Photovoltaic Maximum Power Improvement Using Two Axis Solar Tracking

I. Daut, M. Sembiring, M. Irwanto, S. Hardi, R. Chan, I. Nisja and K. Anayet

***Abstract* – Photovoltaic (PV) are system which composed of semiconductor materials and convert solar energy directly into DC electric energy. The amount of electrical energy that provided from the PV system is directly proportional to the intensity of the sun light which falls on the module surface. However, the change observed in sun light does not occur linearly, for this reason it is desired that the PV module be fixed in a way that it face the sun or have a system which tracks the sun. This paper presents to develop 50 W of PV. For comparison, this research used two 50 W of PV modules that one of PV modules is placed on fix position (without solar tracking) and the other one with solar tracking. PV module output terminals are connected to a lamp 12 V/5 W as load. The result shown that the average improvement of open circuit voltage = 5.5 %, load voltage = 22.8 %, load current = 11.3 % and power = 41.9 %.**

***Index Terms*-- Photovoltaic, Maximum power, Solar tracking, Smart relay.**

I. INTRODUCTION

Photovoltaic system is a very important alternative energy and its efficiency been increasing by researcher. There are three method for increasing the efficiency of PV, the first is the increasing the efficiency of solar cell, the second is the energy conversion system included MPPT control algorithm and the third is the using solar tracking system [1]. The method of maximum power point is based on closed loop current control, in which the reference current is determined from the fitted function of I_{mpp} versus $P_{\max}$, points of a particular photovoltaic generator (PVG) [2]. A simplified computer model of the PVG is given and computer simulation for demonstrating the effectiveness of the proposed algorithm are presented. From the result of the simulations and experiment studies, it is concluded that that the proposed approach can be used as a robust and fast acting maximum power point tracking.

This paper is presented to develop 50 W of PV tracking system using smart relay SR2 B121JD. The system was designed into two parts, that are mechanical movement and electrical controller. The mechanical movement consist of dc motor and gears for moving the PV module from east to west and north to south . The electrical controller consist of a voltage and current divider circuit [3] and smart relay. Smart relay inputs were voltage comparison which got from voltage divider circuit, and its outputs connected to driver circuit for moving two dc motor. The motors would move based on the higher voltage comparison.

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II. PHOTOVOLTAIC AND SOLAR TRACKING

A. Photovoltaic

Physics of the photovoltaic (PV) cell is very similar to the classical p-n junction diode (Fig. 1). When light is absorbed by the junction, the energy of the absorbed photon is transferred to the electron system of the material, resulting in the creation of charge carriers that are separated at the junction. The charge carriers may be electron-ion pairs in an electron hole pairs in a solid semiconducting material. The charge carriers in the junction region create a potential gradient, get accelerated under the electric field and circulate as the current through an external circuit. The current squared times the resistance of the circuit is the power convert into electricity. The remaining power of the photon elevates the temperature of the cell [4].

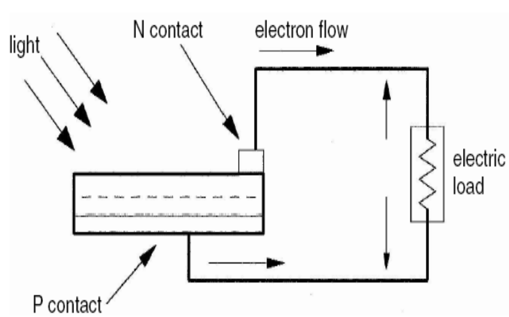

Fig. 1. Photovoltaic effect converts the photon energy into voltage across the p-n junction

For obtaining high power, numerous such cell are connected in series and parallel circuits on a module area of several square feet (Fig. 2). The solar array or panel is defined as a group of several modules electrically connected in series and parallel combinations to generate the required current and voltage.

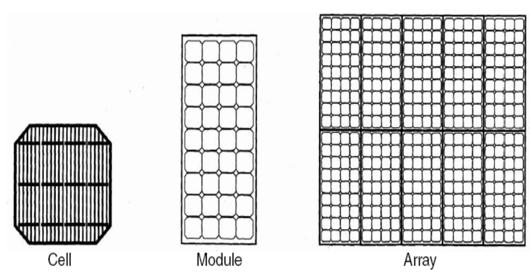

Fig. 2. Several pv cells make a module and several modules make an array

PV converts solar energy directly into direct current electric energy. The amount of electrical energy which will be obtained from the photovoltaic (PV) system is directly proportional to the intensity of the sun light which falls on the module surface. However, the change observed in sun light does not occur linearly, for this reason it is desired that the solar panel be fixed in a way that they face the sun or that they have a system which tracks the sun. Sun tracking system is designed in a way to track the sun on single axis. The movement of PV module is controlled to follow the sun's radiation by LDR sensor using smart relay SR2B121JD. Maximum benefit is derived from solar energy by providing that the PV module system be oriented at a right angle to the sun which will be got maximum power.

B. Circuit of solar tracking

A mechanic movement and input/output circuit of smart relay are shown in Fig. 3.

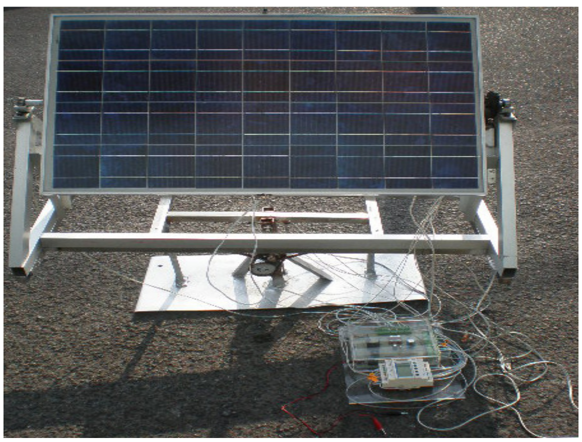

Fig. 3. A mechanic movement and input/output circuit of smart relay

A block diagram of solar tracking is shown in Fig. 4.

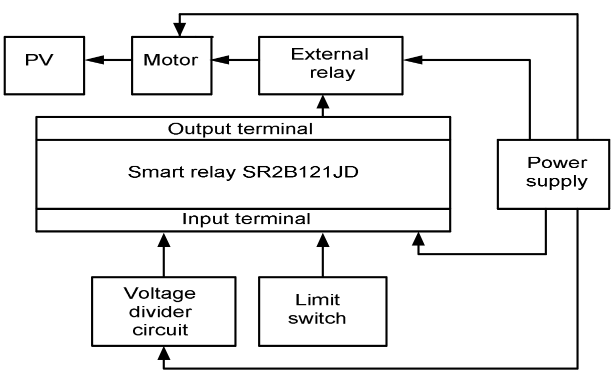

Fig. 4. A block diagram of solar tracking

Two LDRs are installed on east and west of PV module. If the east LDR gets intensity of the sun light is higher than west LDR, the PV module will move to east. Otherwise, if the west LDR gets higher intensity , the PV module will move to west. When the intensities of both LDRs are same, the DC motor will stop. The east and west limit switch will stop DC motor, when they are touched by PV nodule. With the same mechanism, two LDRs are installed on north and south of photovoltaic module, accordingly.

III. Research Methodology

A. The used device

The devices used in this research consist of :

1. Hardware
   a. Photovoltaic 50 W
   b. dc motor
   c. Smart relay SR2B121JD
   d. Voltage and current divider circuit

2. Software
   The software used was Zeliosoft2

B. Research procedure

The research procedure can be drawn by a flow chart in Fig. 5.

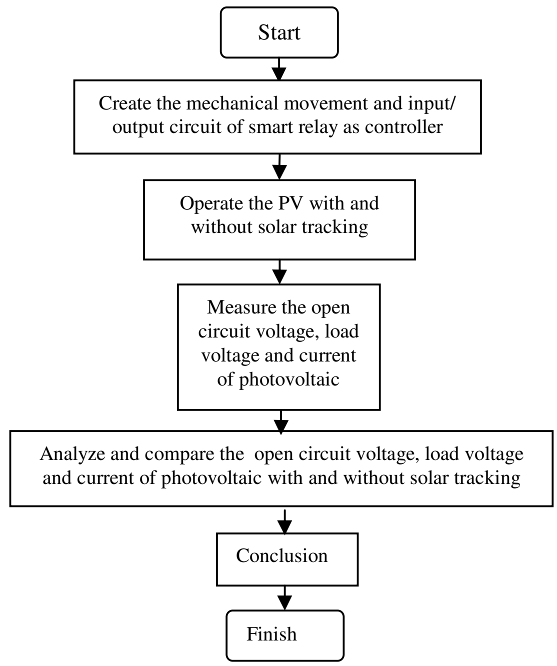

Fig. 5. Flow chart of research procedure

IV. Result And Discussion

For the comparison, this project used two 50 W of PV modules, that first modules was placed on fix position (without solar tracking) and the second module with solar tracking. PV module output terminals are connected to a lamp 12 V/5 W as load. Open circuit voltage (V_{oc}), load voltage (V_L), load current (I_L) and power of PV module output terminal were measured every 30 minutes from 7.00 am to 7.300 pm. V_{oc} - H, V_L - H, I_L -H, and P-H curve are shown in Fig. 6, 7, 8 and 9, respectively.

Fig. 6 shows that the open circuit voltage of photovoltaic, V_{oc} raised using solar tracking. The average improvement percentage is 5.5 % as shown in Fig. 10.

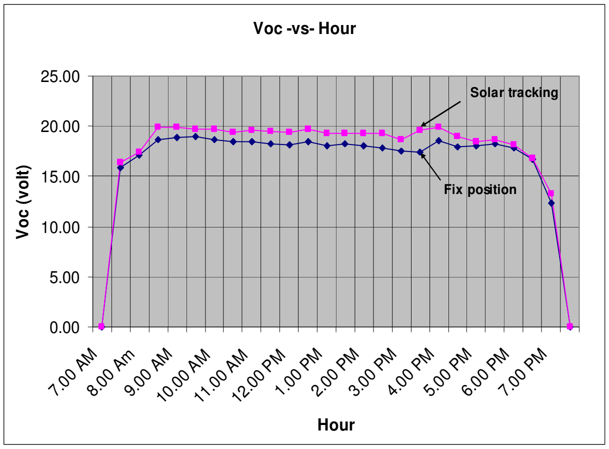

Fig. 6. A V_{oc} - H curve

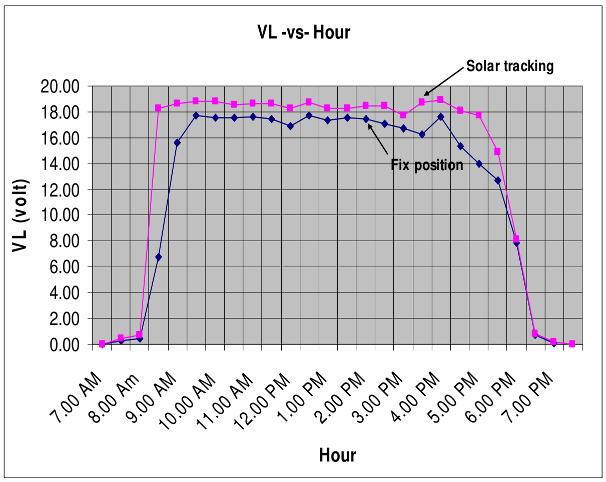

Fig. 7. A V_L - H curve

Fig. 7 shows that the load voltage of photovoltaic, V_L raised using solar tracking. The average improvement percentage is 22.8 % as shown in Fig. 10.

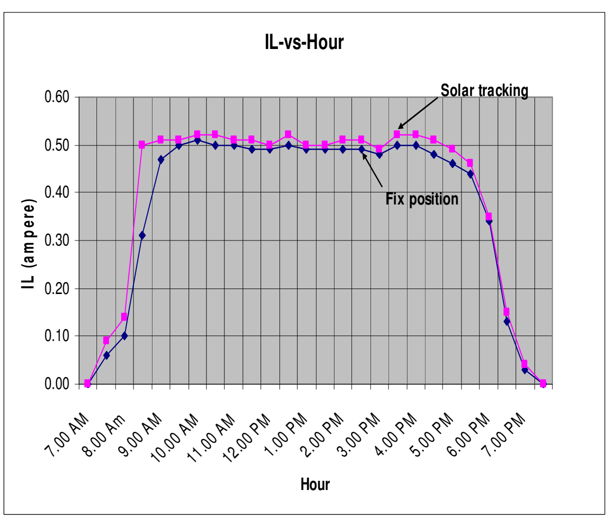

Fig. 8. I_L -H curve

Fig. 8 shows that the load current of photovoltaic, I_L raised using solar tracking. The average improvement percentage is 11.3 % as shown in Fig. 10.

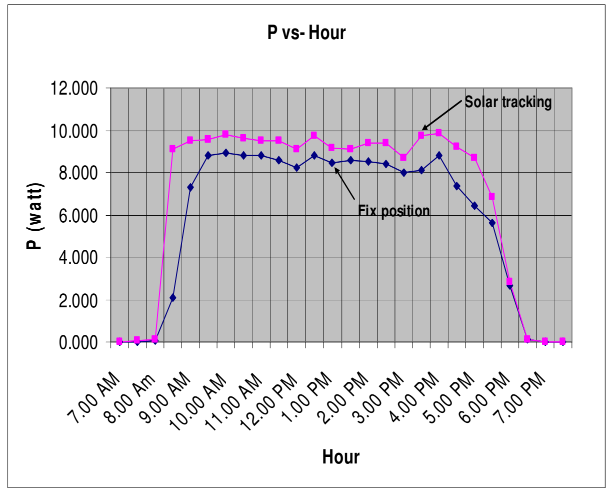

Fig. 9. P-H curve

Fig. 9 shows that the power of photovoltaic, P raised using solar tracking. The average improvement percentage is 41.9 % as shown in Fig. 10.

Fig. 6 to 9 display that the 50 W of PV module with solar tracking is better than fix position (without solar tracking). The average improvement of V_{oc} = 5.5 %, V_L = 22.8 %, I_L =11.3 % and P = 41.9 % as shown in Fig. 10.

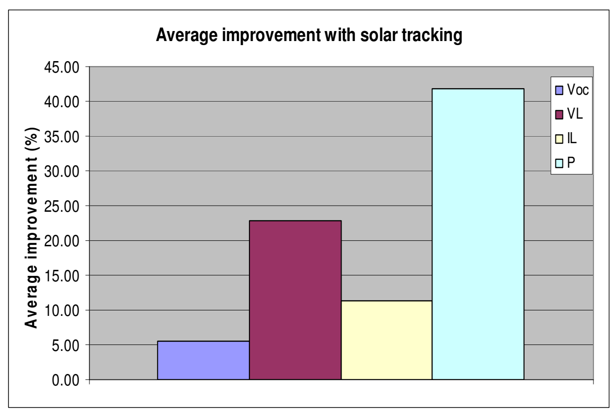

Fig. 10. Average improvement of V_{oc}, V_L, I_L, and P with solar tracking

V. Conclusion

The smart relay and its input circuit (voltage and current divider circuit) can be used to track solar.

The performance of PV module with solar tracking is better than fix position (without solar tracking). The average improvement of V_{oc} = 5.5 %, V_L = 22.8 %, I_L =11.3 % and P = 41.9 %.

VI. References

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VII. Biographies

Ismail Daut received his B. Elect.Eng. (Hons) from University of Science Malaysia in 1980 and MSc in Electrical and Electromagnetic Engineering from University of Wales, College of Cardiff, United Kingdom in 1991 and PhD in Energy Conservation and Power Engineering from University of Wales, College of Cardiff, United Kingdom in 1994. His research interest includes energy conversion, electrical machine design and high voltage. He has authored and co-authored more than 150 technical papers in the national, international journal and conferences.

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