Designing of Dual Axis Solar Tracking System using DC Gear Motor

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Abstract— It has been proven that owing to the huge utilization of energy, the non-renewable resources will be finished within a few years. Henceforth, the globe is moving towards renewable energy resources. On top of that, solar energy has become one of the most economic way to gain maximum energy. In order to get produce more electricity of a photovoltaic (PV) system, the sun tracking system will be required. By using normal solar tracker one can utilize solar energy but having low efficiency. By using Dual Solar-Tracker we can increase the efficiency of pay loads such as photovoltaic cell. Dual Solar Tracker has two degree of freedoms (D.O.F). Since we all know that sun has continuously changing angles throughout a whole year. Hence Dual Solar Tracker can rotate in both directions. It can follow the sun at any angle, which results in increment in efficiency of photovoltaic cell. Our aim is to obtain maximum electricity through a natural way and we carry a success with the help of proper guidance.

Keywords: Solar tracking, Gear motor, solar panel, Dual axis, DC motor, Power.

I. INTRODUCTION

Our project focuses on "Designing of Dual Axis Solar Tracking System using DC Gear Motor."

There are some new varieties of advanced energy, however electricity has been observed to be one of the cleanest and most effective forms. One potential answer to unreliable or non-existent central electricity distribution systems is to possess distributed generation system (DG). A distributed generation system is characterized by the very fact that the electricity is made domestically instead of outwardly. DG is often employed in under developing nations; but, typically within the style of tiny generators that run on various types of fossil fuels. With the speedy increase in population and economic development, the issues of the energy crisis and warming effects Are nowadays a cause for increasing concern. The utilization of renewable energy resources is that the key answer to those issues. alternative energy is one of the first sources of copious and inexhaustible energy that not only provides alternative energy resources, but it can be a big solution for pollution. Solar power includes a comparatively lower value, straightforward to put in and maintains, and for underprivileged countries close to the equator, ideal for the. But, the matter with solar power is that it's directly captivated with intensity level. to obtain the most quantity of energy, a solar array should be perpendicular to the sunshine supply. as a result of the sun moves each throughout the day in addition as throughout the year, a solar array should be able to follow the sun's movement to provide the most potential power. the answer is to use a chase system that maintains the panel's orthogonal position with the sunshine supply. There are several tracking systems styles on the market together with passive and active systems with one or 2 axes of freedom. This project develops AN automatic following system which can keep the solar panels aligned with the sun which can maximize efficiency.

A. Solar Energy

Solar energy may be a non-conventional supply of energy. Non-Conventional supply of energy means the energy that is out there free in nature.

B. Solar Tracker

The device that is ready to trace the daytime motion of the sun exactly and shift in vertical/horizontal axis consequently within the direction of sunshine. solar trackers could also be single axis (passive or active) or dual axis (only active). single axis trackers typically have a manual elevation (axis tilt) adjustment on a second axis that is calibration throughout the year. The most immediate and technologically attractive use of solar power is through electrical phenomenon conversion. The physics of the PV cell (also known as solar cell) is incredibly kind of like the classical p-n junction diode. The PV cell converts the daylight directly into electricity (DC) electricity by the photovoltaic impact. A PV panel or module could be a prepackaged interconnected assembly of PV cells. In order to maximize the power output from the PV panels, one must keep the panels in an optimum position perpendicular to the radiation throughout the day. As such, it's necessary to have it equipped with a Sun tracker. Compared to a hard and fast panel, a mobile PV panel driven by a Sun tracker might boost systematically the energy gain of the PV panel. Solar tracking is that the most applicable technology to boost the electricity production of a PV system. to realize a high degree of tracking accuracy, many approaches are wide investigated. Generally, they'll be classified as either open-loop tracking varieties based on solar movement mathematical models or closed- loop tracking varieties using sensor-based feedback controllers. within the open-loop tracking approach, a trailing formula or control algorithmic rule is employed.

- The angle and the elevation angles of the Sun were determined by solar movement models or algorithms at the given date, time and geographical data. The control algorithms were executed during a chip controller.
- Within the closed-loop chase approach, numerous active sensing element devices, like charge couple devices (CCDs) or light dependent resistors (LDRs) were used to sense the Sun's position and a feedback error signal was then generated to the system to continuously receive the utmost radiation the PV panel.

II. MODELLING AND ANALYSIS

This section presents background data on the most subsystems of the project. Specifically, this section discusses LDR and gear motor theory in order to supply a far better understanding on how they relate to the solar tracker.

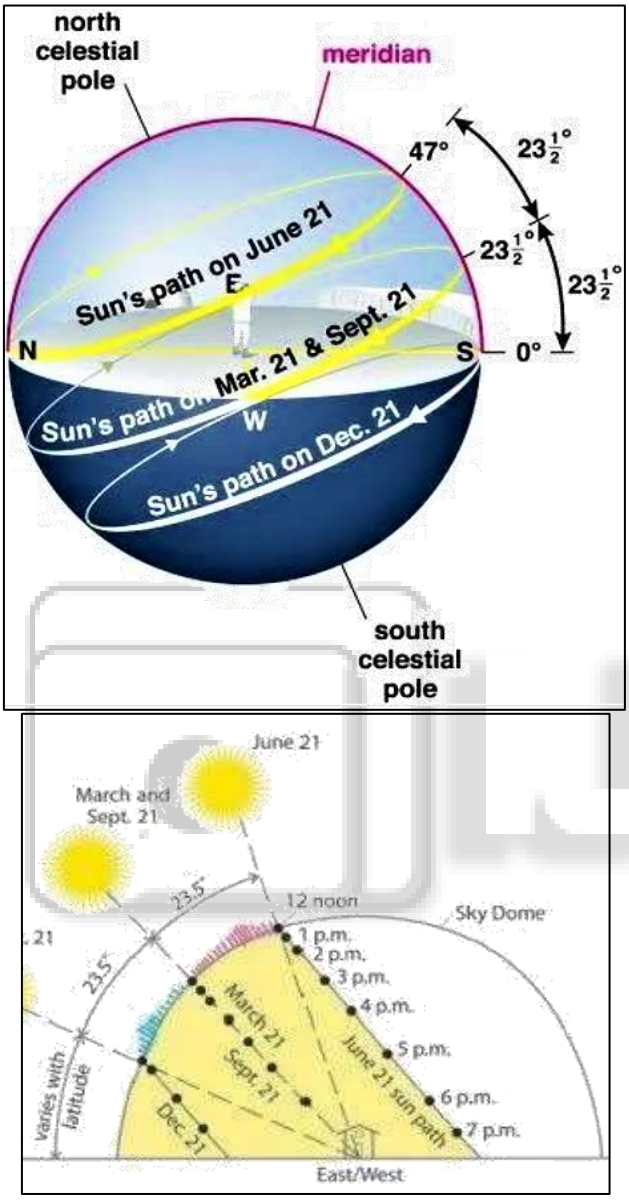

Fig. 1: Different positions of the sun throughout a year

Double axis solar trackers have each a horizontal and a vertical axis then will track the Sun's parent motion specifically anyplace within the World. this kind of system is employed to manage astronomical telescopes, then there are many software systems on the market to mechanically predict and track the motion of the sun across the sky. By following the sun, the efficiency of the solar panels is raised by 30-40%. the dual axis star tracking system is additionally used for concentrating a solar reflector toward the concentrator on heliostat systems.

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A. Solar Power Fundamentals

A basic understanding needs how a photovoltaic panel works. solar panels are shaped out of solar cells that are connected in parallel or series. once connected serial, there is a rise within the overall voltage, connected in parallel will increase the general current. every individual cell is often created out of crystalline silicon.

PV cells contains layered silicon that is doped with completely different components to create a p-n junction. The p-type aspect can contain further holes or positive charges. The n-type facet can contain further electrons or negative charges. This distinction of charge forms a region that is charge neutral and acts as a form of barrier.

Once the p-n junction is exposed to light, photons with the proper frequency will type a further electron hole combine. However, since the p-n junction creates an attainable.

Difference the electrons cannot jump to the alternative facet entirely the holes can. Thus, the electrons should exit through the metal instrumentation and flow through the load, to the instrumentation on the opposite facet of the junction.

As a result of the PV cells generate current, cells panels are usually sculptured as DC current sources. The number of current a PV panel produces contains a correlation with the intensity of sunshine the panel is fascinating the traditional to the cell is perpendicular to the cells exposed face. The daylight comes in strikes the panel at associate angle.

Here, A represents some limiting issue among the design of the panel as a result of they cannot convert 100% of the daylight absorbed into current. By this calculation, the utmost power generated are getting to be once associate is striking the PV cell on its traditional and no power are getting to be generated once the daylight is perpendicular to the traditional. With a tough and quick electrical device, there is important power lost throughout the day as a result of the panel is not unbroken perpendicular to the sun's rays.

B. Immobile Versus Mobile

Different power applications need different chase systems. Surely applications a tracking system is simply too expensive and can decrease the max power that's gained from the solar battery. thanks to the very fact that the planet rotates on its axis and orbits around the sun, if a PV cell panel is immobile, the absorption efficiency is going to be significantly less at sure times of the day and year.

The utilization of a following system to stay the PV cell panel perpendicular to the sun will boost the collected energy by 10 -100% looking on the circumstances. If a chase system isn't used, the solar battery ought to still be orientated within the optimum position. The panel must be placed wherever no shadow can fall on that at any time of the day. Additionally, the simplest angle ought to be determined supported the geographical location of the panel. As a general guideline for the hemisphere, the PV panel ought to be placed at a angle capable the latitude of the positioning and facing south.

However, for a lot of correct position and tilt angel a theoretical model of the sun's iridescence for the length of a year is made and also the angel and position are matched to the model.

C. Light sensing element Theory

Light sensing elements are among the foremost common sensor type. the best optical sensor is a Photo resistance which can be a mineral (Cads) kind or a metallic element compound (Gas) type. Consecutive maximize in quality is that the photodiode followed by the phototransistor. The sun tracker uses a mineral (Cad) LDR for light sensing.

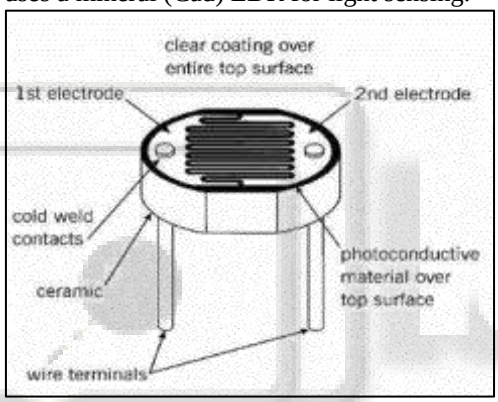

Fig. 2: LDR circuit

This is often the smallest amount valuable and least complicated form of light Device. The CdS LDR may be a passive element whose resistance in inversely proportional to the number of sunshine intensities directed toward it. To utilize the LDR, it's placed serial with a resistance. A voltage divider is therefore shaped and therefore the output at the junction is set by the two resistances.

Figure-2 illustrates the LDR circuit. during this project, it had been desired for the output voltage to increase as the light intensity increases, so the LDR was placed within the high position.

D. Gear Motor and Driver Theory

Fig. 3: DC gear motor

A gear motor is associate all-in-one combination of a motor and gearbox. The addition of a gear head to a motor reduces the speed whereas increasing the torsion output. The most vital parameters with regard to gear motors are speed (rpm), torsion (lb.-in) and efficiency (%). so as to pick out the foremost appropriate gear motor for your application you want to initial compute the load, speed and torsion needs for your application. Once the planning calculations are performed, and therefore the application parameters are outlined, you can use this knowledge to see that motor or gear motor can best suit your application.

E. Developed Closed-Loop star pursuit System

The diagram of the developed closed-loop star tracking system is illustrated in Figure-4 describing the composition and interconnection of the system. For the closed-loop tracking approach, the solar tracking downside is a way to cause the PV panel location (output) to follow the daylight location (input) as closely as potential. The sensor-based feedback controller consists of the LDR detector, differential electronic equipment, and comparator. within the pursuit operation, the LDR detector measures the daylight intensity as a reference signal.

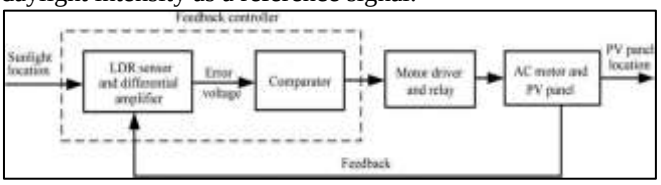

Fig. 4: Block diagram

The unbalance in voltages generated by the LDR device is amplified then generates a feedback error voltage. The error voltage is proportional to the distinction between the daylight location and the PV panel location. At this time the comparator compares the error voltage with a specific threshold (tolerance).

If the comparator output goes high state, the motor driver and a relay are activated thus as to rotate dual-axis (azimuth and elevation) tracking motor and produce the PV panel to face the Sun. consequently, the feedback controller performs the important functions: PV panel and daylight are constantly monitored and send a differential control signal to drive the PV panel till the error voltage is a smaller amount than a pre-specified threshold worth.

III. PROBLEM STATEMENT

It is undeniable fact that several researches have been conducted during last 2 decades for solar tracking system in order to get maximum electricity. However, majority are not as effective and sustainable as by using gear motor. Provided that we talk about stepper motor, it is cheaper than gear motor and Arduino circuit, but it is less effective for driving the solar panel, and creates unwanted noise. On the other hand, Arduino circuit can be productive for some extent, but its value and maintenance cost is very high (about $15). Moreover, as geographic change, it is necessary to make new Programme according to sun position.

IV. METHODOLOGY

According to final or practical model, there are 4 LDR sensors which are mounted on solar plate. Sensor measures intensity of the light and generates analog voltage single into the input of the comparator circuit. Two sensors are used to

track sun's exact position while other pair in the horizontal axis. Apart from that, comparator units and diode are used in electric network which can compare the voltage level between 2 pair of LDR sensors. Afterwards, voltage sent to the diode. A microcontroller, which is considered as a main unit for whole system. The output that is received from comparator unit goes to the microcontroller unit and then it adjusts the direction and the movement of the DC gear motor. Both the motors are joined with average size rod (according to length and width of the solar plate), that can help to move a plate. Figure-5 and Figure-6 show 3D view of our model and final working model respectively.

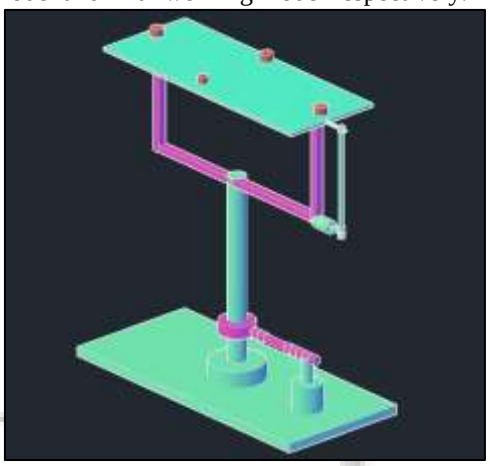

Fig. 5: 3D Design of model

Fig. 6: Working Model

V. RESULT

Time	Static Panel Power (watt)	Tracking Panel Power (watt)	Power gain by tracking panel
8:00 am	2.32	5.462	135.43%
9:00 am	5.001	6.96	39%
10:00 am	5.18	6.532	26%
11:00 am	5.657	6.546	15.72%
12:00 am	6.427	7.238	12.62%
1:00 pm	6.25	6.692	7%
2:00 pm	5.756	6.18	7.37%
3:00 pm	3.647	5.812	59.36%
4:00 pm	0.784	2.50	218.87%
5:00 pm	0.237	0.287	21%

Table 1: Power value of static and tracking panel

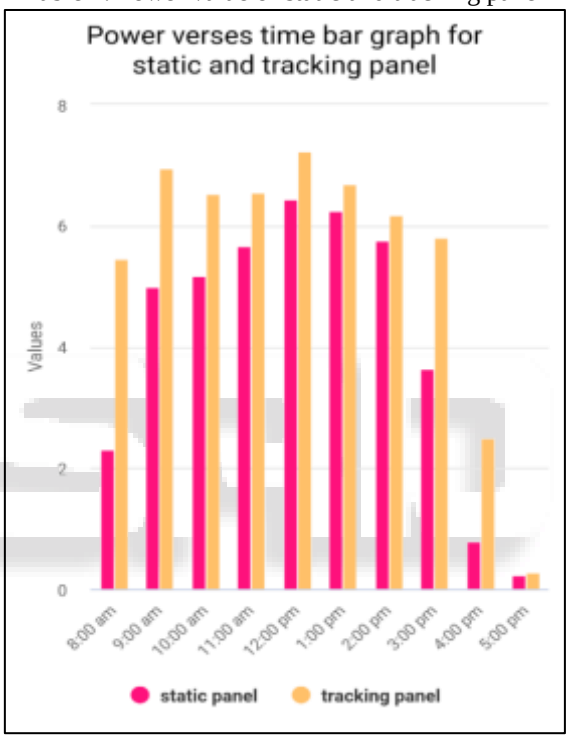

Fig. 7: Chart showing power Vs Time

As can be seen from the table chart, compare to static panel, maximum power can be achieved by tracking system. In fact, at 8:00 am the power output almost gets doubled with the help of solar tracking system. As time pass on the output value always higher than stable panel.

VI. CONCLUSION

In presented paper, the research methodology and other terms related to design of tracking system have been successfully discussed, also working model are used on daily basis. During testing time, it has been observed that the system can easily move according to sun position and move back to the initial position in night. The design, fabrication and electrical network is very simple and sustainable as compared to stepper motor and Arduino circuit. Initially, although the cost can be proven high as compared to stable solar, the overall expenditure will be paid off within a short time because of its efficiency range (approximately 30% to 40%). In addition, owing to higher

efficiency rate, there would be less solar plate required which can reduce the space.

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