1. The effect of solar cells control strategy on the net power in single axis rotation

Diya ARAFAH*, Khaled IWAIWI, Mahmoud SALHAB

* Palestine Polytechnic University, P. O. Box 198, Hebron, Palestine, darafah@ppu.edu

Abstract

Solar power generation has been used as a renewable energy since years ago. The solar panels could be mounted as a fixed frame facing the sun, or, as a single axis rotating frame that track the sun position.

Many control strategies are proposed to track sun position over the horizon. In the present study two control methods has been implemented: in the first method the sun position is pre-determined based on latitude and altitude as a look-up table. While in the second method, the look-up table is assisted by a simple algorithm that search for the sun position which yields the maximum power output from the PV cell.

The solar system is driven by a DC linear actuator geared motor that will rotate the frame through a simple mechanism. The two control strategies have been compared in terms of the net power output.

Keywords: Solar cells, PV cells, solar tracking, single axis rotation

2. Introduction

The solar energy is known to be one of the preferred renewable green energies, which is much cleaner and free from harmful products to the environment compared with the conventional counterparts. Maximizing power output from a solar system is desirable to increase efficiency. In order to maximize power output from the solar panels, one need to keep the panels aligned with the sun, means that the tracking of the sun is required.

Solar trackers are the most appropriate and proven technology to increase the efficiency of solar panels through keeping the panels aligned with the sun's position [1]. Solar trackers get popularized around the world in recent days to harness solar energy in most efficient way. In the literature many strategies are proposed to control the solar panel tracking [2].

3. Experiment Design

The present study aims to verify experimentally the effect of solar panel tracking strategy (single axis rotation) on the net useful power output. For this purpose, thre fixed position

solar panel mounting is compared with two control methods: The look up table and the maximum power search. The solar panel is mounted on the rotating frame (see Figure 1) and the Arduino Uno is used for the real-time monitoring of the system.

Figure 1: Single axis solar tracker

3.1 The fixed position

In this method, the solar panel is mounted at a fixed orientation (inclination angle) with respect to the sun path during the day. The power output is recorded at specific clock times using current and voltage sensors at solar panel output.

3.2 The look up table

In this method the geographic location of Hebron city (Latitude and Longitude) is used to determine the sun path along the day. For this purpose Solar Position Algorithm (SPA) [3] is used to create "look up table" that gives the sun position (Sun Azimuth angle) at specific clock time each day of the year. The microcontroller (Arduino Uno) sends the required Azimuth angle to the DC linear actuator geared motor that will rotate the frame of the solar panel to reach the required position. The DC linear actuator is fitted with limit swith in order to protect the structure from over rotation, as well as, an encoder to verify that the frame reached the required position. The power consumed by the actuator, as well as, the

power output of the solar panel is recorded in order to calculate the net useful output power.

3.3 The maximum power search

In this method, the look up table of Sun Azimuth angle described above is used alongside with a search algorithm; the algorithm will search for the maximum power output of the solar panel within a range of ±5 degrees about the specified Azimuth angle. The final position of the solar panel will be the one that yields the maximum power output from the panel.

4. Results and Discussion

The different methods explained previuosly are tested, the tests performed on three successive days starting from 8:00 AM till 6:00 PM, on each day a specific method was tested. Figure 2 summarize the recorded data. The power search method yielded the maximum power output from the solar panel.

5. Acknowledgement

The authors acknoweldge Palestine Polytechnic University – Deanship of scientific research and graduate studies for the financial support of the project.

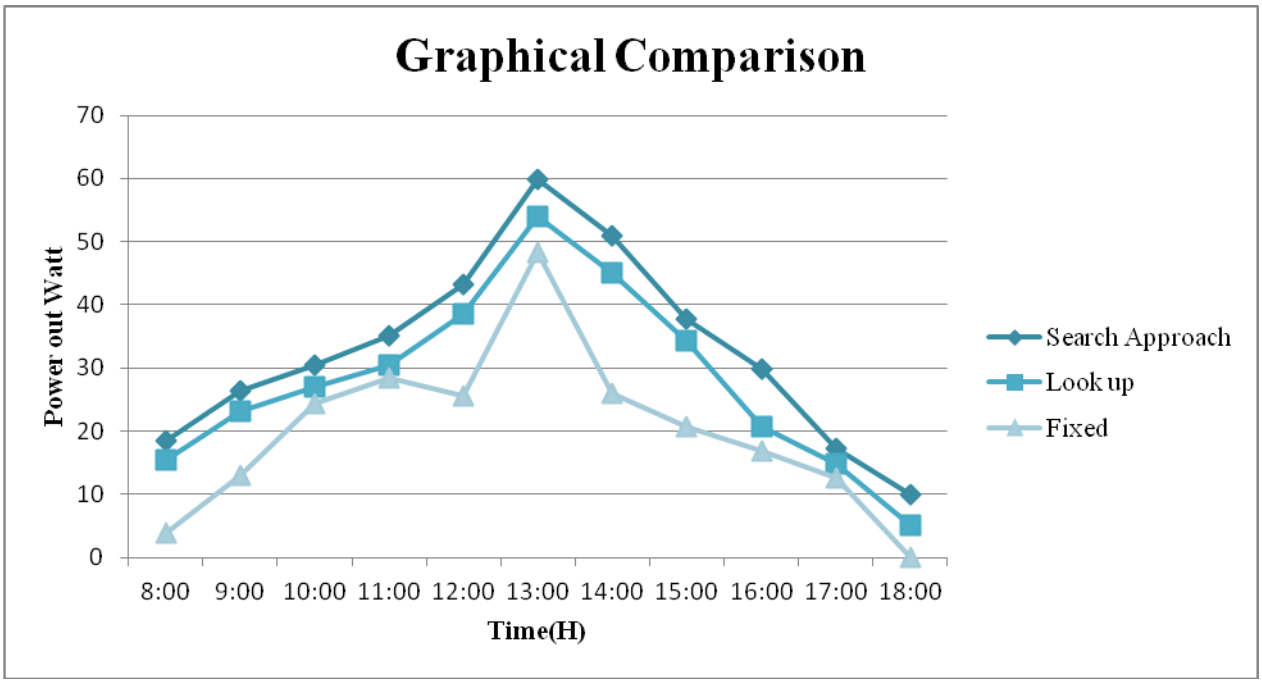

Figure 2: Graphical Comparison

References

[1] Hamed B, El-Moghany MS. Fuzzy controller design using FPGA for photovoltaic maximum power point tracking. Fuzzy controller design using FPGA for photovoltaic maximum power point tracking. 2012;1(3).

[2] Huang F, Tien D, Or J. A microcontroller based automatic sun tracker combined with a new solar energy conversion unit. In1998 International Conference on Power Electronic Drives and Energy Systems for Industrial Growth, 1998. Proceedings. 1998 Dec 1 (Vol. 1, pp. 488-492). IEEE.

[3] Rizal Y, Wibowo SH. Application of solar position algorithm for sun-tracking system. Energy Procedia. 2013 Jan 1;32:160-5.