Making Model of Dual Axis Solar Tracking with Maximum Power Point Tracking

Mitul G. Ravat[1] Mr M.D. Solanki[2]
[1]M.E. Student [2]Assistant Professor
[1,2]Department of Electrical Engineering
[1,2]Shantilal Shah Engineering College, Bhavnagar, Gujarat, India

Abstract— Now a days solar harvesting is more popular. As the popularity become higher the material quality and solar tracking methods are more improved. There are several factors affecting the solar system. Major influence on solar cell, intensity of source radiation and storage techniques The materials used in solar cell manufacturing limit the efficiency of solar cell. This makes it particularly difficult to make considerable improvements in the performance of the cell, and hence restricts the efficiency of the overall collection process. Therefore, the most attainable maximum power point tracking method of improving the performance of solar power collection is to increase the mean intensity of radiation received from the source used. The purposed of tracking system controls elevation and orientation angles of solar panels such that the panels always maintain perpendicular to the sunlight. The measured variables of our automatic system were compared with those of a fixed angle PV system. As a result of the experiment, the voltage generated by the proposed tracking system has an overall of about 28.11% more than the fixed angle PV system. There are three major approaches for maximizing power extraction in medium and large scale systems. They are sun tracking, maximum power point (MPP) tracking or both.

Key words: Dual Axis, Solar Tracking, Power Point Tracking

I. INTRODUCTION

Climate change one of society's most inevitable challenges. Engineering efforts to address these challenges have largely focused on development and refinement of mechanical, electrical and material technologies that generate and store renewable energy, such as solar arrays, wind turbines and fuel cells. In recent years, growing attention has been drawn to computational methods, such as control theory, artificial intelligence and operations research that are essential for the energy efficient and reliable operation of these systems. The uses of alternative sources such as solar energy are becoming more wide spread. To make solar energy more viable, the efficiency of solar array systems must be maximized. A feasible approach to maximizing the efficiency of solar array system is solar tracking. Proposed in this report is a system that controls the movement of a solar array so that it is constantly aligned towards the direction of the sun. Solar modules are devices that cleanly convert sunlight into electricity and offer a practical solution to the problem of power generation in remote areas. The solar tracker designed and constructed in this project offers a reliable and affordable method of aligning a solar module with the sun in order to maximize its energy output. Automatic Sun Tracking System is a hybrid hardware/software prototype, which automatically provides best alignment of solar panel with the sun, to get maximum output (electricity).

A prototype of the automatic dual-axis solar tracking system with a designed sun position tracker mechanism and control system designed in this paper. The sun position tracker mechanism was composed of the embedded system, DC motors, driver, real time clock, voltage divider circuit for voltage measurement. According to feedback signal of V the controller command DC motors to controls elevation and orientation angles of solar panels the that the panels always maintain perpendicular to the sunlight. Each parameter of the system was collected by the controller and control program on PC.

As a result of the experiment, the voltage generated by the proposed tracking system has an overall increase of about 28.11% more than the fixed angle PV system in winter days.

II. DESIGN OF SUN TRACKING SYSTEM:

A. *Structure Design –Rotate and Tilt*

Rotate and Tilt structure is chosen for a smoother movement on dynamic search system. This structure is friendly to the base motor. It does not stress the first level structure through unnecessary load torque from the structure above it. This design involves first rotating the PV panel to the desired direction and then tilting it to the desired tilt angle in order to get maximum irradiance. Rotate and tilt system has a rotational structure at the base platform and the tilting structure at the second level. To make sure the structure is stable and the load torque is constant for the rotational motor, the centre of gravity of tilting structure is aligned at the rotating centre. Figure 1 shows the idea and implementation of rotate and tilts system.

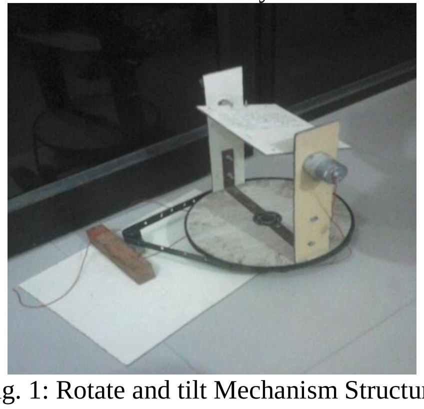

Fig. 1: Rotate and tilt Mechanism Structure

B. *PV cell as a sensor*

In this sun tracking system, small polycrystalline PV cells are used as the sensors to determine the solar irradiance. The very important electrical characteristic of the solar panel used is the short circuit current, ISC. ISC increases with the increase in the irradiance. To put it more accurate, ISC is proportional to the irradiance in the cosine function of the angle between a normal to the collector face and the incoming solar beam radiation. Figure2 illustrates the angle described above.

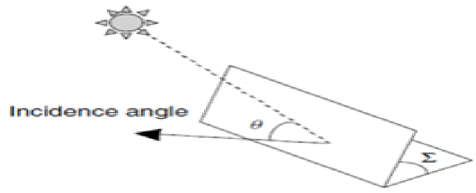

Fig. 2: The incidence angle, ϴ between normal to the collector face and incoming solar beam radiation [4] Isc α Solar radiation × cos ϴ

Solar cell can hence be tilted around while short circuit current is being measured. The maximum current will indicate the best insolation when the incident angle is zero degree.

The MPP can also be determined from the short-circuit current of the panel (ISC), because IMPP is linearly related to it under varying atmospheric conditions.

$$I_{MPP} = k_I I_{SC}$$

Similar to fractional open circuit voltage, the constant must be determined for each type of system. Determining ISC is more challenging, because doing so from time to time not only increases power loss and heat dissipation, but also requires an additional switch and current sensor. Obviously, this increases component count and cost. The simplest implementations do not require microcontrollers, but for better accuracy and to solve problems related to partial shading, more processing power is necessary to sweep the panel current from 0 to ISC, and memorize the output voltage profile The maximum power point voltage has a linear dependency on the open circuit voltage VOC under different irradiance and temperature conditions. Computing the MPP (Maximum Power Point) comes down to:

$$V_{MPP} = k_V V_{OC},$$

The constant k depends on the type and configuration of the photovoltaic panel. The open circuit voltage must be measured and the MPP determined in some way for different ambient conditions. Usually, the system disconnects the load periodically to measure VOC and calculate the operating voltage. This method has some clear disadvantages, temporary loss of power being an obvious one. An alternate method would be to use one or more monitoring cells, but they also need to be chosen and placed very carefully to reflect the true open circuit voltage of the system. Although this method is quite simple and robust and does not require a microcontroller, the constant only allows a crude approximation of the MPP. Other algorithms will significantly increase the top power drawn from the same PV installation.

C. Operating principle and working Algorithm

The proposed dual axis sun tracking system can tracked the sun in two axes- horizontal and vertical. The first motor will rotate the solar panel to track the sun in the horizontal axis. Once it has established the correct direction of the sun, it will start tracking in the vertical axis to get the best tilt angle. The working principle of the tracking system is based on the P & O MPPT of solar cell used under the correct conditions. In short, the system will take a step in unidirectional and sense the change in the voltage of the solar cell. If a negative response is obtained from the feedback of the sensor, the system will turn around and move in the same direction until it reaches the maximum point. If any fluctuation detect by ADC then motor step is taken and there is a delay set.so after some time motor start stepping as per ADC signal. Small minimum change in intensity is required before a further step is taken. Besides the algorithm, searching conditions need to be specified to anticipate the changing environment condition such as movement of cloud over the sun which causes a variation in the intensity of solar irradiance. Without these searching conditions, the sun tracking system will be searching nonstop to react to the changing intensity. The conditions of interest are as follow:

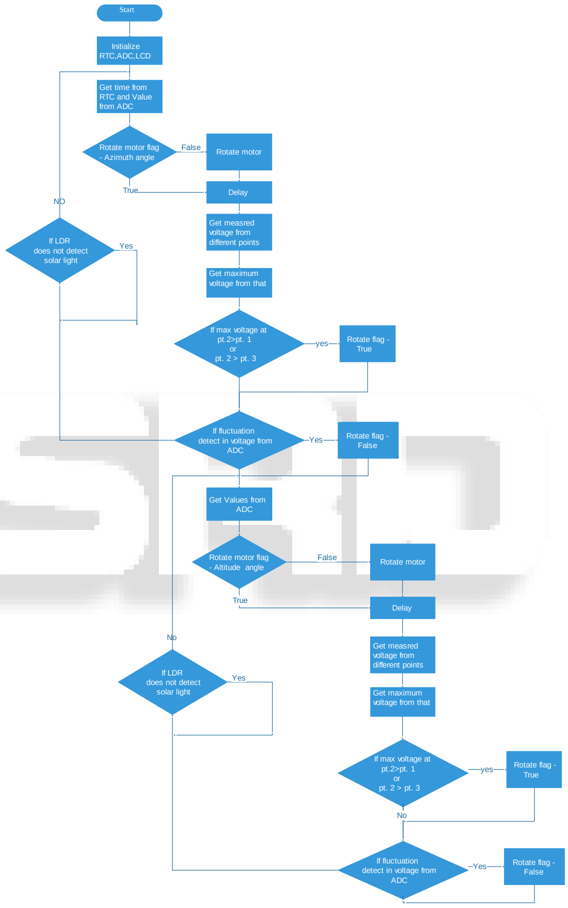

Fig. 3: Flow chart of solar tracking searching algorithm

1) Search trigger and its frequency

The system can search whenever there is a specified change in the solar intensity. This condition can be used in the indoor experiment where the light intensity can be closely controlled. However, in the unpredictable outdoor environment, this condition could not be applied because the fluctuation in solar intensity due to moving cloud is prevalent. Therefore, to tackle this problem, a periodical search is more appropriate. Since the movement of the sun could be estimated about 15 degree is equal to an hour, an appropriate user predefined search cycle of 5, 10, 15 minutes can be chosen to track the sun pretty accurately.

2) Condition for searching

With the predetermined searching cycle, the system still needs another condition for starting the search. This condition will be able to handle the current fluctuation in the solar intensity. The system will sample the solar intensity every second for a period of four seconds. The results are analyzed to check whether the peak to peak variation is less than a user predefined value of 1 V If the condition is satisfied, the system will start the search. This condition could increase the possibility of getting constant intensity during the search, but it cannot guarantee the unpredicted future outcome. To ease the concern over this matter, the search is made in the shortest time possible. Normally it will take about 1-2 seconds provided it does not start from a fresh search. The whole working algorithm is summed up in the flowchart shown in figure 3.With the algorithm being defined, sun tracking system will start tracking from sun rise. As the sun moves, the system will use the roll DC motor to track the movement in azimuth plane and tilt DC motor to track the movement in the altitude plane to get the best tilt angle.

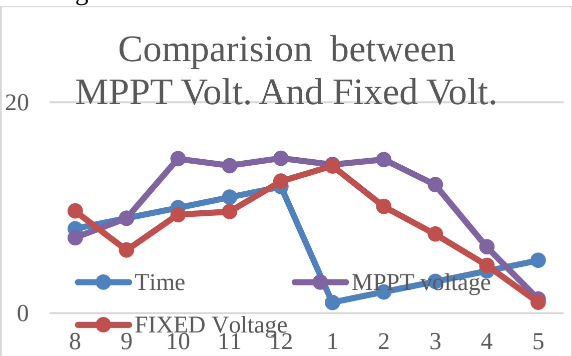

Fig. 4: Comparison between MPPT voltage and Fixed Voltage

D. Sun tracking system results

The first part will analyse the power generated by the solar cells with and without dynamic tracking system.

1) Experiments Conditions

Weather	Sunny
Starting Time	16/11/2014 8:00 AM
Ending Time	16/11/2014 5:00PM
Duration	10 Hours

2) Experimental Results

Type	Dynamic Tracking System	No tracking system
Load	13.6Ω	13.6Ω
Average Voltage	10.796	8.427
Average Current	65.558	34.488
Average Power	0.872865	0.362676
Improvement	51.0189	N.A.

The effectiveness and reliability of the P & O MPPT as sensors are verified by experimental results. For a comparison, a static PV cell and a PV cell with a dynamic tracking system are tested under the together under the same condition. The measured power conversions of the cells are the basis for performance comparison. The effectiveness of the system was tested under winter conditions.

III. CONCLUSION

In this paper, an intelligent solar tracking system based on embedded microcontroller PIC16F877A is present and implemented. This solar tracking system consists of Voltage divider circuit as a voltage sensor, embedded controller, control mechanism and solar tracking equipment. The P & O MPPT technique is used for sun position is introduced briefly in order to trace the movement of the sun. The hardware structure of the intelligent solar tracking system based on PIC16F877A microcontroller is introduced in detail. Meanwhile, P & O MPPT control strategy and the software code for DC motor is described. This proposed solar tracking system can improve the photoelectric conversion efficiency of the solar cell array with high accuracy.

REFERENCES

[1] Ahmad Al Nabulsi, Ammar El Nosh, Abdulrahman Ahli, Mohamed Sulaiman and Rached Dhaouadi “Efficiency Optimization of 150W PV System Using Dual Axis Tracking and MPPT”, IEEE International Energy Conference, 2010.

[2] Santhosh K V ,Tamal Dutta and J S Rajshekar,” 2 D Tracking System for Solar Panels Using SVM Implemented by Motion Assistant of Lab VIEW”, International Conference on Signal Processing, Image Processing and Pattern Recognition [ICSIPRl,2013.

[3] Zolkapli, AI-Junid , Othman Z, Manut, A. and Mohd Zulkifli “High-Efficiency Dual-Axis Solar Tracking Developement using Arduino”, 2013 International Conference on Technology, Informatics, Management, Engineering & Environment (TIME-E 2013) Bandung, Indonesia, June 23-26,2013.

[4] S. Dasgupta, Freddy Wilyanto Suwandi , S. K. Sahoo, *S. K. Panda,” Dual Axis Sun Tracking System with PV Cell as the Sensor, Utilizing Hybrid Electrical Characteristics of the Cell to Determine Insolation”,IEEE-International Conference On Advances In Engineering, Science An Management (ICAESM -2010) December 6,9,2010.

[5] LIM ZI CHAO,” DUAL AXIS SOLAR TRACKER STUDY”,IEEE International Energy Conference,2010.

[6] Trishan Esram, and Patrick L. Chapman, “Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques”, IEEE TRANSACTIONS ON ENERGY CONVERSION, VOL. 22, NO. 2, JUNE 2007.

[7] Akihiro Oi, “DESIGN AND SIMULATION OF PHOTOVOLTAIC WATER PUMPING SYSTEM”, IEEE International Energy Conference September 2005.

[8] Manuela Sechilariu, Baochao Wang and Fabrice Locment,” Building Integrated Photovoltaic System with Energy Storage and Smart Grid Communication”, IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 60, NO. 4, APRIL2013.

[9] WANG Wei and LI Shaoyuan," Model Predictive Control of 2-axis Solar Tracker for Solar Energy System",Proceeding conference of 31st chinese control conference,25-27 July 2012.