International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 04 | April-2016 www.irjet.net p-ISSN: 2395-0072

Simulation of Modified P&O MPPT Technique for Solar PV Cell Using MATLAB/SIMULINK

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Abstract - *This paper deals with P & O method in which the MPPT algorithm is based on the calculation of the PV output power and the power change by sampling both the PV current and voltage. In this thesis an improved P&O MPPT algorithm for PV module is proposed. Since the solar PV panel have a non-linear voltage-current relationship, which greatly affected by sun irradiation and temperature, hence, it is necessary to identify an effective method in extracting maximum amount of power from PV cell/modules over the past decade, there were many types of algorithm have been published. Firstly the photovoltaic system is designed by using perturb and observe method. Then we check the performance of solar PV cell under difference irradiance levels. This technique has drawback that it cannot perform under sudden change in irradiance, temperature etc. So the modified Perturb and Observe (P&O) or more commonly known as variable step size P&O method was introduced and implemented throughout the project to overcome the common drawbacks of conventional P&O method. The operation of the entire solar MPPT system was observed through MATLAB/Simulink simulation. With the same equation of power, a new MPPT algorithm has been compared with the conventional P&O technique that it reaches to the maximum power much faster than the conventional P&O. The complete system is modelled and simulated in the MATLAB/SIMULINK.*

***Key Words*: Maximum Power Point Tracking, Photovoltaic, Perturb and Observe, Solar PV cell**

1. INTRODUCTION

Renewable energy resources exist over wide geographical areas, in contrast to other energy sources, which are necessary to increase the power demand and reduce the environmental problems in the world. Rapid deployment of renewable energy and energy efficiency is resulting in significant energy security, climate change mitigation, and economic benefits. In international public opinion surveys there is strong support for promoting renewable sources such as solar power. Among through various renewable energy sources, photovoltaic arrays are used in numerous applications such as water pumping, charging the batteries, grid connected PV module system etc.

As we know from power-voltage curve of solar panel, there is an optimum operating point such that the PV retains the maximum power to the load. The operating point changes with the variation of solar irradiation and cell temperature. Therefore various methods for maximum power point tracking are developed. The problem is associated with conventional P&O technique is that it has slow response in reaching to the maximum power point and hence to overcome to this problem a new MPPT technique has been developed. In this paper a new MPPT technique is proposed which is modified perturb and observe algorithm to reach fast to MPP compared to the conventional P&O technique.

2. EQUIVALENT CIRCUIT OF PV SOLAR CELL

The solar cell is the basic unit of a PV system. An individual solar cell produces direct current and power typically between 1 and 2W, hardly enough to power most applications. Solar cell or photovoltaic (PV) cell is a device that is made up of semiconductor materials such as silicon, gallium. arsenide etc. that converts sunlight directly into electricity. The voltage of a solar cell does not depend upon only solar irradiance but also on cell temperature. PV modules can be designed to operate at different voltages by connecting solar cells in series. When solar cells absorb sunlight, free electrons and holes are created at positive and negative junctions. If the positive and negative junctions of solar cells are connected to DC electrical equipment, current is delivered to operate the electrical equipment.

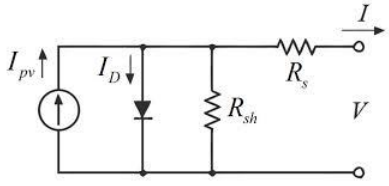

Fig. 1

The output current is given by-

$I = I_{PV} - I_D$

Where,
I_{PV} = photon current produced by cell
I_D = diode current
The diode current I_D is given by-

$$I_D = I_o [\exp (qV_d/kT) - 1]$$

I_0: reverse saturation current of diode,
q: elementary electron charge (1.602x10^-19 C),
V_d: diode voltage,
k: Boltzmann constant 1.381x10^-23 (J/K)
T: temperature in kelvin (K)
An equation represents about solar cell-

$$I = I_{pv} - I_o [\exp (qV_d/kT) - 1]$$

Where V_d is the output voltage of the PV cell.

3. Perturb & Observe Method

The P&O algorithm is most widely used for MPPT solar PV cell, also known as hill climbing method. This algorithm has very simple arrangement and small measured parameters. In this algorithm the module voltage is continuously perturbed and compared with the previous voltage. A slight perturbation is introduced in this method. Due to this perturbation the power of the module varies. If the power increases then perturbation is continued in that direction. After reaching at peak point the power at MPP is zero and then decreases hence the perturbation reverses in that direction.

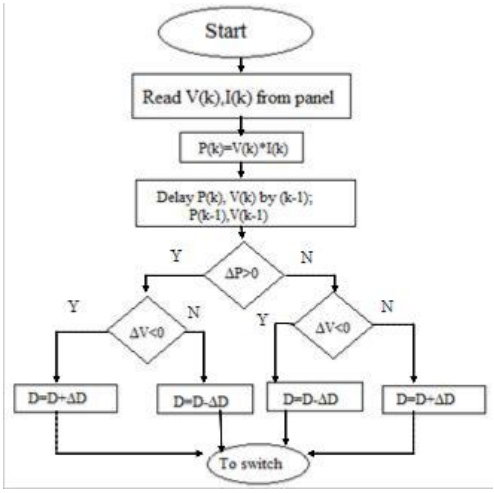

Fig. 2 Flowchart of P&O Algorithm

3. Modified Perturb & Observe Method

In modified P&O algorithm a new MPPT algorithm for PV module is proposed which is based on conventional P&O algorithm. As shown in figure below, the modified P&O method enumerates an additional computation of PV array power at the mid-point of MPPT control period. [11]

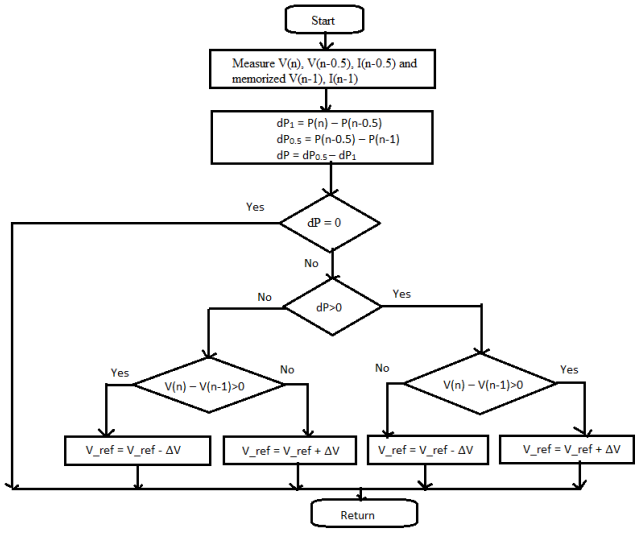

Fig. 3 Flowchart of modified P&O algorithm

The power difference $dP_{0.5}$ between mid-point power P(n-0.5) and the starting power P(n-1) of MPPT control consists of both power change by MPPT control and irradiance change.
A power difference dP can be calculated as: -

$$dP_{0.5} = P(n\text{-}0.5) - P(n\text{-}1)$$
$$dP_1 = P(n) - P(n\text{-}0.5)$$
$$dP = dP_{0.5} - dP_1$$

After evaluating above equations the MPPT controller can track the right direction to obtain the maximum power point of PV array.

4. Simulation and Experimental Results

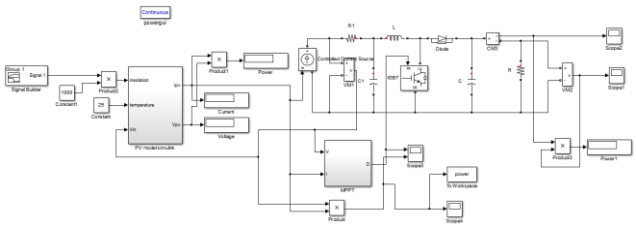

Fig. 4 Block diagram of P&O MPPT system

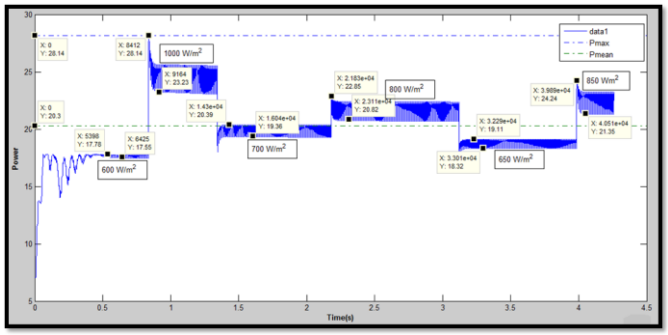

Fig.5 Characteristics of power for conventional P&O

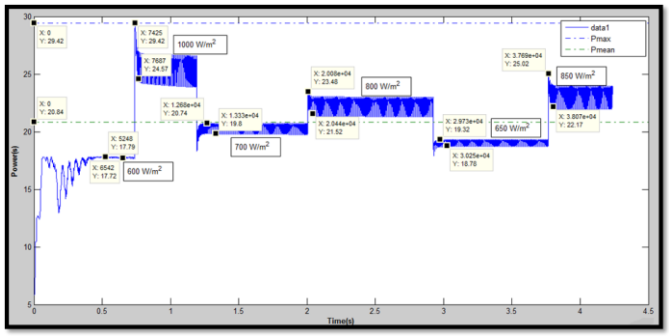

Fig.6 Characteristics of power for modified P&O

From fig.5 and fig.6, the values of power at different irradiance levels are shown.

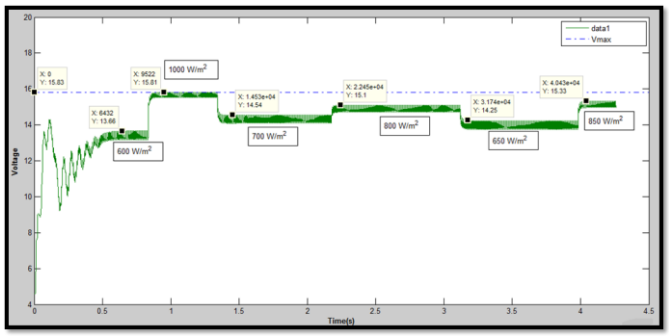

Fig. 7 Characteristics of voltage for conventional P&O

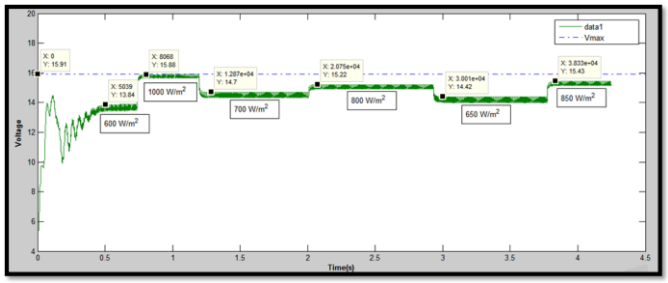

Fig.8 Characteristics of voltage for modified P&O

From figure 7 and 8, the voltage at different irradiance levels are shown.

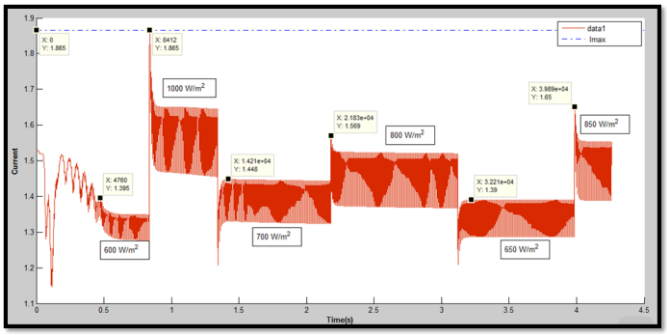

Fig.9 Characteristics of current for conventional P&O

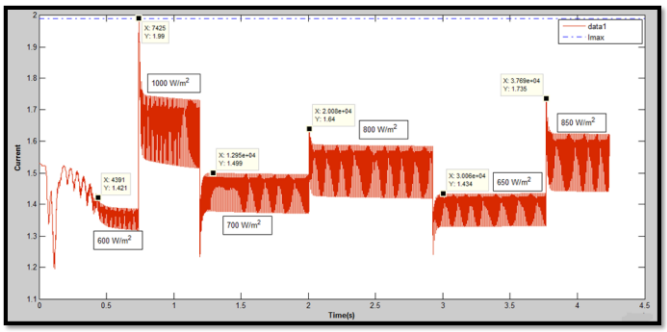

Fig.10 Characteristics of current for modified P&O

From figure 9 and 10, the values of current at different irradiance levels are shown. The modified P&O curves have small oscillations at steady state conditions than the conventional P&O method. Then the efficiency of modified P&O method improves better.

Table -1: Table of system parameters

S. NO.	Parameter	Value
1.	Ns	36
2.	V_{MPP}	13.6 volt
3.	I_{MPP}	2.2A
4.	V_{oc}	17.2 volt
5.	I_{sc}	2.5 A
6.	P_{max}	31W
7.	a	1.6

5. CONCLUSIONS

A modified perturb and observe MPPT method have been presented. The maximum power point is obtained successfully by this algorithm. We can see the performance of the modified P&O algorithm at different irradiance and at constant temperature. All the simulations were done through MATLAB/Simulink. From results it is concluded that the modified P&O algorithm has successfully overcome the

drawbacks of conventional P&O algorithm by providing the fast convergence speed and small oscillations.

ACKNOWLEDGEMENT

I would like to thank Dr. G. K. Banerjee, Dean, School of Engineering & Technology, IFTM University who has supported to me for this work.

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