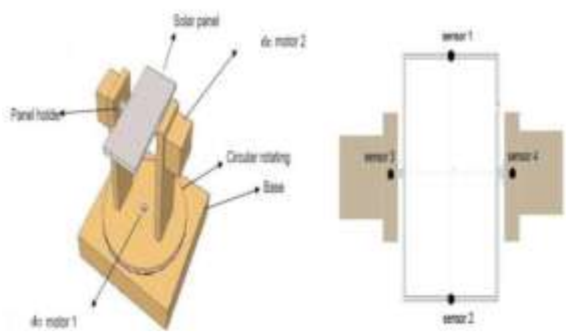
The purpose of an inverter is to convert DC power to AC power. Inverters are an integral part of many technologies including uninterruptable power supplies, induction heating, high-voltage direct current power transmission, variable frequency drives, electric vehicle drives, and multiple renewable energy applications. All of these technologies use inverters to achieve different goals, but all produce AC power from a DC input.

2.14 WORKING OF INVERTER

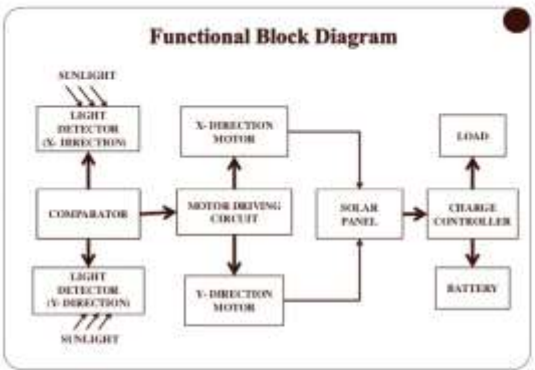
Inverters play a crucial role in any solar energy system and are often considered to be the brains of a project, whether it's a 2-kW residential system or a 5-MW utility power plant. An inverter's basic function is to "invert" the direct current (DC) output into alternating current (AC).

3 EXPERIMENTAL SETUP

The proposed tracking system does tracking of sunlight more effectively by providing PV panel rotation in two different axis. In dual-axis tracking system optimum power is achieved by tracking the sun in four directions. In this way we can capture more sun rays. Movement in two axes is explained with the help of figure which is explaining basic idea behind dual axis tracking.



3.1 BLOCK DIAGRAM OF DUAL AXIS SOLAR TRACKER

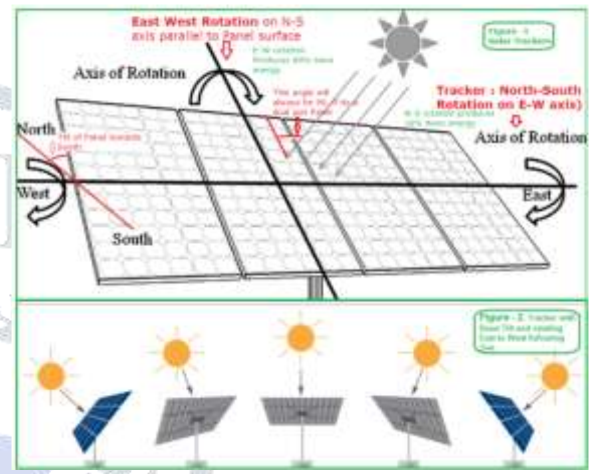


3.2 PRINCIPLE OF OPERATION

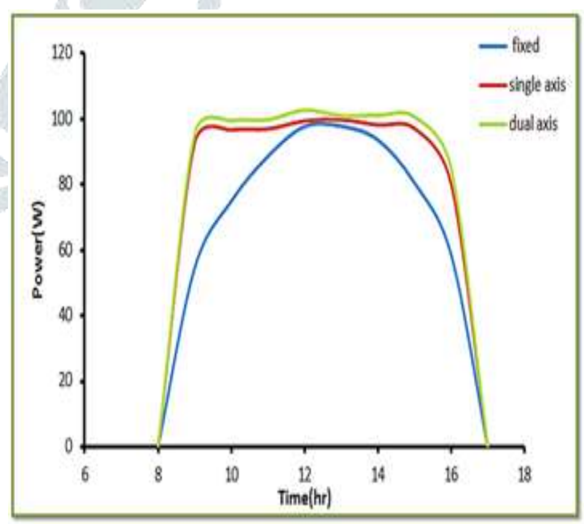
The p-n junction within the cell ensures that the mobile charge carriers of the same polarity move off in the same direction. These electrical charges are conducted away as DC power, by placing metal contacts on the top and bottom of a PV cell. If an electrical load is connected between the to p and rear contacts to the cell, electrons will complete the circuit through this load, constituting an electrical current in it. The energy in the incoming sunlight is there by converted into electrical energy. The cell operates as a "quantum device", exchanging photons for electrons. Ideally, each photon of sufficient energy striking the cell causes one electron to flow through the load. In practice, this ideal is seldom reached. Some of the incoming photons are rejected from the cell or get absorbed by the metal contacts (where they give up their energy as heat). Some of the electrons excited by the photons relax back to their bound state before reaching the cell contacts and thereby the load. The electrical power consumed by the load is the product of the electrical current supplied by the cell and the voltage across it. Each cell can supply current at a voltage between 0.5V-1V, depending on the particular semiconductor used for the cell. Since the electrical output of a single cell is quite small to generate sufficient amount of electricity multiple cells are connected together to form a module or a panel The PV module is the primary component of PV system and any number of PV modules can be connected to generate the desired amount of electricity. The modular structure of a PV system is considered an advantage since at any instant a new module can be incorporated to the system to satisfy the new electricity requirement. Different PV modules vary in structure; however, they generally include the following elements: glass cover in which the transparent glass cover is placed over the PV cell for protection reasons, anti-reflective sheet which is used to enhance the effect of the glass cover while the anti-reflective coating is used to block reflection, cell and frame and panel backing which are used to hold all the pieces together and protect the PV cell from damage.

3.3 WORKING

A Solar Tracker is basically a device onto which solar panels are fitted. This device tracks the motion of the sun across the sky ensuring that the maximum amount of sunlight strikes the panels all throughout the day. After finding the sunlight, the tracker will try to navigate through the path ensuring that the best exposure to sunlight is detected. To track path of sun from azimuth rotation about the polar axis follows the sun during the day from east to west, by using solar cells we create voltage difference across them according the voltage difference, upper motor will run & main solar panel move according to sun position which is perpendicular to the sun rays. Similarly, according to elevation (Tilt) angle follows seasonal changes in the tilt of the earth's axis by using another two solar cells the bottom motor rotate &main solar panel move according the earth position.



3.4 COMPARISON OF FIXED & SINGLE AXIS TRACKERS VS DUAL AXIS TRACKERS:



4 CONCLUSION

Dual axis tracker perfectly aligns with the sun direction and tracks the sun movement in a more efficient way and has a tremendous performance improvement. The experimental results clearly show that dual axis tracking is superior to single axis tracking and fixed module systems. Power

Captured by dual axis solar tracker is high during the whole observation time period and it maximizes the conversion of solar irradiance into electrical energy output. The proposed system is cost effective also as a little modification in single axis tracker provided prominent power rise in the system. Through our experiments, we have found that dual axis tracking can increase energy by about 40% of the fixed arrays.

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