J. Solid St. Sci. & Technol. Letters, 2015, Vol. 16 No. 1-2, pp. 6-10
http://letters.masshp.net/ | ISSN 0128-8393

AUTOMATIC SOLAR RADIATION TRACKER USING ELEVATION OF SUN ANGLE FOR MAXIMUM SOLAR ENERGY

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ABSTRACT

There are many ways to track the sun by implementing fixed installations, single-axis trackers or dual axis tracker and using a concentrator. In this study, the prototype using single axis system is developed for automatically tracking solar position by detecting the elevation angle of the sun. The data of elevation retrieve from NOAA database extracted to text file format and stored in micro SD card used as input of detector system. This data will feed up to Arduino Mega 2560 as microcontrollers and convert it to step value send to motor drive. Stepper motor is used as the driving mechanism for this system move the solar panel to position that that perpendicular toward sun. Result shows that using this system, the efficiency of solar panel increased compare with the fixed installation of solar panel.

Renewable energy sector is fast gaining ground as a new growth area for most countries with high potential it presents environmentally and economically. Solar energy plays an important role as a primary source of energy. Among the renewable energy source, solar power is recognized as the most inexhaustible, bottomless and safe energy. Among all renewable systems, photovoltaic system is the one which has a great chance to replace the conventional energy resources. Solar panel directly converts solar radiation into electrical energy. Solar panel is mainly made from semiconductor materials. Silicon (Si) used as the major component of solar panels, which is maximum 24.5% of efficiency. Unless high efficient solar panels are invented, the only way to enhance the performance of a solar panel is to increase the intensity of light falling on it [1]. Basically, solar tracker cell is using LDR as the sensor to detect the position of the sun and unfortunately the efficiency of using LDR as the input sensor is not the best solution to track the sun [1-2]. In this project, data of elevation angle is used as input of the tracking system. The elevation or zenith angle is stored as text file and it will be read as input by the microcontroller to rotate the solar panel in order to get desire angle of sun. The data of elevation angle of the sun is retrieve from NOAA database. In this study, 5.5 V 2 W solar panel is used. There were several studies that have been conducted on improvements of solar tracking systems. The following are from the previous studies and projects.

A. Solar Tracker Robot using Microcontroller

The project is using LDR as input to search for optimal absorption solar energy can be done by solar panels to absorb energy from the sun. This project applies an axial search and use servo motors to move the solar panel towards the sun to find the best. Digital compass used in this project for solar search robot to move across the sun's position in the axis is set in the program and using PIC16F877A as the microcontroller [3].

B. Design, Development and Performance Test of an Automatic Two-Axis Solar Tracker System.

The project applied the bi-directional motor movement of the azimuth and elevation angles to find the optimum position of the sun while using three units LDR to find the optimum position of the sun. Three units LDR will compare each other to determine the best position of the sun before the micro controller member command to the DC motor to move towards the direction of solar panels required. The project uses a micro-controller ATMEGA32 to control motor movement and thus be able to determine the optimum position of the sun to the absorption of energy by the solar panels [4].

C. Sun Tracking by Peak Power Positioning for Photovoltaic Concentrator Arrays.

The project applied the bi-directional search and search process performed by the peak power that can be absorbed by the solar panels. Using micro-computer as a micro-controller to move the motor to allow the solar panel to find the optimum position of the sun. The basic method used in the TACS is as follows: once the various shown close to the sun (using directional information derived from sensor output of the sun), a systematic process of movement and finding additional new peak power point start. When a new peak position of power have been found, many held in this position a few seconds until a new cycle begins. When performed at regular intervals, this process resulted in peak power tracking PV array [5].

In this project, the movement of solar panel will be controlled based on data of elevation angle of sun that read from micro SD card. The Arduino Mega 2560 will read the data of elevation angle every 15 minutes interval. The data in degree converted to step value and send to motor drive and rotate the stepper motor according to elevation angle of sun. The stepper motor moved the solar panel perpendicular toward sun position.

System architecture. Figure 1 shows the architecture of the whole of this system including micro SD card, micro SD card reader, Arduino Mega 2560, easy driver as motor driver, and stepper motor. Arduino Mega 2560 will be used as a major role in this system as microcontroller of the system. Arduino Mega 2560 will be read the data of elevation angle of sun saved in text file format that stored in micro SD card every 15 minutes interval through SPI (Serial Peripheral Interface). The signal send to motor driver and start rotate the motor according to elevation angle.

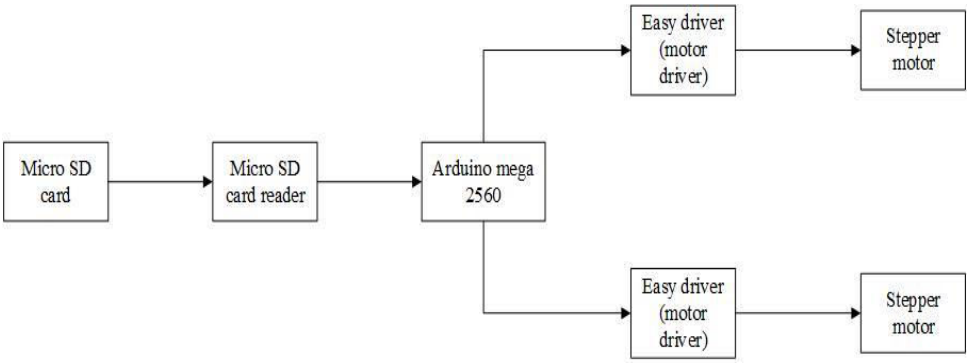

Figure 1. Block diagram of solar tracking system

System algorithm. Figure 2 shows the flowchart of the algorithm that operates the system. The algorithm consists of data reading, conversion from degree to steps, time delay for every 30 minutes interval. Data in degree extracted from NOAA database saved in text file format. This data stored in SD card and converted into step value before sending to the motor driver. The motor driver rotates the solar panel to position that perpendicular toward sun. Figure 3 shows the hardware of solar tracking system.

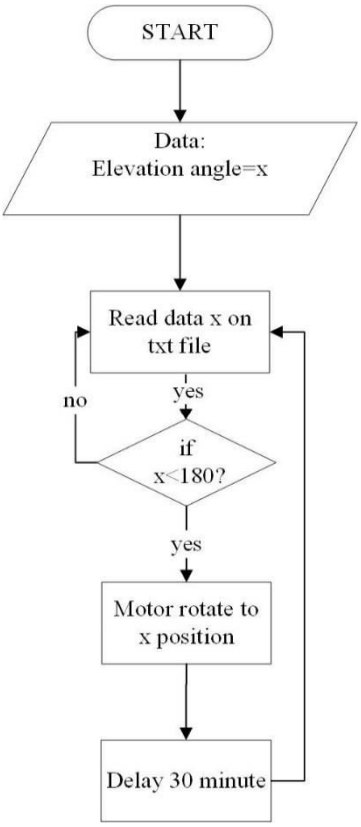

Figure 2. Flowchart of the system

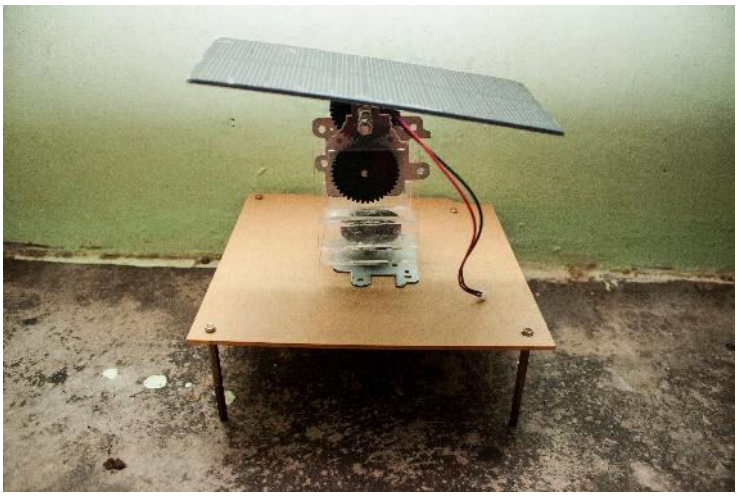

Figure 3. Hardware of the system

This analysis is being held for comparing value of voltage between fixed tracking solar panel with the automatic single axis solar tracking systems. The recorded voltage readings were taken twice, on 19 MAY 2014 and 24 MAY 2014. The fixed solar panel has been set to perpendicular with ground surface. The data of voltage of solar panel for fixed axis and single axis has been recorded in 30 minutes interval. The graph of solar panel's voltage versus time for both date shows in Figure 4 and Figure 5, respectively. Result shows that the voltage of the solar panel installed in this system is increasing during 8.00 am to 11.00 am and 3.30 pm to 6.00 pm compared with

fixed tracking solar panel. From 11.30 am to 3.00 pm, the data shows that the value of voltage almost same for these two system. It is because during that time the sun almost perpendicular with ground surface.

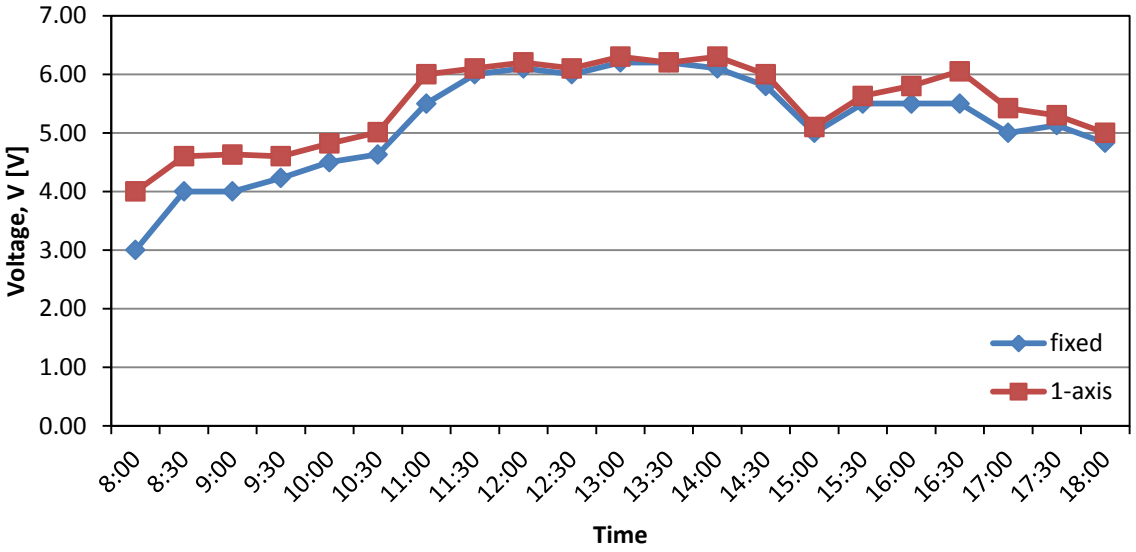

Figure 4. Graph of Voltage of solar panel versus time recorded on 19 MAY 2014

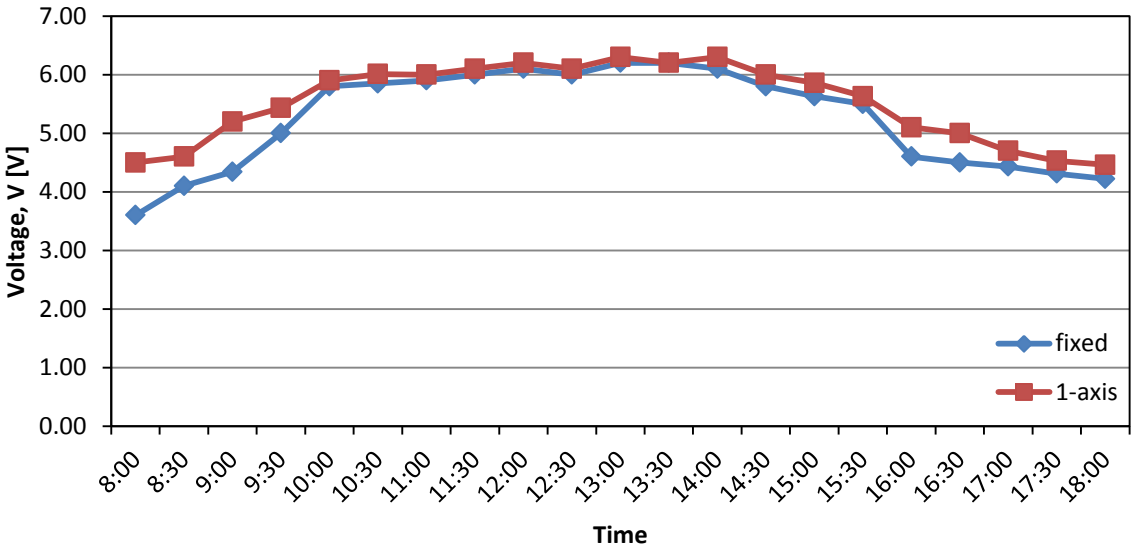

Figure 5. Graph of Voltage of solar panel versus time recorded on 24 MAY 2014

In conclusion, this project created a new method to track down the sun position by implementing single axis solar tracker that can read data elevation angle of the sun from a simple database such as text file. The results also show that the system with automatic single axis solar tracking systems have the ability to increase the efficiency of solar panel compared with fixed tracking solar panel.

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