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A Project Report on Automatic Sun Tracking Solar Panel Based on Open Loop Concept

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***Abstract* — This paper deals with the design & analysis of the Automatic Sun Traking Solar Panel based on open loop concept. The main objective of the project is to harnsess the maximum amount of sunlight from sun and coverting it to elctricity so that it can be easily used and transferred. This can be done by aligning the solar panel perpendicular to sun rays so that maximum sunlight can be converted into electrical form. As this system give maximum efficiency. The main feature of this tracker is that it is independent of the intensity of sunrays. It directly takes the coordinate of the sun according to its position and align itself according to that. As well as it gives higher efficiency, high reliability. The advantage of this project is to provide access to an everlasting and pollution free source of energy. This project can be used in form of decentralised generation. And when connected to big battery banks then can independently fullfill the needs of local areas.**

Index Terms:– open loop concept, everlasting, Decentralised.

I. INTRODUCTION

Their are various form of energy which we are using in form of themal, chemical, mechanical, electrical and etc. The most popular form of energy is Electrical Energy as it is easy to tranfer with maximum efficiency. The demand of Electrical Energy is increasing day by day. We are mostly generating it through conventional sources like fossil fuels, nuclear fuels etc. But the conventional sources are limited and creates pollution and exhaust one day. So we are shifting to non conventional sources like wind, solar, tidal, geothermal etc. The Solar Energy is the biggest form of energy, all the the other form of energy depends on it only like wind is due to air currents which is due to expansion of air by solar energy only, fossil fuels due to life cycle which also depend on Solar Energy. So instead of taking it indirectly we can directly convert into electrical enrgy by using photovoltaic cell, or Solar cell . But we are not able to harness that much amount of energy. Solar energy can be converted to electrical energy through solar panels. They give maximum output when rays incident on 90 degree. But in current scenario we are using fixed solar panel so it is not able to give maximum output hence the efficiency decreases.

II. AIM AND OBJECTIVE

2.1 Aim of the project

Aim of the Project is to harness the maximum amount of solar energy through Sun.

2.2 Objective of the project

The solar panel gives the best output when the solar plate is perpendicular to incident rays (Sun rays). So the system which will be having continuously 90 degree with sun will be more efficient than the conventional fixed solar panel system. Objective of our project is to design and construct a system that continuously track Sun and allign the Solar panel perpendicular to sun rays.

III. PROPOSED WORK

Solar Angles and Geometry

The orbit of the earth is almost circular at an average distance of 149.6 million km. The axis of rotation of earth is tilted by an angle $\varepsilon = 23.441°$ with respect to the normal to the plane of the orbit of earth. The plane orbit of the earth is known as the plane of the ecliptic. The plane passing through the equator of earth is inclined at right angle to the plane of the ecliptic, at an angle ε where ε is angle of obliquity.

To find solar angles, we need to define suitable reference frames. Three principal reference frames are used which are the ecliptic, the equatorial and the horizon reference frames. These frames are referenced to the centre of the earth and the apparent motion of the sun is considered for calculations.

- Declination angle *(δ)*:-It is the angle of the sun's position in north or south of the earth's equator. The axis of earth is tilted 23.34° from the plane of the orbit of earth around the sun and the earth causes the declination angle to vary from 23.45° north on December 21 to 23.45° south on June 21 during its rotation around the Sun.
- The altitude angle or elevation angle (α):- It describes how high the sun is visible in the sky. The angle is measured between an imaginary line between the observer and the sun. The altitude angle becomes negative when the sun goes below the horizon.
- Solar azimuth angle (Υ_s):-It is the angle between south and the projection of the line of sight to the sun on the ground. A negative azimuth angle indicates west of south, and a positive solar azimuth angle indicates a position east of south.
- The latitude (w):-It is the which ranges from 0 degree at the equator to 90 degree at the poles. Latitude is always used with longitude for precise location. Any location on

the surface of the earth then can be defined by the intersection of a longitude angle and a latitude angle.

Types of Systems

Their are generally two types of system :-

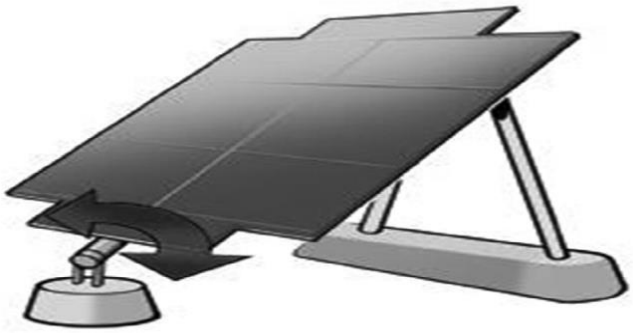
- Fixed:- These are fixed at some position and angle and which remain same until and unless they are changed by some person.These are simple to install.
- Tracking:- These system automatically moves accoding to the sun position. These are typical and complex to install but gives better efficiency.

Tracking is genrally of three types:-

- Active tracker:- These system uses some sensors like Light Detecting Resistors(LDR), Ambient light sensor etc to track the intensity. With the help of these sensors the matrix is formed on the basis of which the solar plate rotates towards sun.
  Drawback :- The trakes tracks intensity not sun so when the clouds covers sun the tracker moves toward where it finds best intensity but as soon as the cloud moves the the plate again come to the previous position which was having more intensity, So due to this again and again rotation of the whole system which is driven by motor decreases the efficiency and consumes more power from the system again and again. As well as the positoning of tracker is done by making a matrix which is also a complex.
- Passive tracker:- In this the tracking is done by using a low boiling point compressed gas fluid that is driven to one side or the other (by solar heat creating gas pressure) to cause the tracker to move in response to an imbalance.
  Drawback :- As in this the precision is not so much accurate and so it is not suited for pv cells. Case can be possible when the sun move but the temperature not rises. As this is a mechanical system fiction can also reduce its accuracy.
- Open loop tracker:- This is classified into two system
  - Time based :- In this a time is fixed so after every fixed time the plate rotate from some angle.
    Drawback :- The day time vary in every season as it is smaller in winter and longer in summer so positioning is not so much accurate.
  - Altitude based:- In this the sun is tracked fully and the sun is positioned by satellite so the positioning is accurate.If any cloud comes on it then also it will track sun and as soon as the cloud moves it will be at the position just perpendicular to the sun.

Types of Tracker on the basis of Axis of Rotation:-

- Single axis:- In this the Solar panel moves only on one axis. It either moves left and right or up and down according to the axis attached to the mechanism. This is simple in comparison to other. This tracks the sun but can't fully track due to limitation of movement in one direction.



- Dual axis**:-** In this the Solar panel moves on both axis. It can move left and right as well as up and down according to the position of the Sun. This is more complicated in comparison to other. This tracks the sun.

In this project we are going to use Altitude based open loop tracking system and it is single axis tracking system. The position of the Sun is calculated by solar position calculator. All the work is processed by PLC connected to it. The PLC stores all the position of sun according to the time. The PLC gives signals to relays connected to the motors of the mechanism. Their are two relays for each axis for forward and backward movement of the mechanism. The relays supply the power when it is given signal and the power is according to the motor which can be AC or DC.

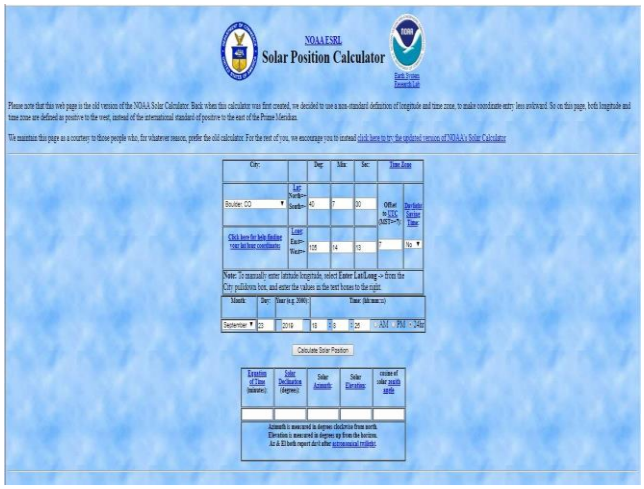
The Project consist of three different parts:-

- Solar Tower:- It consist of the mechanism which rotates the solar panel and can be single axis or dual axis. The solar panels are connected in different combination in series and parallel according to the inverter specifications. The rotating mechanism is connected to motors which are controlled by control panel. The control panel comprises of PLC, Relays and supplies.
- Batter Bank: - It consist of number of batteries which can be lead acid batteries or collection of battery cells. The capacity of the plant is decided by the capacity to store energy. The number of batteries decides whether this system can be independent of other system or need to be used with other system.
- Invertor :- This part consist of circuits invertors. The invertors are made of high quality of thyristors

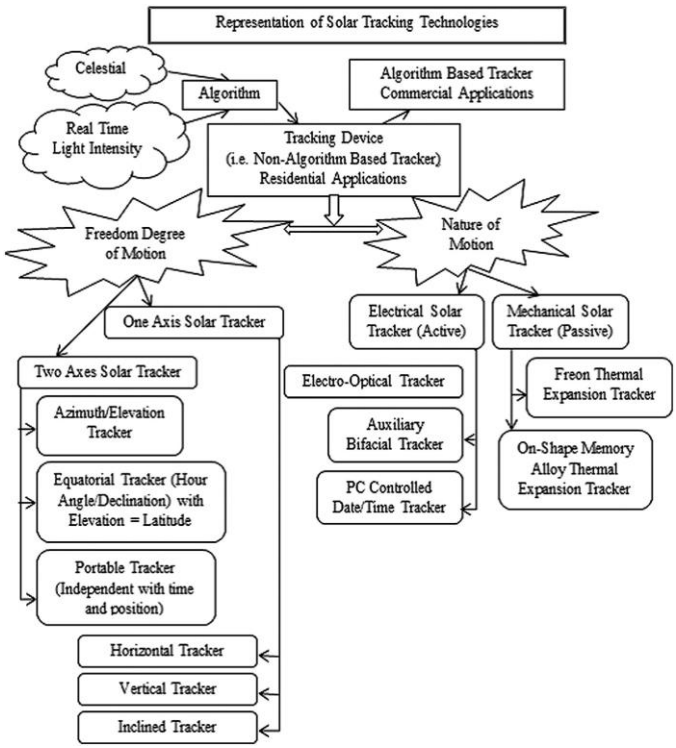
which are robust in nature and can work continuously.

IV. SOLAR POSITION CALCULATOR

We get coordinates of Sun by US site of NASA according to our coordinates. The site contains NOAA Solar position calculator as shown in figure



V. BLOCK DIAGRAM



VI. COMPARISON BETWWEN TRACKERS

Here is the comparison table showing different kinds of trackers:

Type of solar system		Performance	Capabilities	Number of axis	Possible manufactures	Technical restrictions
Single axis solar tracking system	Horizontal single axis tracker (HSAT)	68% compared to fixed panel	Less complicated, less expensive, rigid and stable. less likely to be damaged during storms	1	ARRAY Technologies Inc., USA SAHAJ SOLAR, India WUXI HAOSOLAR Technology co., Ltd, China DEGE Renergie GmbH, Germany	Occupy lot of space because there are to be arranged horizontally
	Vertical single axis tracker (VSAT)	62% compared to fixed panel when loss due to wind force taken into account	Less complicated, less expensive	1	ARRAY Technologies Inc., USA WUXI HAOSOLAR Technology co., Ltd, China DEGE Renergie GmbH, Germany	Easily affected by wind force. So support should be taken care
	Tilted single axis tracker (TSAT)	69% compared to fixed panel	More suitable for smaller latitudes i.e. places which are close to equator	1	ARRAY Technologies Inc., USA WUXI HAOSOLAR Technology co., Ltd, China DEGE Renergie GmbH, Germany	The inclination should be calculated very accurately to avoid shading and wind loss
	Polar aligned single axis trackers (PASAT)	Still experiments are going on.	More suitable for larger latitudes i.e. places which are far from equator	1	ARRAY Technologies Inc., USA WUXI HAOSOLAR Technology co., Ltd, China DEGE Renergie GmbH, Germany	Still experiments are going on this. Pros and cons has to be studied
Dual axis solar tracking system	Tip-tilt dual axis tracker (TTDAT)	78% compared to fixed panel without considering the extra manufacturing cost of dual axis	Able to track the sun in both directions (east-west as well as north-south). & Able to minimise the up-sun shading.	2	ARRAY Technologies Inc., USA ALL EARTH RENEWABLES,USA TITAN TRACKERS, Europe DEGE Renergie GmbH, Germany	Should be attached on a long pole so wind forces will be very high
	Azimuth–altitude dual axis tracker (AADAT)	82% compared to fixed panel without considering the extra manufacturing cost of dual axis	More suitable for greater latitude where substantial seasonal variation in sun's height and arc. & The weight of the array is distributed over a portion of the ring	2	ARRAY Technologies Inc., USA OPEL SOLAR, Canada DEGE Renergie GmbH, Germany	Its pivoting mechanism rests on the ground so occupies a large space and these are not suitable for northern climates with snow build up
Passive tracking system		40% compared to fixed panel	With the help of passive materials like SMA (shape memory alloy),the additional parts can be eliminated	–	ZOOMWORKS,USA	The cost of the material for an actuator will be very high and availability of some materials will be difficult Also sluggish in moving cold temperature

VII. PROJECT PICTURES

The project pictures are shown in fig:

Fig1. Front Image

Fig2. Top Image

VIII. CONCLUSIONS

The innovative design of the sun tracking solar panel have increased the development of many solar thermaland PV systems. It has been showed that the sun trackers can be classified into two that is single axis and dual axis or actice or passive trackers. The result represents that the Altitude based dual axis Solar trackers are more efficient. The experimental results shows that the efficiency of solar panel to generate electricity is increased by minimum 5-8%. This percentage increase is calculated after reducing all the energy used in the tracking system and mechanism of the project. This technique can be used in villages which are deprieved of electricity as connecting them to national grid can be costly. So this can be used as a form of decentralized generation. This increases reliability. The fault clearing time becomes less as it not connected to complex grid.

REFERENCES

[1] Anusha, K., S. Chandra, and Mohan Reddy. 2013. "Design and Development of Real Time Clock Based Efficient Solar Tracking System." International Journal of Engineering Research and Applications (IJERA) 3 (3): 1219–1223.

[2] Anyaka, B. O., D. C. Ahiabuike, and M. J. Mbunwe. 2013. "Improvement of PV Systems Power Output Using Sun-Tracking Techniques." International Journal of Computational Engineering Research 3 (9): 80–98.

[3] Batayneh, W., A. Owais, and M. Nairoukh. 2013. "An Intelligent Fuzzy Based Tracking Controller for a Dual-axis Solar PV System." Automatic in Construction 29 (2013).

[4] Dhanabal, R., V. Bharathi, R. Ranjitha, A. Ponni, S. Deepthi, and P. Mageshkannan. 2013. "Comparison of Efficiencies of Solar Tracker Systems with Static Panel Single Axis Tracking System and Dual Axis Tracking System with Fixed Mount." International Journal of Engineering and Technology (IJET) 5 (2): 1925–1933.

[5] Ganesh, N. Jeya, S. Maniprakash, L. Chandrasekaran, S.M. Srinivasan, and A. R. Srinivasa. 2011. "Design and Development of a Sun Tracking Mechanism Using the Direct SMA Actuation." Journal of Mechanical Design 133 (1): 1–14.

[6] Robert, A. Jay, Del Rosario, C. G. Reggie, and P. Elmer Dadios. 2014. "Optimization of a Small Scale Dual-axis Solar Tracking System Using Nanowatt Technology." Journal of Automation and Control Engineering 2 (2): 134–137.

[7] Gupta, Bhupendra, Neha Sonkar, Brahman Singh Bhalavi, and J. Pankaj Edla. 2013. "Design, Construction and Effectiveness Analysis of Hybrid Automatic Solar Tracking System for Amorphous and Crystalline Solar Cells." American Journal of Engineering Research 2 (10): 221–228.

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