A Review on Automatic Sun Tracking Systems by using Photovoltaic Panels

Shreyansh Adlak[1], Prof. S. S. Kumbhalkar[2]
Department of Mechanical Engineering
[1]G. H. Raisoni College of Engineering, Nagpur
[2]Professor, G. H. Raisoni College of Engineering, Nagpur

Abstract-*Solar energy is the best & infinite form of energy available which can be used with easy setups. The sun radiation is converted into well-known form of energy known as electricity by the use of photovoltaic panels. This paper is for review on automatic sun tracking systems which uses photovoltaic cells to collect sun radiation & convert it into electrical energy.*

Keywords: Solar Panels, Photovoltaic cells, LDR, Microcontrollers, Sun tracking.

I. INTRODUCTION

Sun rays provide radiation & heat from which energy or say solar power obtained. It is renewable form of energy & is harm less to the environment. It is a type of green energy as it is available in infinite amount unlike petrol or charcoal. With changing time & improving technologies the ways for accessing, storing & utilizing solar energy is also increasing with improvement in intelligence of systems designed. These systems collect the solar energy & convert it into a feasible form that can be used for general purposes.

II. HARNESSING SOLAR RADIATON

The basic way to harness solar radiations are solar panels. These solar panels basically photovoltaic panels equipped with photovoltaic cells. This panels act as conductors for conducting sunrays, gets the heat energy from solar radiation & hence create a useful form of energy known as solar energy.

This panels are easy to install but with a limited motion with respect to the movement of sun. This results in less efficient comparing with another source of energy. This are not much economical too in comparison with fuels like petrol etc.

These panels can be installed anywhere such as roof tops, windows & open areas. With increasing interest in renewable energy sources solar panels are being used in variety of different possible field like automobile, electricity production, water heating etc.

III. REVIEW OF WORK DONE

João M. G. Figueiredo1 & José M. G. Sá da Costa2 et.al. [1] worked for quantifying the solar energy production by maximizing the incident solar radiations on the solar panels. They developed a tracking system for the PV-systems which works on real time basis. This system basically searches for the orientation of surface with respect to incident radiation of sun rays. The tracking system constituted of 2- orthogonal axis. By using a PLC (Programmable Logic Controller) they compared the electrical power produced by the PV cells in corresponding to the orientation & also managed to change the DOF (Degree of Freedom) of the axis. The PLC system directly controls the tracking system & also commands the PV panels. The SCADA (Supervisory Control & Data Acquisition) system is used as a supervisory system for controlling the experimental prototype. The SCADA responds according to the request made by the user & providing the results by working on the codes or logical algorithm requested. They developed 3-user level for the operating the tracking system: Operators, Supervisors, Administrators. They derived that there was an increase in power generation of magnitude (ca. 25%) by using the tracking system prototype on the PV-Panels then compared to the PV-panels on which the tracking system in not installed.

Somtoochukwu Ilo et.al. [2] designed a single axis tracking system using embedded Microcontroller system which automatically rotates the solar panels with respect to the rise & dawn of sun in a day collecting maximum solar radiation possible. The tracking system can actuate mechanism automatically to position the solar panels from the input received i.e. following the path of sun. The tracking system is equipped with a microcontroller which detects the change in voltage levels of a LDR (Light Dependent Resistor) installed on a voltage divider circuit & also converts the analog signals to digital signals displaying it on LCD display. The Microcontroller determines if the voltage is less then 3V the panel will be moved 5.2o east to west. The moment won't stop until the sensor output is 3V or the panel has rotated 180o from east to west & if the voltage output is less than 3V through full range movement the panel moves to its initial position. Again, if the voltage is greater than or equal to 3V which indicates rising of sun the panel will be rotated 5.2o west. Microcontroller compares the two output values with respect to the old & new positions of the sun. If the new value is greater old value the movement continues to the west & values are compared again until the new value is less than old, at this point the solar panel will be rotated 5.2o to the east. At this point the panel is in right position to absorb the maximum light intensity. The average time between rotational movement of panel by 5.2o west is 4 minutes, as the sun moves 1o in every 4 minutes. The Microcontroller calculates the output & tracks the sun for the best positioning of the panel. The authors considered two cases by neglecting the atmospheric conditions to calculate the energy per unit area for a day by using dW=I*S*dt. Case I: for fixed collector systems the energy per unit area was 8.41 kWh/m2 day. For, Case II: for solar panels controlled by tracking systems the value was 1.32 x 10kWh/m2 day. Comparing the theoretical results of the two cases the energy produced in Case II is more as compared to Case I. The research concluded that by controlling the solar panels with a tracking system installed on them equipped with Microcontrollers maximizes the solar panel output by positioning the panels for maximum solar radiation absorption with the movement of sun.

G.Kalamani et.al. [3] focused his research on developing a dual axis tracking system by dividing the system into two categories (a) azimuthal, (b) polar to optimize the production of electric energy by using PV-cells. The prototype system proposed was independent of geographical locations. The panel used were meant to rotate in two different planes azimuth & elevation. For efficient collection of sunrays, the panel surface was introduced to two parameters 1st angle of azimuth Ψ which refers the movement of the panel face from east to west and the angle of tilt α which refers the movement of panel face from north to south. The basic concept was to make the sunrays fall normal on the solar panel surface for maximum absorption of sun rays with highest conversion efficiency. The author classified the dual axis system in two basic types: (a) azimuthal & (b) polar. For azimuthal tracker axis there is only single rotational motion around vertical axis, whereas for polar tracker axis there two independent rotational motions around the polar axis. They developed a direct relationship between incident solar radiation intensity & voltage drop across the resistor by using symmetric photo-resistors separated by a solid barrier to provide shadow to a single resistor at a time. When sun light falls on the panels there is a change in physical values of resistors. With increase in solar radiation resistivity of the photo resistors decreases& hence voltage drop across the photo resistor decreases; as a result, the voltage drop across the variable resistor increases. The microcontroller computes the values & also supervises the movement of panels. There is a limitation of 50o vertically. Therefore, the azimuth drive rotates for a total of 260o from sunrise to sun set. The proposed system is intelligent enough that during night hours it does not send any signal by sensing low intensity of light rays after sunset & during sunrise the LDR senses the light & moves the panel facing towards East in a short period of time. The conclusion derived follows that by orthogonally aligning the panel to the sun maximum sun radiation can be absorbed for maximum energy conversion.

Parasnis N. V. et.al. [4] worked for an economically efficient prototype of a dual axis sun tracking system. The experimental setup uses 4 LDR, a microcontroller; the interface between LDRs & micro controller is a ADC (Analog to Digital Converter). 3DC motors are setup for moving the solar panels. They used a temperature sensor in the prototype for monitoring outputs of PV-cells with change in temperature. For ZigBee (XBee) wireless protocol to maintain exchange of data & for supervising the whole porotype. The limited equipment usage foe the setup makes it economically easy for setup in general usage. Simulation was carried on Proteus software for 3 different weather conditions on 3 different days. They derived that; (A) for a clear & sunny day fixed solar panels were providing maximum output for only between 11:00 AM to 3:00 PM, whereas the prototype was 60% efficient at 7:00 AM 95% efficient during 12:00 Noon & 83.7% efficient at 5:00 PM. (B) for a partly cloudy day fixed solar panels were 62.7% effective between 11:00 AM to 2:00 AM, whereas the prototype was 66% efficient in morning hours at 9:00 AM 68% efficient at 12:00 Noon & 60% efficient at 5:00 PM. (C) for a completely cloudy day the results were not much promising but the prototype was more efficient than the fixed solar panel, The average energy generation by fixed solar panel was 2.170 W whereas for the prototype was 3.096 W. The conclusion for this prototype derived was that it can be used for different weather conditions & is more efficient than the fixed solar panel setup in every way.

Kianoosh Azizi and Ali Ghaffari. et.al. [5] used fuzzy logic & image processing technique for developing a dual axis tracking system. They developed a low cost & precise dual axis sun tracking system (DAST). They stated that when output of LDR becomes zero the error signals are not actually zero. They derived that solar trackers have non-linear behavior. So, they used fuzzy logic approach for designing non-linear controllers because of its simplicity for design & execution. Initially the solar panel is oriented using the LDRs output. Then the tracking prototype is setup with respect to the consideration of azimuthal rotation (from east to west) & altitudinal motion (referring to change in height of sun). The prototype has a camera installed with a image processing unit, microcontroller & a electromechanical structure. They divided the DAST algorithm in to two modes (A) LDR- based mode considering LDRs as a discrete elements & (B) image processing based mode. In image processing based mode there is a transparent screen between camera (considered as XY plane) & glass lid with a pin hole for sunspot in it. The movement of sun provides the location of sun on the XY plane. The position of sun spot is determined by the image processing unit & suitable data is forwarded to the fuzzy logic controller (FLC) & the FLC hence controls the movement of motors on the solar panel. This process is repeated till the tracking error is reached desired range. The voltage difference across the azimuthal set of LDRs & altitudinal set of LDRs provides data to the controller; this actuates the motor until these sensor voltages becomes zero. The fuzzy logic decided the movement of solar panels. The experimental prototype provides promising increased output results in DAST as compared to the fixed solar panels. There was 81% more output power between 7:30 – 9:00 AM, 105% increase during 15:00 – 17:00 PM; whereas there was 30 - 41% increase of power output during mid-day hours. The average power output was increased by 60.45% for the whole day. The conclusion derived for this prototype was it was precise & of low cost as compare to other tracking systems installed on solar panels. The prototype was independent of geographical location & was providing improved results with a error vale of less than 0.15 degree using fuzzy logic & image processing.

IV. CONCLUSION

From this review it can be stated that using tracking systems with the solar panels for their motion with respect to the changing position of sun the sun radiation absorption can be increased resulting in increase in power output of the solar panels as compared to the fixed solar panels. Number of tracing system can be designed by using the reference papers mentioned below for developing a hybrid & efficient tracking system. It was found that dual axis system as more advantages & efficiency over single axis tracking systems. & also dual axis tracking systems are independent of geographical location & in some cases are efficient in different wether condition.

REFERENCES

[1] João M. G. Figueiredo1, José M. G. Sá da Costa2, “Intelligent Sun-Tracking System for Efficiency Maximization of Photovoltaic Energy Production”, RE&PQJ, Vol. 1, No.6, March 2008.

[2] Somtoochukwu Ilo, Tochukwu Chiagunye, Aguodoh Patrick and Egbosi Kelechi, “An Intelligent Sun Positioning and Intensity Tracker System for Solar Panels with LCD Display”, International Journal of Electrical Electronics & Computer Science Engineering Volume 2, Issue 6 (December, 2015) | E-ISSN: 2348-2273 | P-ISSN: 2454-1222

[3] G.Kalamani, A.Manoranjitham, P.Manikandan*, “Efficiency Maximization of Photovoltaic Energy Production by Sun-Tracking System”, South Asian Journal of Engineering and Technology Vol.2, No.22 (2016) 24–30. ISSN No: 2454-9614.

[4] Parasnis N. V., “AUTOMATIC SOLAR TRACKING SYSTEM”, INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT] ISSN: 2394-3696 VOLUME 3, ISSUE 1, JAN.-2016.

[5] Kianoosh Azizi and Ali Ghaffari,“ Design and Manufacturing of a High-Precision Sun Tracking System Based on Image Processing”, International Journal of Photoenergy Volume2013, Article ID 754549.