A STUDY ON INCREMENTAL CONDUCTANCE ALGORITHM FOR MAXIMUM POWER POINT TRACKING OF PHOTOVOLTAIC SYSTEMS

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ABSTRACT

Today, the consumption and deployment of conservative energy, & environmental pollution caused due of it is increasing with the modernization of world. To minimize the pressure on conventional energy source it's the need to have more concerned about looking alternative sources for power generation. Solar can play important role as an alternative energy being a renewable energy source. Among the renewable resources, photovoltaic panels and wind- generators are primary contenders. The gain of Photovoltaic (PV) is that it has very small conversion efficiency, less maintenance & causes no pollution.

The expenditure of solar system utilizing photovoltaic (PV) cells can be reduced by using efficient power system which is designed to extort the greatest probable power from the photovoltaic module using sun tracking and maximum peak-power point track (MPPT) technique. In sun tracking technique PV panel is oriented according to sun within a day to generate a highest possible power from it. To exploit the increase in the extraction of electricity using photovoltaic (PV) systems, implementation of maximum power point tracking method of photo-voltaic system using an incremental conductance algorithm, sun tracking technique and data logging software for monitoring the performance of solar system is presented in this work. In the photovoltaic (PV) systems, the instantaneous terminal voltage & output current are reliant on the thermal energy and solar intensity. Thus, locating peak power point is essential for accumulating as much power as possible from solar panels.

KEYWORDS: Maximum power point tracking (MPPT), Perturbation and observation (P & O), and Incremental conductance (InC).

INTRODUCTION

Since the late twentieth century, global warming and energy shortage are becoming serious issues. Solar power is a substitute technology that will optimistically guide us away from our combustible fuel dependent energy sources. In response to these issues, clean and renewable energies such as solar power, wind power, or tidal energy are receiving great interests in recent years. The solar as a source has the advantages of being inexhaustible and noiseless, and no mechanical power generator is required. Therefore, photo-voltaic (PV) system has fascinated more attention. The ultimate aim of the progress of solar systems is maximizing the effectiveness of power conversion and decreasing the cost. As the power produced by a solar panel is not linearly dependent on its load, a switching power converter together with maximum power point control is essential for keeping solar panels to operate at the maximum power point [3].

A diversity of methods for maximum power point (MPP) extraction has been proposed [2]. Most methods are dependent on perturb and observational (P&O) method [1]. Although P&O is simple to execute, except it has some limitations like it fails under quickly varying environment condition and normally requires a long time to move toward the peak power point. In addition, the perturbation could cause the operation point to fluctuate around the MPP, resulting in unnecessary power wasting. To overcome these restrictions we use Incremental Conductance method [4] [7].

Solar energy monitoring and electricity generation system is a multi-power system, mainly consisting of the photo voltaic panels, battery banks, and power inverter components. Due to the distinctive nature of solar energy resource, the technique to progress the utilization of solar energy resources has long been a topic of concern [8]. The overall improvement of solar based energy system is an important method to develop the employment of solar power resources. Solar power acquisition is particularly important and the data should be capable to meet the wide-ranging, concurrent and real-time requirements. Real-time data and its legality are associated to the complete solar power system security. Trustworthy data communication is related to the real significance and application value of monitoring system. Comparing a traditional monitoring system and the system handling real-time data, reliable communication media, and the network intelligence allows a user-friendly interface of solar monitoring system [6].

INCREMENTAL CONDUCTANCE ALGORITHM

The presumption of the incremental conductance process is to find the variation in the open circuit voltage for solar panel modules by experimenting and evaluating the incremental Conductance with the instantaneous conductance of solar panel modules. This algorithm operates by tracking for the voltage at maximum power point at which the instantaneous conductance is matching to the incremental conductance. If the value of incremental conductance is similar to that of instant conductance, then it represents that the maximum operating power point is sought. The schematic of the theory is shown in Fig. 1.

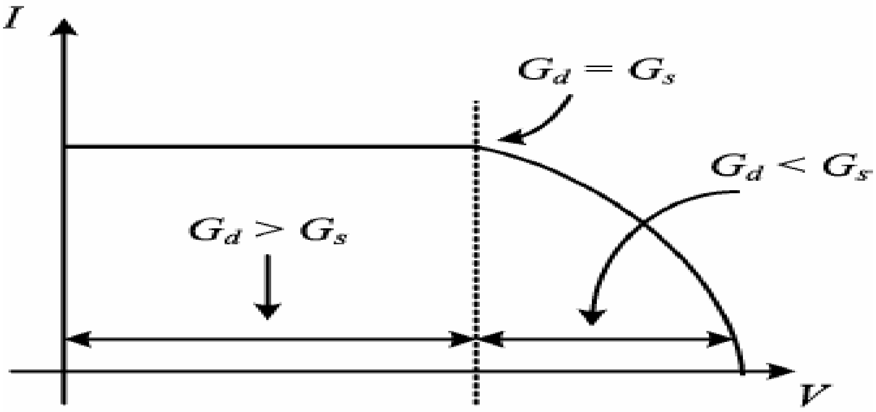

Figure 1

When the operating performance of solar panels is within the constant current area, the resultant power is proportional to the terminal voltage. That means the resultant power is directly proportional to the voltage of solar cell modules (if dP/dV > 0, gradient of the power curvature is positive), then the operating power point of photo voltaic modules passes through the peak power point, it's working is identical to constant voltage. Hence, the resultant power will be inversely proportional with the open circuit terminal voltage of PV modules (if dP/dV < 0, gradient of the power curvature is negative). When the operating peak power point of PV modules is accurately on the peak power point, the gradient of the power graph is zero (dP/dV = 0) and can be represented as,

$$\frac{dP}{dV} = \frac{d(VI)}{dV} = I\frac{dV}{dV} + V\frac{dI}{dV} = I + V\frac{dI}{dV} \qquad (1)$$

By the relationship of change in power to the change in voltage, above equation can be written as follows,

$$\frac{dI}{dV} = -\frac{I}{V} \qquad (2)$$

dI and dV represent the current and voltage deviation respectively. The stationary conductance (Gs) & the dynamic conductance (Gd) of solar modules are given below,

$$G_s = -\frac{I}{V} \qquad (3)$$

$$G_d = \frac{dI}{dV} \qquad (4)$$

The peak power point can be sought if,

$$G_d\big|_{V=V_m} = G_s\big|_{V=V_m} \qquad (5)$$

When the above equation (i.e. $G_d = G_s$) exists, the maximum operating power point of PV cells is tracked by MPPT system. However, the following conditions will happen while the operating point and maximum power point are different:

$$\frac{dI}{dV} > -\frac{I}{V} \ ; \ (G_d > G_s, \frac{dP}{dV} > 0) \qquad (6)$$

$$\frac{dI}{dV} < -\frac{I}{V} \ ; \ (G_d < G_s, \frac{dP}{dV} < 0) \qquad (7)$$

Equations (6) and (7) are used to find the possibilities of voltage perturbation when the operating power point of PV module approaches toward to the maximum power point. In the methodology of tracking MPP, the node voltage of solar cells will constantly vary until the equation (2) is satisfied. Fig. 2 is the flow chart representing the incremental conductance algorithm. The main dissimilarity between incremental conductance and P&O algorithms is the verdict on shaping the values of terminal voltage perturbation [5]. When stationary conductance Gs is similar to dynamic conductance Gd, the peak power point is found.
From the flow chart drawn in Fig. 2, it can be indicated that the atmospheric conditions don't change and the operating point is situated on the maximum power point where variation in voltage and current is zero. If change in voltage is zero (dV = 0) but if there is change in current (i.e. dI > 0), it signifies that the sun radiation increases and the potential at the maximum power point increases. Meanwhile, the MPP locater has to increase the operating terminal voltage of solar cells so as to indicate the maximum power point. Conversely, as the sun radiations reduces and the voltage of the panels maximum power point reduces, if dI < 0. This is where the maximum power point tracking system needs to reduce the operating voltage of PV panels [8].

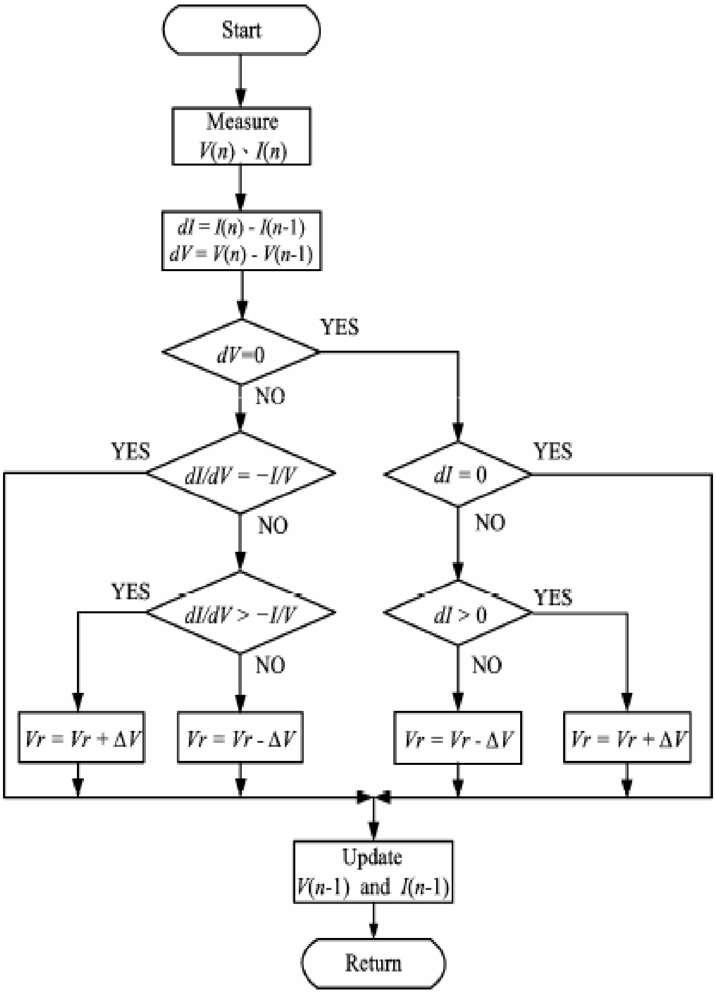

Figure 2. Flowchart

As the open circuit voltage and short circuit current of PV modules vary during a voltage attainment and dI/dV > −I/V (dP/dV > 0), the working voltage of solar cells is spotted on the left side of the highest operating power point of the PV graph, and has to be increased in order to indicate the maximum operating power point. If change in the current with voltage is given as dI/dV < −I/V (dP/dV < 0), the working voltage of solar cells will be spotted on the right side of the highest operating power point of the PV graph, and has to be bargained in order to find the maximum power point. The benefit of the incremental conductance process to those of the other MPPT methods is it can analyze and locate the accurate perturbation direction for the terminal voltage of PV modules. Also, it is able of locating the peak operating point more accurately in extremely uneven weather environment and exhibit less oscillatory performance about the MPP in contrast to the P & O process [5]. In presumption, when the maximum operating power point is found by the resultant conditions (dI/dV = −I/V and dI = 0) of the incremental conductance method, it can evade the perturbation happening close to the maximum power point which is typically happen for the other MPPT algorithms. Normally the tempo of operating voltage is then permanent. However, it signifies that perturbation incident is still occurs near the maximum power point in steady weather situation after attempting some trials. This is due of the reason that the likelihood of meeting condition dI/dV =−I/V is extremely small.

CONCLUSION

There are several approaches to finding and positioning the maximum power point for PV modules and assembly of cells. At low intensity of irradiance, technique like CV may be more appropriate as they have more noise immunity. In general, for whatever method that is chosen, it is superior to be precise than fast. Fast methods lean to oscillate about the maximum power point due to interference of noise present in the power conversion system. Therefore, the incremental conductance (InC) method is suitable as it is capable of reducing the ripple about the maximum power point and has advantages of exact perturbing and tracking direction and steady maximum operating voltage.

REFERENCES

1) N. Femia, G. Petrone, G. Spagnuolo, and M. Vitelli, “Optimization of perturb and observe maximum power point tracking method,” Power Electronics, IEEE Transactions on, vol. 20, no. 4, pp. 963–973, 2005.[2] O. Wasynezuk, “Dynamic behaviour of a class of photovoltaic power systems,” Power Apparatus and Systems, IEEE Transactions on, no. 9,pp. 3031–3037, 1983.
2) K. Ohniwa and T. Sato, “A simplified maximum power tracking method for photovoltaic solar system,” IEEJ Trans. Power Syst., vol. 106-B,no. 7, pp. 72–78, 1984.
3) I. Altas and A. Sharaf, “A novel on-line mpp search algorithm for pv arrays,” Energy Conversion, IEEE Transactions on, vol. 11, no. 4, pp.748–754, 1996.
4) Y. Kuo, T. Liang, and J. Chen, “Novel maximum-power-point-tracking controller for photovoltaic energy conversion system,” Industrial Electronics, IEEE Transactions on, vol. 48, no. 3, pp. 594–601, 2001.
5) Md. Hammad Uddin, Md, Ali Baig, and Md.Ali, “Comparison of P & O and IC, MPPT tracking algorithms on real enviournmental conditions”, IEEE, 978-1-5090-1252-7/16/2016 IEEE
6) C. Pan, J. Chen, C. Chu, and Y. Huang, “A fast maximum power point tracker for photovoltaic power systems,” in Industrial Electronics Society, 1999. IECON’99 Proceedings. The 25th Annual Conference of the IEEE, vol. 1. IEEE, 1999, pp. 390–393.
7) T. Esram and P. Chapman, “Comparison of photovoltaic array maximum power point tracking techniques,” Energy conversion, IEEE transactions on, vol. 22, no. 2, pp. 439–449, 2007.
8) F.E.Tahiri, K.Chikh, M. Khafallah, and A.Saad, “Comparative study between two maximum power point tracking techniques for PV systems”, 2nd International Conference on Electrical and Information Technologies ICETT'2016, 978-1-4673-8469-8/16/2016 IEEE