Review on Designing of Dual axis solar tracking system

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ABSTRACT – *The solar energy is one of the renewable energy Resource. Well a solar tracker is a device that positions the PV modules perpendicular to the sun in order to help them absorb more solar energy and convert it into electrical energy. The main objective of this paper is to prove the fact that this dual axis solar tracker design is a more efficient. Many different mechanisms are applied to increase the efficiency of the cell to reduce the cost. The system is designed to be stable while it is operating and also to resist the weather, temperature and minor stress of mechanism.*

1 INTRODUCTION

The solar tracker is the device that positions the PV modules perpendicular to the sun in order to help them absorb more solar energy and convert into electrical energy.in other terms, it helps the panels track the solar energy and drawthe maximum power required to power up electronic appliances. Especially in dual axistracker system there are two trackers, where formertracks the sun rays from east
- west or north-south, and the latter tracks the sun from all directions. Themain reason we call it dual axis because they consists of two axis where one axis move from north to south and other axis move from east to west. Hence they are known as “dual- axis” solar trackers. The dual-axis can generate up to 40%electricity than the static solar panel. And the dual-axis is quite flexible.

The main advantage of dual axis tracker is it does not need a lot of space to accommodate. The upfront investment cost needed for the dual axis solar tracker is bound to pay off. Although the design is bit complex hence it might be difficult to set up these trackers, and it has a short lifespan because its movable parts can get damaged. Nowadays the common confusion is which solar tracker is better- is that a single-axis solar tracking or the dual-axis solar tracking. Well both the model have their own advantages and disadvantages. As we compare single-axis tracker gets one point based on the design and it also receives a brownie point for being more cost effective than dual-axis. On other hand, the dual-axis solar tracker is more efficient than a single-axis tracker. More components allow it to draw more energy fromdifferent angles. So in terms of efficiency the tracker will steal the race. Besides the dual-axis will get more goodie points for the kind of itsflexibility and its efficiency.

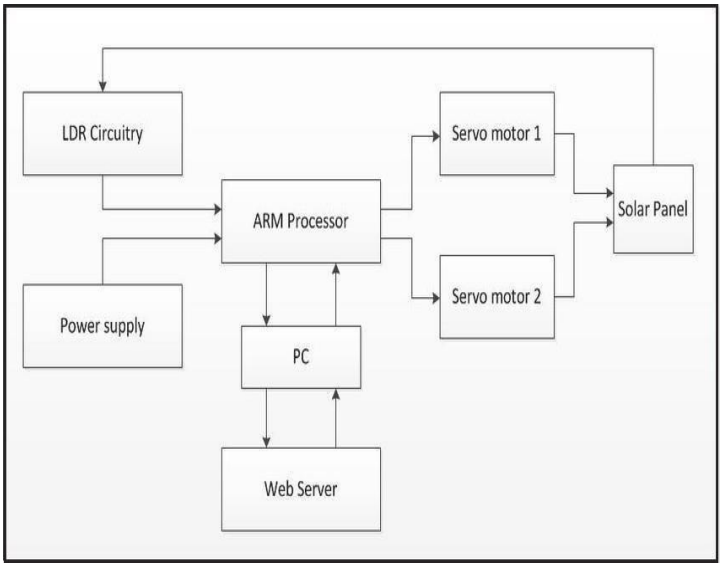

Fig: 1 Block diagram of dual axis solar tracking system

METHODOLOGY

The main aim of this project is to analyze the performance of dual-axis solar tracking system. There are three main components that is input, main controller, output. The LDR is given as a inpu, Arduino uno as a main controller, and servo meter as a output. This project can be done in two ways as a software and a hardware.

LDR (light dependent resistor)

LDR's are mainly known as a photocell. As name states it is special type of resistor that works on photoconductivity principle which means that resistance changes according to the intensity of the circuit. The resistance decreases with an increase in the intensity of the light the devices are used where there is a need to sense the presence and absence of light is necessary. As per now we are using LDR in dual-axis solar tracking system so that the intensity of the light is sensed by LDR and it will be the input to the main controller.

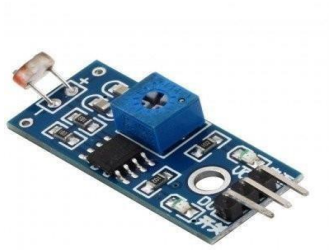

Fig:2 Light dependent resistor

SERVO MOTOR

Servo motor is a type of DC motor where in dual axis servo motor is used to control the movement of the solar panel. Servo motor works on (PWM) pulse width modulation principle, means its angle of rotation is controlled by the duration of applied pulse to its control PIN. It rotates maximum of 180degree. The DC motor is available electronic application where PWM analog signal will go through electronic circuit and convert analog signal into digital signal. Here in the dual-axis consists of two servo motors, one is for horizontal axis and vertical axis respectively.

Fig:3 Servo motor

SOLAR PANEL

It is the device that converts sunlight into electricity by using photovoltaic cells. These PV cells generate electrons when it is exposed to light,the electrons flow through the circuit produces direct current (DC). there are many types of panel which is distinguished among efficiency, price,temperature in the markets.

Here in this project we install dual-axis solar tracker the major difference between solar panel collects energy from the sunlight and coverts it into renewable energy. A sun-tracking solar panel typically does the same thing but only different is that the tracker within these solar panels helps the device to move in the sun's direction using solar tracker increase the amount of solar energy whichis received by the solar energy collector and improves the energy output of heat / electricitygenerated.

Fig:4 Solar panel

ARM (advanced RISC machines)

AMR stands for advanced RISC machines considered to be a family of central processingunit. It is a low level programming device that is closest to the machine language. These are multipletypes of assembly languages but ARM is an increasingly popular assembly language.

SOFTWARE

The software part consists of programming by C program. The this is connected as input to the system the codes are target to Arduino UNO be compiled and updated.

HARDWARE

The hardware consists of few parts like solar tracker, servo motors, and LD

ARDUINO UNO

The Arduino microcontroller acts as the main controller of the whole system, light-dependent resistor is used as a light sensor to detect sunlight while the function of the servo motor is to rotate the solar panel to align with the sunlight. The prototype of the solar tracking system was build and tested

MICROCONTROLLER

By connecting a battery to the solar panel, you can store the energy generated by the solar cells and this energy can be used when required. There are separate charge controller circuits dedicated to efficiently control the charge acquired from solar panels and charge the batteries.

WORKING DUAL AXIS SOLAR TRACKING SYSTEM

The proposed tracking system tracks sunlight more effectively by providing PV panel rotation along two different axis. The tracker is composed of four LDR sensors, two stepper motors and PIC microcontroller. A pair of sensors and one motor is used to tilt the tracker in suns east-west direction and the other pair of sensors and the motor which is fixed at the bottom of the tracker is used to tilt the tracker in the suns north-south direction. Two stepper motors are all in use in this system. Upper panel holder stepper motor tracks the sun linearly and base stepper motor tracks the parabolic displacement of the sun. These stepper motors and sensors are interfaced with a microcontroller. The microcontroller gives the command to the motors on the basis of sensors input. LDR sensors sensethe light and sends signal to microcontroller.

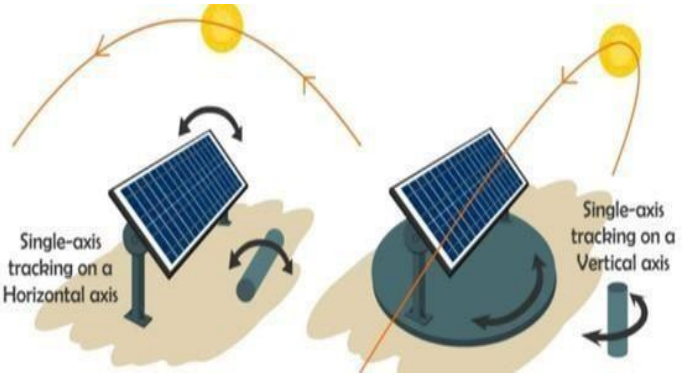

Fig:5 Single axis tracking on vertical and horizontal direction

fig:6 Dual axis tracking in the direction of sun

Microcontroller does the comparison of signals received from LDR sensors and on the basis of stronger signal it is deciding rotation direction of stepper motors. Microcontroller is an intelligent device which functions on the basis of input that it receives from the sensor thus activating motor driver circuit. The controller activates driver circuits and moves stepper motors to new positionswhere light falling on sensor pairs is same. If

difference arises, then the motor moves the panel until the light falling on the sensor is same.

Algorithm takes data from the sensors. Analog signals from sensors are converted to digital signals using analog to digital converter (ADC). This ADC module has to be present in the microcontroller or has to be added externally. Digitized signals are forwarded to microcontroller. The step angle and movement direction of stepper motors is calculated once the digitized signal isreceived.

COMPARISION BETWEEN SINGLE AXIS AND DUAL AXIS SOLAR TRACKING SYSTEM

What are the basic pros and cons of single axis vs. dual axis solar tracking systems?

There are mostly "pros" for both . . .but you need to use the right system for the right reasons. Generally Dual-axis trackers are more accurate in pointing directly at the sun which is usually the brightest spot in the sky, however, Dual axis comesat the price of higher complexity and lower reliability (more down time and more maintenance) than single axis. On the other hand single axis offers lower cost and higher reliability since there are fewer things that can go wrong overthe life of the system . . . which may be expected toexceed 20years or more. Watch a group of dualaxis trackers in an overcast day and you'll see thempointing all over the sky. Meanwhile, a group of single axis trackers will be all facing the same direction and producing about the same amount of energy per hour with a lot less wear and tear.

Application of Single-Axis Tracking System

Single-axis trackers usually move from the east to the west and follow the Sun's direction. Single-axis trackers have only one angle that is used as the axis of rotation. This type of tracker can increase electricity production by more than 30%. These trackers provide an efficient, simple, and low-cost way to improve the functioning of solar installations. Also, these trackers can optimize the performance of the Sun during the summer and spring seasons, when the Sun is in a higher position in the sky. Also, the performance drops during the other times of the year for the horizontal position of the Sun. At higher latitudes, vertical axis trackerswork better.

1. Horizontal Single-Axis Solar Tracker (HSAT)
2. Horizontal Tilted Single-Axis Solar Tracker(HTSAT)
3. Vertical Single-Axis Solar Tracker (VSAT)
4. Vertical-Tilted Single-Axis Solar Tracker (VTSAT)

Advantages of Single-Axis Solar Tracking System

- Single-axis trackers are more reliable.
- Single-axis has a longer lifespan than dual- axis trackers.
- Single-axis trackers are cheaper than dual- axis trackers because they have a simple mechanism and operate at a low cost.
- Single-axis trackers are ideal for companies with a lower budget or generally cloudy areas.
- Single-axis trackers are nearly 32.17% efficient compared to a fixed solar tracker mount panel.
- These trackers follow the Sun from East to West, providing consistent power output allday long.
- The trackers generate 15-16% higher annual power as compared to a static station of the same installed capacity.
- Single-axis trackers provide the highest density of PV panel placement per square.
- The payback period is lesser for the investment of the solar project, and asignificant increase in profits.

Disadvantages of Single-Axis Solar TrackingSystem

- Energy output is lower by single-axis tracker during sunny conditions compared to dual-axis trackers
- Limited technological upgrade.

Application of Dual-Axis Solar Tracking System

Dual-axis trackers have two rotation axis degrees, which are called the "primary axis" and the "secondary axis." The rotational axis can move downwards or upwards to adjust with the angles of the Sun throughout the day. Dual-axis tracking allows for the most accurate orientation of the solar device and is said to provide 40% more output through energy absorption. However, these solar trackers are more complex and expensive. Dual- axis trackers continually face the Sun as they can move in two different directions. There are twotypes of altitude-based dual-axis trackers — tip-tilt and azimuth-altitude. Typically, dual-axis tracking is used to orient a mirror and redirect sunlight along a fixed axis towards a stationary receiver.

Advantages of the Dual-Axis Solar Tracking System

· Dual-axis trackers follow the Sun continually and provide constant power output throughout the day.

· These solar trackers provide a reasonable solution in cases of the limited power capacity of the connection to the grid.

· Dual-axis trackers need smaller space and provide an opportunity to use the remaining area around for other additional purposes
such as car parking, gardening, and others.

· These trackers generate 45-50% higher power output per year, as compared to a static station of the same installed capacity;

· Dual-axis trackers provide the optimal solution for areas that may hinder solar
productivity. Some of these areas could be a complicated structure of the ground, complicated relief, stone protrusions, descent towards the North, and others.

· The payback period on investment is lower in the case of dual-axis trackers. Also, there
will be a significant increases Disadvantages of Dual-

Axis Tracker

· Dual-axis trackers have higher technical complexity, which makes it potentially
vulnerable to glitches.

· These trackers have a shorter lifespan and lesser reliability.

· Low performance in cloudy or overcast weather se in profits during their lifespan.

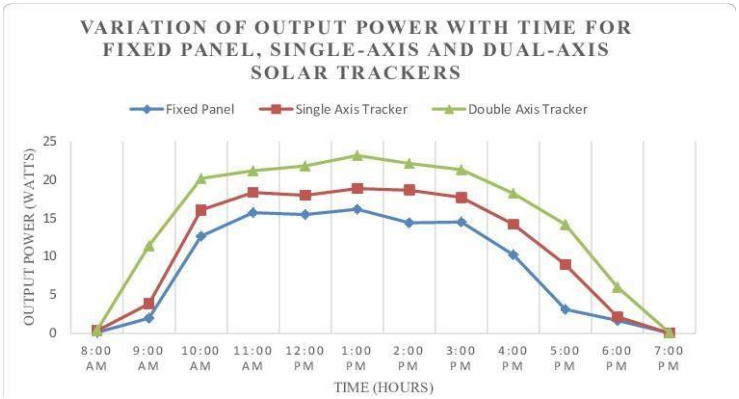

Fig:7 Efficiency graph on fixed panel, single axis and dual axis

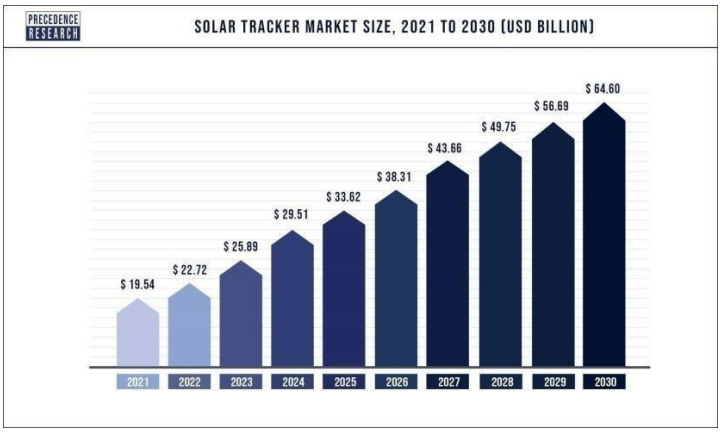

Fig:8 Marketing graph of solar tracker

LITERATURE SURVEY

The following are the review on the different paper based on dual axis solar tracker

Tarlochan Kaur, Shreya Mahajan, Shilpa Verma, Priyanka and Jaimala Gambhir[1] presented the Arduino based low coast active dual axis solar tracker where they have used the Arduino uno as the inexpensive controlling unit. The system was tested in a law view this tracker is cost effective, simple and efficient , operates automatically. This developed solar tracker can be also used for some small scale solar generations at remote areas.

Aditya Sawant, Deepak Bondre, Apurva Joshi, Prasad Tambavekar, Apurv Deshmukh[2] has designed a automated dual axis solar tracker based on high sensors. Here they have worked on

designing the dual axis solar tracker considering all the aspects related to it as per the rating the required components have been fixed. They have designed the algorithm for controlling the motionof tracker. The main components is light sensors and the optimal efficiency after comparing single and dual axis showed the reading of efficiency of dual axis of 24.78% more than a single axis.

Md. Tanvir Arafat Khan, S.M Shaher Tanzil, Rifat Rahman, SM Shafiul Alam [3] they have designed and constructed automatic solar tracking system they have also presented a means of tracking the suns position with the help of a microcontroller. The prototype represents the method for tracking the sun in both normal and bad condition this feature of a solar tracker is simple mechanism to control the system. They have concluded that though prototype has limitations in hardware areas as initial set ip, still it provides an opportunity for improvements of the design in future.

Divya Mereddy, Vijaya Rama Raju.V, Tharun Sadula [4] they have developed a smart dual axis solar tracking as per the technology for these present modern days they have used a 555 timer. The importance of the timer in tracking is that dual axis track the output of 36% more than the non- tracking panel as the LDR's cannot detect the suns position on cloudy day tracking mechanism has to stop, in that period it acts non-tracking system.They have portrayed that at the one side they have been seeing the improvement in requirement ofelectrical energy, and on other side it has beenimproving the pollution so at this time the efficiency of the system had improved significantly by using LDR's , sensors and timer and this solar tracker is also efficient , economical and easy to implement.

Midriem Mirdanies, Roni Permana Saptra [5] the have proposed a dual axis solar tracking designusing a combine method of astronomical calculation and camera based feedback correction for tracking sun possible moreover by twing their two model they have implemented and expected to have continuous robustness to deal with different whether conditions. stimulation of the algorithm have been conducted to generate the random data for the stimulation.

Yusha'u, Mae Irshaida, Majeed Soufian[6] they have developed dual axis solar tracker by using FPGA(field programmable gate array) fuzzy logic has been suggested for this project . fuzzy logic controls, implements on FPGA these are low cost, flexible and efficient, currently the speed of the wing as considered in design of the fuzzy controller by marking the response of the system slower and stabilized in wind condition. This project has a horizontal override feature which balances the panel horizontally. At the night, controller reset the panel. The total energy collected by the solar panel is expected to increase significantly justifying the implementation of the control system.

M.H.M Sidek, W.Z.W Hasan, M.Z.A.Ab Kadir, S Shafie , M.A.M. Radzi, S.A.Ahmad, M.HMarhaban
[7] they have designed a project called GPS Based portable dual axis solar tracking system using astronomical equations . in this project the solar PV movement is controlled by using P1C18f4680 microcontroller acts as system main branch this system was designed to compute the calculation and generate the database of suns through the years and the sun position data base is stored in non-volatile 2GB memory card. Then the GPS module is connected to the microcontrollervia standard serial Rs-232 that continuously send to the microcontroller sentences which contain a string character. These simplicity practical and effective of solar tracking system provides a powergeneration that can be deployed anywhere on the earth surface.

Mahdi Saeedi, Reza Effatnejad [8] they have designed a new project of dual axis solar tracking system with LDS's sensors by using thewheat stone bridge circuits here an analog controller is used for its control system. DASTcontrol system is a closed loop system that uses wheat stone bridge circuit along with LDR's. in thispapers they have designed a new DAST based on LDR's which adjust the PV panel relative to the angle of the line ray by moving simultaneously on two axes DAST is very simple, cost effective control system that utilizes wheat stone bridge circuit function. here in this project if thecontroller was used it was possible to control PV panel on the metal structure both individually and in an integrated manner this experimental finding

of the solar tracking system can help develop solar energy applications.

Ch.Vishwanath Sharma, Vadthya Jagan , Sonia Srinivas, Anem Y.V.B.N.Sujith Naidu [9] in this paper they have designed and implemented the master-slave configuration for dual axis solartracker with the application of master-slave configuration the number of configuration requires for the dual axis motion of PV panel in solar farm are reduced in the working condition of Arduino- uno and attached LDR's to operate more number ofsolar panels with dual axis motion the components requirement is increased. To overcome this master- slave configuration is introduced to obtain the maximum solar power with minimum quantity of sensors and microcontrollers. This is stated that the voltage,current and power generation is far better than the single axis.

Jeng-nan juang, R.Radharamanan [10] they have designed the project of solar tracking system foe renewable energy and hence they have proved that their project is best by making the lowest power consumption because the maximum amount of output power was needed their project was relatively affordable ,easy to transport and efficient.This design weighs less than 100lbs, and consistsof wheels for added probability.

CONCLUSION

This paper has presented a review of many researches on different tracking system where the team designed and built a solar tracking system that fulfills the human needs and all the requirements for the low cost, it is clear that the solar tracking system plays an important role to guarantee the maximum solar energy generationfrom dawn until dusk. This solar successfully calculates and generates the sun's trajectory path through the year. The tracker also capable to position the PV panels towards the sun automatically during the initial set up. Therefore for capturing the energy is the best way because it results an efficient profitable production.

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