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Analysis of Perturbation and Observation Technique used in Maximum Power Point Tracking for Photovoltaic Systems

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ABSTRACT

This paper gives the complete study of one of the MPP Tracking techniques which are developed by the researchers for tracking MPP in a photovoltaic system. The system is developed using PV module interfaced with DC to DC Boost Converter and Perturb & Observe Max. Power pt. Tracking technique. MATLAB /Simulink is used for developing the systems used to track the MPP of the PV system. Simulation of the system is done under different climatic observations and Perturb and Observe MPPT technique. In this paper, simulation results shows the maximum power is produced using Perturb and Observe method.

KEYWORDS

Boost Converter, Perturb and Observe (P&O), MPPT, PV System.

INTRODUCTION

From the past few years there is a tremendous growth of the solar photovoltaic systems from off grid PV to grid tied PV systems. A grid tied PV system consists of PV modules, DC-DC boost converters, Inverters, grid connection equipment. Range of grid connected PV module is from residential to large solar power systems.This systems supplies the excess power to the utility grid. Hence, solar module is simulated using MATLAB/Simulink Two types of solar models can be made, one is single diode based and the other one is double diode base solar PV module. But in this paper, Single diode based solar PV module is proposed. Some mathematical expressions are used to design the PV module. Constant values that is the reference values of Irradiance (1000w/m^2) and Temperature (25). For the best performance of the system, it is necessary to have an effective MPPT algorithm. There are many Maximum Power Point Tracking techniques which are developed by the researchers. Some of them are Perturb & Observe method, Voltage Feedback method, Increamental Conductance method, Linear approximation method, Actual measurement method, Fuzzy Logic Control method. The main purpose of this paper is to analyze the advantages and shortcomings of the perturb & observe method of MPPT. Block diagram of Grid Tied PV system is represented in Fig. 1 .

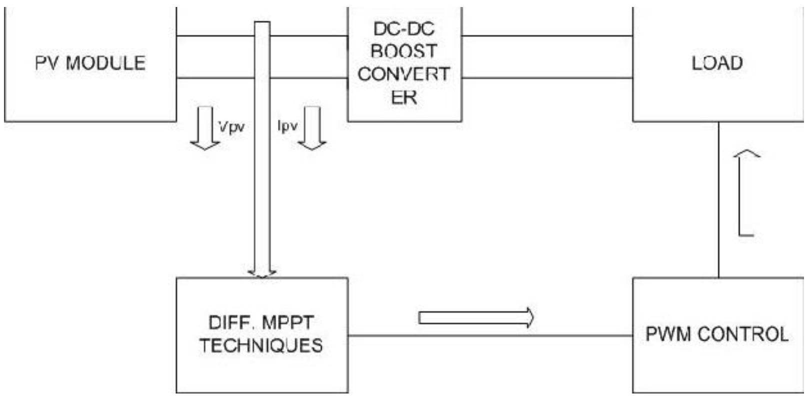

Fig 1: Grid Tied PV system Block Diag.

DESIGN OF PV MODULE

A. Equivalent Circuit

For the designing of PV module, a single diode model is used which is shown in Fig.2. In this circuit Iph is the photocurrent generated by light, Io is the diode saturation current, Ish is shunt current flowing through the shunt resistance Rsh shows the leakage current. Rse is the series resistance represents the losses due to current flowing through it. Voc and I are open circuit voltage and current of the PV module.

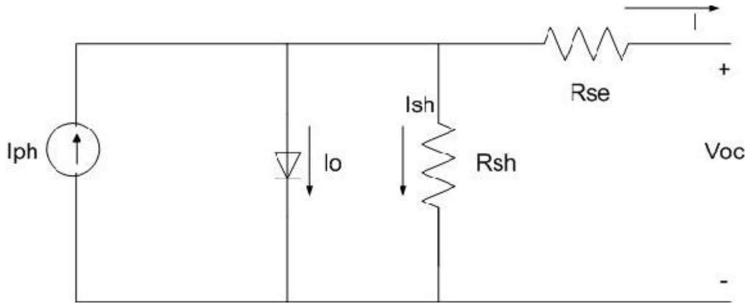

Fig 2: Circuit Diagram of PV Module

By applying KCL in the above circuit diagram

$$I = I_{ph} - I_0 - I_{sh} \quad (1)$$

B. Module Photo Current

The photocurrent (I_{ph})is given by

$$I_{ph} = [I_{sh} + K_i(T - T_r)] \times \left(\frac{G}{G_r}\right) \quad (2)$$

Reference Solar Irradiance (G_r) is 1000W/m^{2,} Solar cell reference temperature (T_r) is 25 , Instantaneous solar irradiance (G), Current temperature coefficient (Ki), Instantaneous cell temperature (T).

C. Module Reverse Saturation Current (I_{rs})

The reverse. saturated current. (I_{rs}) is given by

$$I_{rs} = \frac{I_{scr}}{e^{\left(q \times \frac{V_{oc}}{P_s} \times K \times a \times T\right)} - 1} \quad (3)$$

Electron charge (q) = 1.6*10^{-19}C

Solar Module open ckt. V/g (V_{oc}) = 21.24V,

Number of. cells. in series (Ps) = 36,

Boltzman's const. (k) = 1.3805 x 10^{-23} Joule/Kelvin,

Ideality factor (a)= 1.6

D. Module Saturation Current (I_o)

The saturation current (I_o) is given by-

$$I_0 = I_{rs} \times \left[\frac{T}{T_r}\right]^3 \times e\left[\left(\frac{q \times E_{go}}{a \times K}\right)\right] \times \left\{\left(\frac{1}{T_r}\right) - \left(\frac{1}{T}\right)\right\}] \quad (4)$$

Bandgap energy of semi-conductor (E_{go}) = 1.1 eV for Si at 25 .

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E. Module Output Current (I_{pv})

The output current (I_{pv}) is given by-

$$I_{pv} = \left(P_p \times I_{ph}\right) - \left(P_p \times I_0\right) \times \left[e^{\{q \times (V_{pv} + I_{pv} \times R_{se}) \times P_s \times a \times K \times T\}} - 1\right] \qquad (5)$$

Number of cells connected in parallel (Pp) =1

F. Simultaion Results

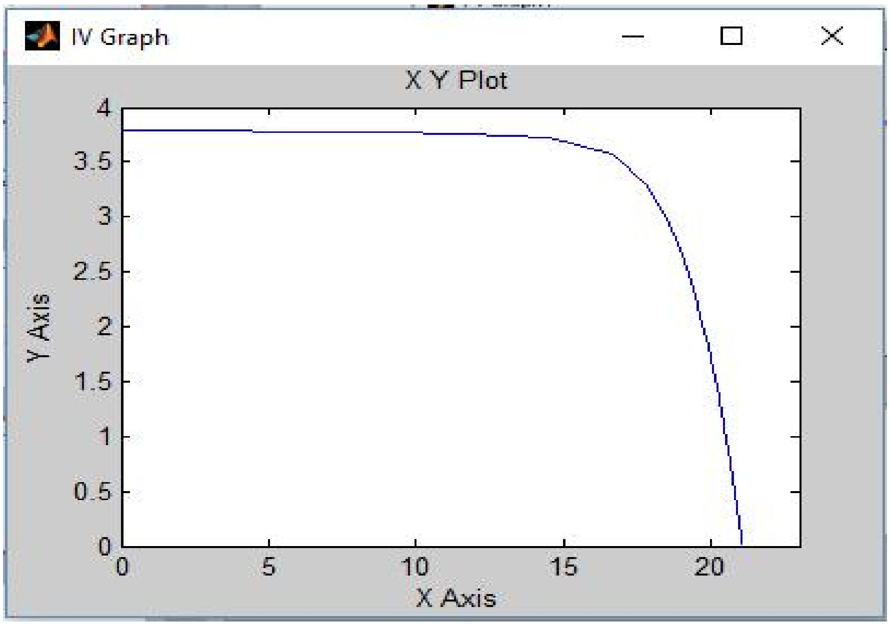

Fig. 3. I vs V Character.

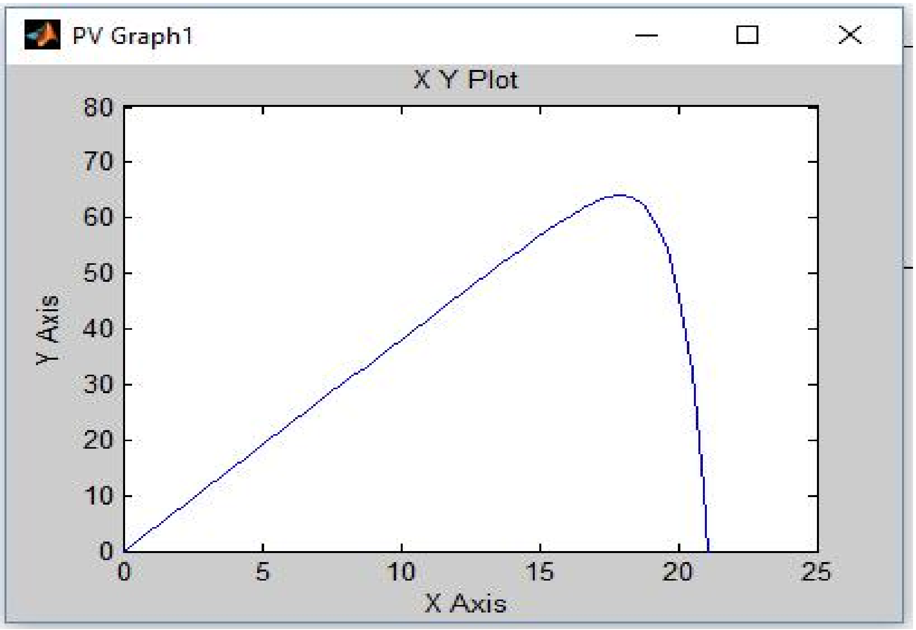

Fig. 4. P-V Character.

DC TO DC BOOST CONVERTER.

The ckt. Diag. for boost conv. configuaration is shown in the Fig 5. It consists of a V/G source DC (Vs), inductance (L), controllable switch(S), diode(D), capacitance (C) & load resistance(R). The DC V/G gain (M_v) is-

$$M_v = \frac{V_o}{V_s} = \frac{1}{(1-D)} \quad (6)$$

V_s is the inpt. V/G, V_o is the outpt. V/G, D is duty cycle whenever switch operates.

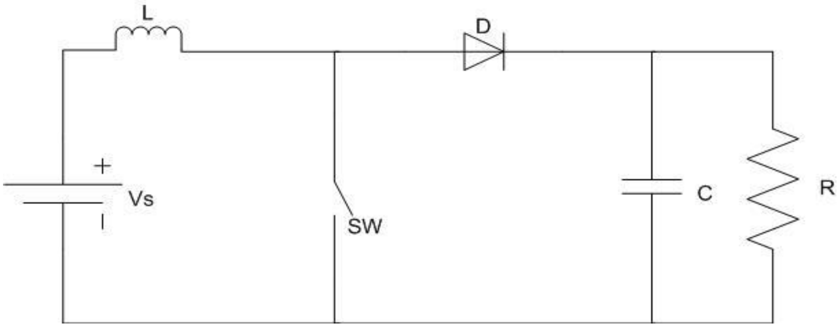

Fig 5. DC to DC Boost Converter configuaration

The Boost conv. operating in the CCM for the value of inductance $L>L_b$ where L_b is the minm. value of inductance for CCM .

$$L_b = (1-D^2)\frac{DR}{2f} \quad (7)$$

The minm value of the filter cap is given by C_{min} ,

$$C_{min} = \frac{DV_o}{V_r RF} \quad (8)$$

Table 1. Components Value of DC to DC Boost Conv.

Elements	Rating
Inductor	120µH
MOSFET	IRF P460
Power Diode	IN5408
Capacitor	330 µF
Resistive Load	50Ω, 50W
Frequency	20 kHz

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DESIGN OF PERTURB & OBSERVE MPPT TECHNIQUE

In this method , operating voltage & power are sampled ($\frac{dp}{dV}$). If $\frac{dp}{dV}$ is greater than 0, then algorithm increase the voltage value towards Maximum Power Point untill ΔP/ΔV is negative. On the LHS of MPP there is linear inc. in power w.r.t. voltage ($\frac{dp}{dV}$>0). But on RHS of the MPP there is increase voltage with decrease in power ($\frac{dp}{dV}$<0). So, this P & O algorithm will try to maintain the maximum power point by perturbing voltage with respective power.

As,

$\frac{dp}{dV} \geq 0$ - left of MPP,

$\frac{dp}{dV} \leq 0$ - right of MPP,

$\frac{dp}{dV} = 0$ - At MPP

Flow Chart

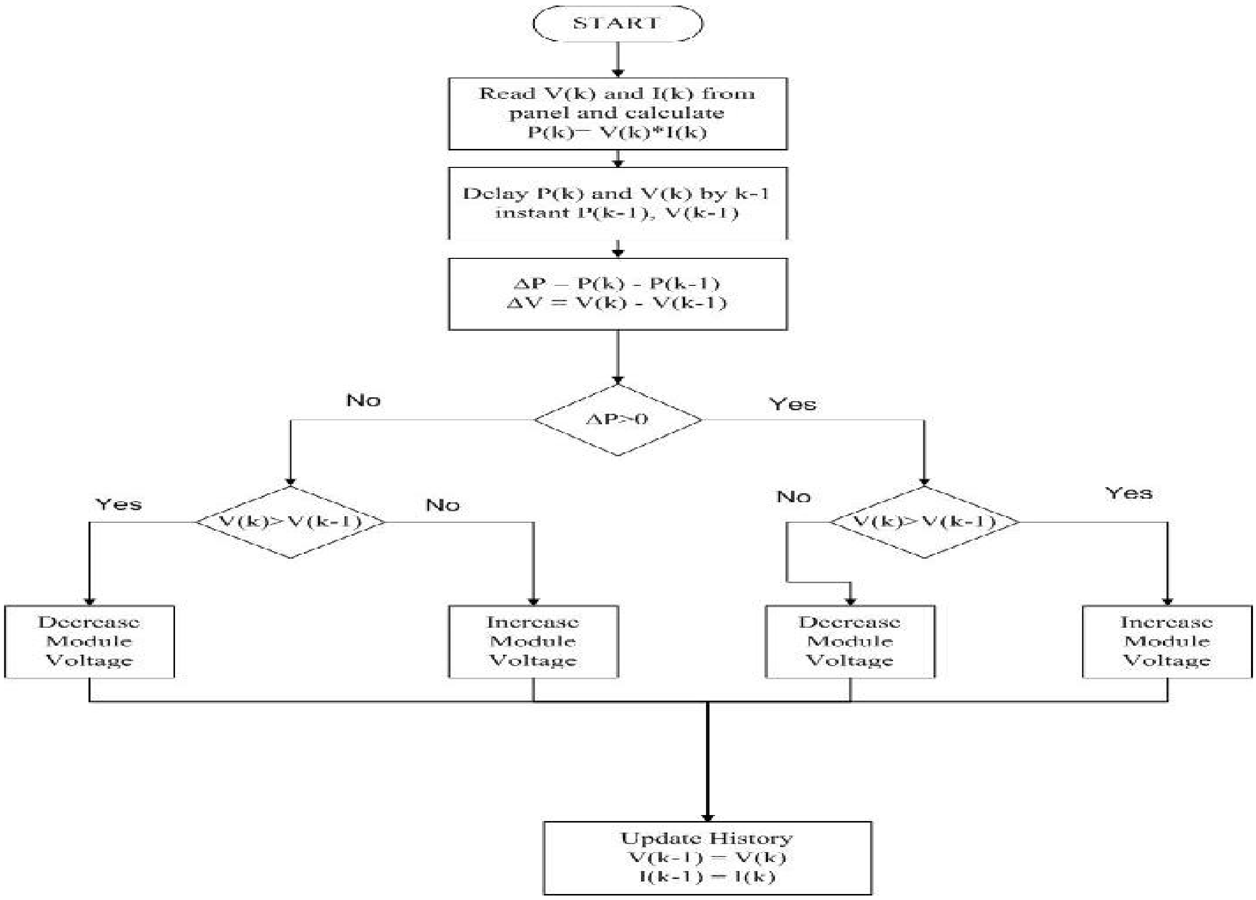

Fig.6. MPPT (P&O) Flow Chart

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Simulation Results

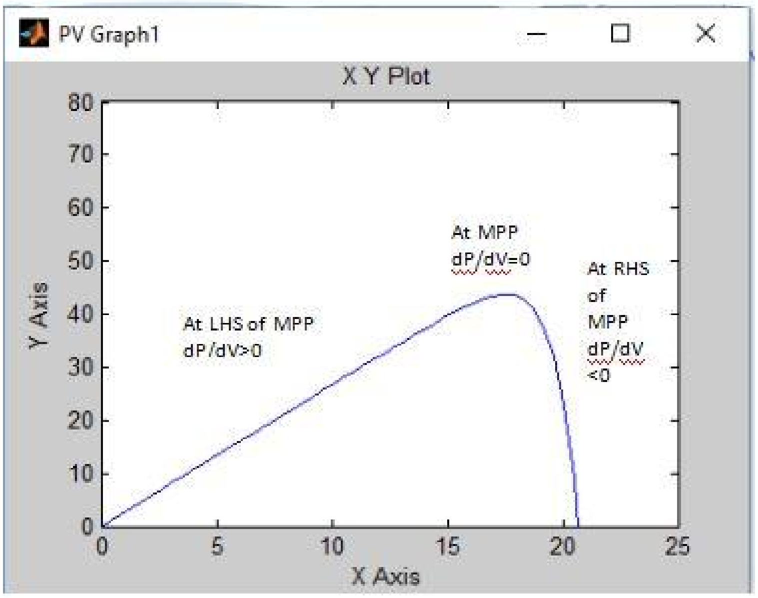

Fig.7. Typical PV curve at 700W/m^2

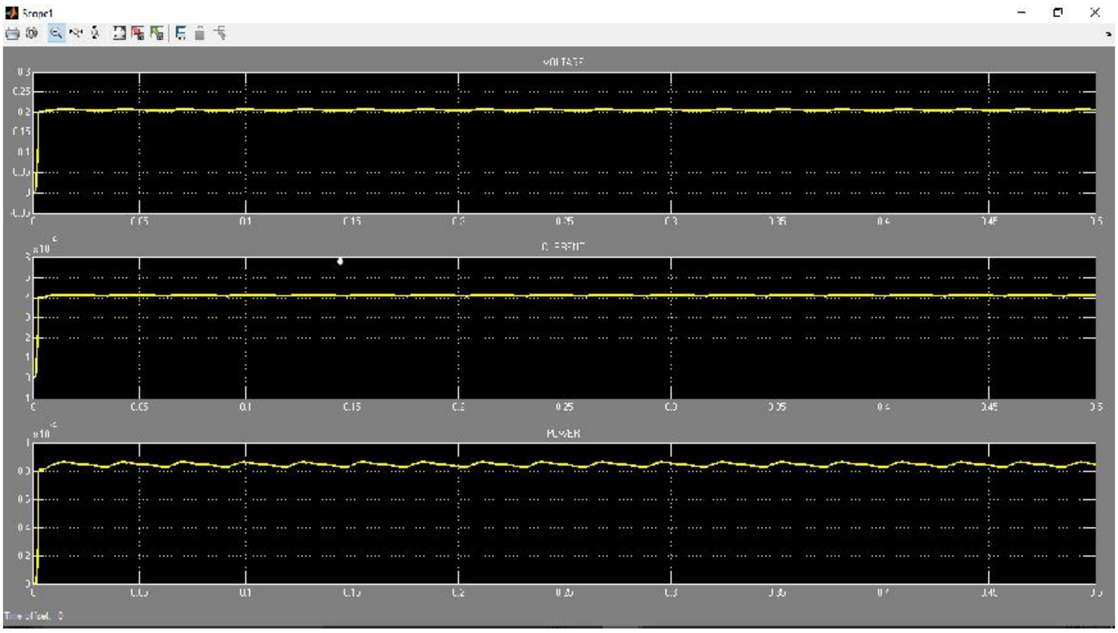

Fig.8. Simulation Results of MPPT (P&O)

CONCLUSION

This paper gives the control strategy of MPP Tracking for PV systems using perturbation and observation method. A V vs t, I vs t and P vs t is plotted from the simulation in this paper. The proposed MPPT technique can improve the performance of the system. It is not that accurate but it is the most common method which is used for MPP Tracking. In future, we can implement this MPPT Technique in the real time system which connected to the grid.

REFERENCES

[1] N. Pandirajan and R. Muthu, “Viability analysis on photovoltaic configuaration”, in Proceedings of the IEEE Region 10 Conference (TENCON’08), Hyderabad, India, November 2008.

[2] Mohamed Azab, “A New Maximum Power Point Tracking for Photovoltaic systems”, World Academy of Science, Engineering and Technology, Vol.34, October 2008.

[3] “PV Balance of Systems Conference Berlin”, Germany, June 2011, http://www.PV-insider.com/

[4] S.Nema, R.K.Nema and G.Agnihotri, “MATLAB/Simulink based study of photovoltaic cells/ modules/ array and their experimental verification”, International Journal of Energy and Environment, vol.1, no. 3, pp. 487-500, 2010

[5] Chen Chi Chu, Chieh-Li Chen, “Robust maximum power point tracking method for photovoltaic cells : A sliding mode control approach”, Science Direct Solar Energy, March 2009.

[6] H.Sugimoto, et. Al, “A New scheme for maximum photovoltaic power tracking control”, IEEE Power Conversion Conference , Nagaoka 1997, Vol.2, pp.691-696.

[7] G.M.S. Azevedo, M.C. Cavalcanti and K.C. Oliveira, “Evaluation of Maximum Power Point Tracking Methods for Grid Connected Photovoltaic systems ”, IEEE Power Electronics Specialists Conference, June 2008, pp. 1456-1462.

[8] Santos J.L., Antunes F., Chehab A. and Cruz C.C., “A Maximum Power Point Tracker for PV systems using a high performance boost converter”, Science Direct. Solar Energy 80, 2006, pp.772-778.

[9] N. Pandirajan and R. Muthu, “Mathematical Modelling of Photovoltaic Module with Simulink”, in Proceedings of the International Conference on Electrical Energy Systems (ICEES’11), Jan 2011.

[10] “Neural network in maximum power point tracker for PV systems”, Science Direct Electric Power Systems Research, July 2010, pp.43-50

[11] S Samal, P K Hota and P K Barik, “Comparitive analysis of MPPT algorithms for maximum power extraction from PV systems”, in Recent Advances and Innovations in Electrical Engineering (RAIEE 2014), VSSUT, Burla, 2014

[12] Abdelsalam, Ahmed K., Ahmed M. Massoud, Shehab Ahmed, and Prasad N. Enjeti, “High- Performance Adaptive Perturb and Observe MPPT Technique for Photovoltaic-Based Microgrids”, IEEE Transactions on Power Electronics, 2011

[13] Abhishek Sakhare, Asad Davari, Ali Feliachi, “Fuzzy Logic Control of fuel cell for stand alone and grid connection”, Journal of Power Sources, 2004

[14] Christopher A. Otiento, George N. Nyakoe, Cyrus W. Wekesa, “A Neural Fuzzy Based Maximum Power Point Tracker for a Photovoltaic system”, IEEE Africon, September 2009.

[15] Cheikh M.S.A., Larbes C., Kebir G.F.T., Zerguerras A., “Maximum power point tracking using a fuzzy logic control scheme”, Revue des Energie Renouvelables, Vol.10, No. 32, September 2007, pp. 387-395.