International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 10, Issue 12 (December 2014), PP.58-64

Development and Analysis of Fuzzy Control for MPPT Based Photovoltaic System

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Abstract:- In PV system control of Power electronics converters are very essential for the efficient utilization of the solar System. This paper proposes modified Perturb & Observe Maximum power point tracking (MPPT) with a fuzzy controller for DC-DC boost converter control in Photovoltaic system under shading and varying atmospheric conditions. This paper proposes a different approach for MPPT of PV system so as to obtain maximum power from PV system. In conventional methods, tracking power contains oscillation in the output power. The Simulation and modeling of Photovoltaic system along with proposed algorithm are done using MATLAB/SIMLINK software. Form Simulation results shows that P & O based fuzzy controller algorithm is transient state is fast, less fluctuations and smooth in signal of generated power.

Keywords: Photovoltaic, Fuzzy, Maximum Power Point tracking, Boost converter, Capacitor.

I. INTRODUCTION

In photovoltaic system generates electrical energy from sunlight. At unique point on P-V or I-V curve of PV system, The PV cell generates maximum power, called Maximum Power Point. Due change in radiation and temperature the current generation from PV modules also changes [3]. Voltage current a curve of PV modules shows nonlinearity for different temperature and radiation conditions an optimum load which extracts the maximum energy from PV cells [3]. There are different approaches for PV module MPPT [4]. They are the open circuit voltage method, constant current voltage method; short-circuit method, incremental conductance method and Per-turb and Observe (P&O).

The constant voltage method is the essay method but in this method 80% of the available Maximum power under different irradiance. By using constant voltage method used to find the output voltage of maximum power. Like constant voltage method, Constant Current method is used to find short circuit current to maximum power. P&O method [3] used for the maximum power by changing the Photovoltaic current or voltage and estimate the change in PV output power. In this paper presents Fuzzy logic controlled maximum point tracking algorithm is proposed based on P&O method. This fuzzy logic controller is fitted to Photovoltaic system and Maximum power point under different irradiance conditions are estimated based on the fitted model. BY using Fuzzy logic Based P&O method able to obtain very fast tracking point with very low steady state oscillations. The purposed Photo voltaic System, Fuzzy control and P &O algorithm are designed using Matlab/Simulink and Fuzzy Tool block.

This paper is organized as follows modeling of Photo Voltaic system presents Modeling and Performance characteristics Section 2. Detail Description about PV System in section 3. The proposed P&O method and fuzzy logic controller presents in section 4.The simulation results shows in section 5. In last section conclusion presented.

II. MODELING OF PV CELL AND ITS CHARACTERISTICS

An equivalent circuit of PV cell is show in Fig 1. The below expression for current in the PV cell equivalent circuit is given by

$$I - I_{pH} - I_S\left(e^{(v+IR_S/NV_t)-1}\right) \qquad (1)$$

Wherer V_t is thermal voltage; I_{PH} is light generated current; Is is saturation current of diodes. N is quality factor. The value of light generated current is in proportion to light intensity(I_r) and

$$I_{pH} = I_r \frac{I_{PH0}}{I_{r0}} \qquad (2)$$

In above expression, Ir represent light intensity, I_{PH0} represent standard light intensity (I_{r0}) light generation current. The model of the photovoltaic module represent by Above model of PV cell. Forget desired voltage and current A number of PV cells is connected in parallel and series. In above expression, Ir represent

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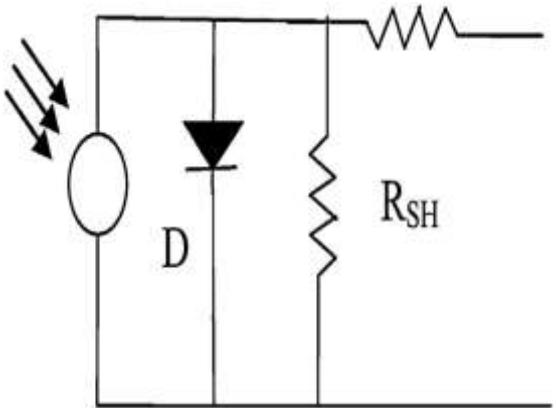

Fig 1 show that equivalent of PV cell

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The bypass and reverse blocking diode with PV cell used to prevent consuming power during less irradiation conditions. A group of series connected PV modules connected in series with blocking diodes and by pass diodes are connected in parallel to each PVcell. Fig 2 Shows the P-V and I-V Characteristics curves of PV cell under various conditions. Curve shows the characteristics of the P–V system under uniform shading conditions, whereas B and C show the characteristics under partially shaded condition without and with bypass and blocking diodes. It is seen from the I–V characteristics shown in Fig. 2 that the presence of bypass diodes will allow the unshaded modules of all the series assemblies to conduct their maximum current at a given irradiation and temperature. On the other hand, if the bypass diodes are not present, the shaded modules will limit the current output of the unshaded modules of the PV string. This may not only lead to a thermal destruction of the PV modules but may also decrease the available output power from the PV array. The blocking diodes will prevent the reverse current through the series assemblies, which generate lower output voltage as compared to the others connected in parallel. This reverse current may cause excessive heat generation and thermal breakdown of PV modules. The PV array having these diodes introduces multiple steps in the I–V characteristics and multiple peaks in the P–V characteristics, under the partially shaded conditions.

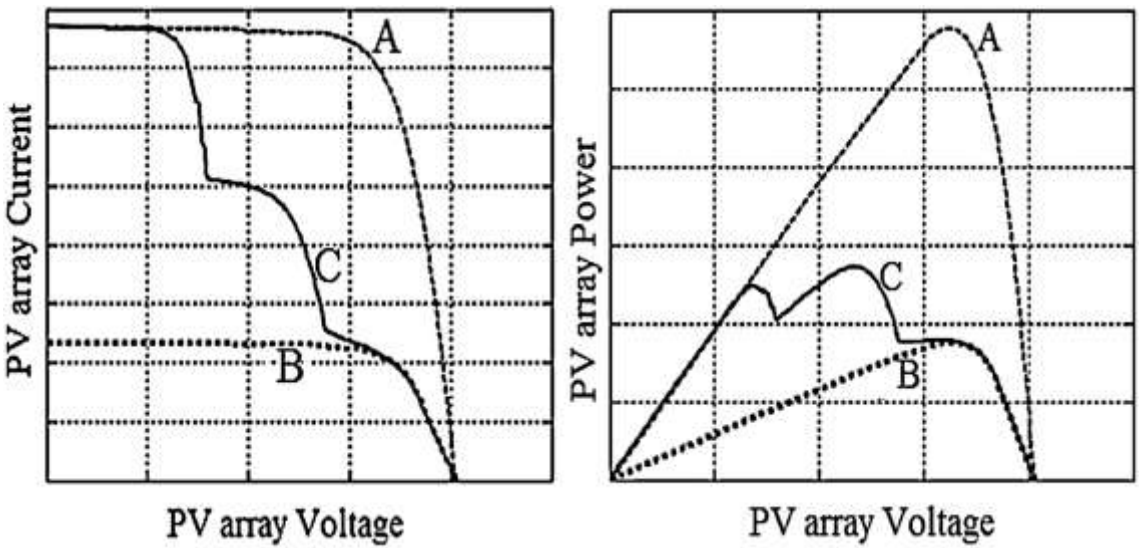


Fig. 2. I–V and P–V characteristic curve of a PV array: (A) under uniform irradiation, (B) Under partial shaded without bypass and blocking diodes, and (C) Under partial shaded with bypass and blocking diodes.

III. SYSTEM DESCRIPTION

Fig. 3 shows the block diagram representation of a PV module, which includes Photovoltaic cell , DC to DC Boost converter, MPPT controller and load. When the sunlight hits the PV Panels the solar array generates electrical voltage and current. The generated electrical output connected to DC-DC boost converter to step up DC output voltage of solar cells. Assume that the solar panel is work under different irradiations conditions. The DC-DC converter is controls by means of a Per-tube and Observed algorithm to track optimum Maximum power point tracking voltage. For generates PWM signals to DC-DC converter a fuzzy controller is used for fast response in transient state, maintain less and smooth steady state ripples in steady state. Then generated power is fed into DC capacitor .The value of the DC-link value is calculated by following equation:

$$C_{dc}=\frac{P}{2\omega V_{dc}V_{ripple}} \qquad (3)$$

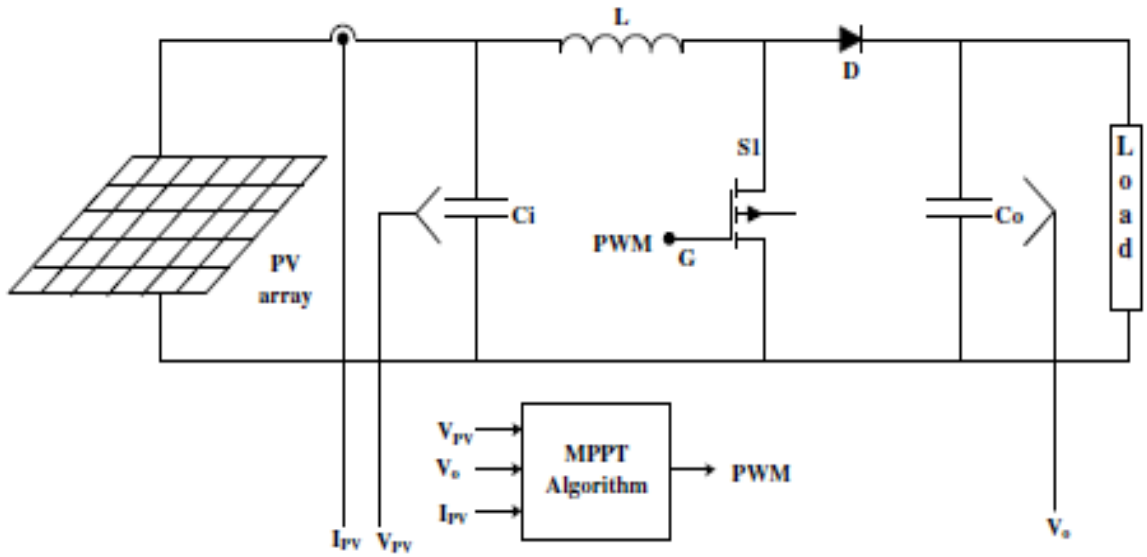


Fig. 3. Block diagram representation of PV system

III. PROPOSED MPPT ALGORITHM AND FUZZY CONTROLLER

Each PV array has an individual tracking operating point where it generates the maximum power. Under varying irradiations conditions and shading condition the PV array characteristics get complicated to presence of multiple peaks. One of the most simplest and successful method for MPPT is Per-tubrb and observation (P&O), for controller power. But this method generates power with some ripples and oscillations. To eliminate this problem P & O method is implemented with the Fuzzy controller used to generate duty cycle calculation for the DC-DC boost converter. The flow chart of modified fuzzy base P& O method:

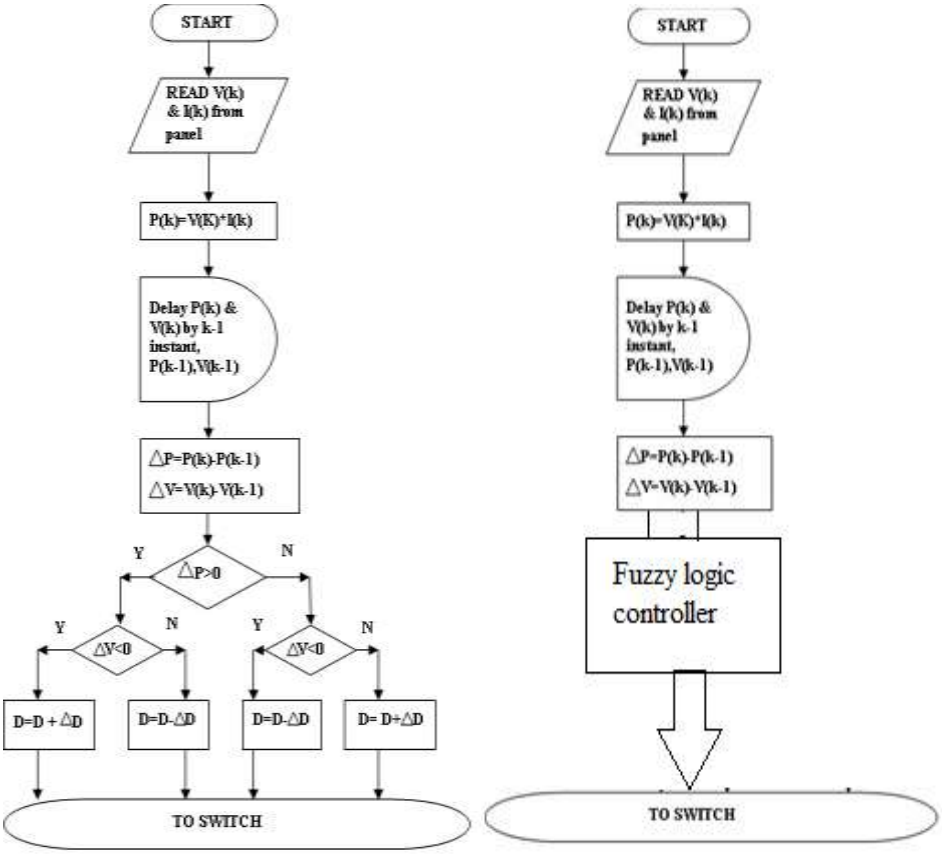


Fig 4 show (a) P & O Method (b) modified P& O Method with fuzzy logic controller

Fig.5 Shows that fuzzy logic control system, consists of Fuzzifications, Rule based control, Decision making, Defuzification. For this FLC system input are consider as error in power difference and change in error in voltage difference . In Fuzzifications process the inputs are converted into seven linguistic variables show in Fig 8 & 9 .For decision making a Mandani method is used with 49 rules shown in figure 8.

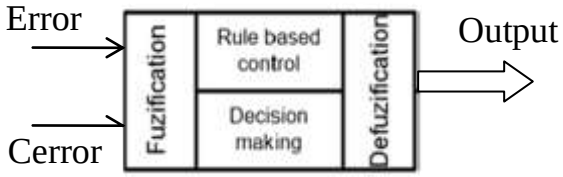


Fig.5 Fuzzy Logic control Systems

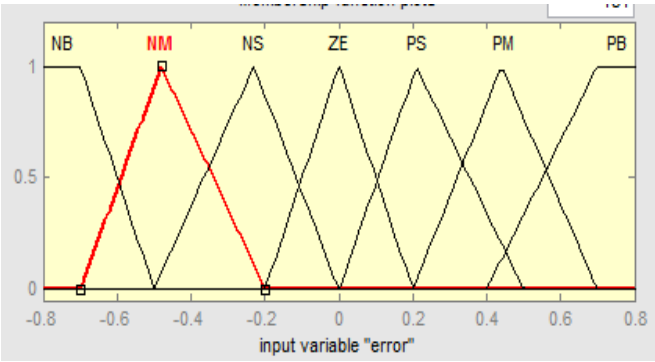


Fig6 power difference error

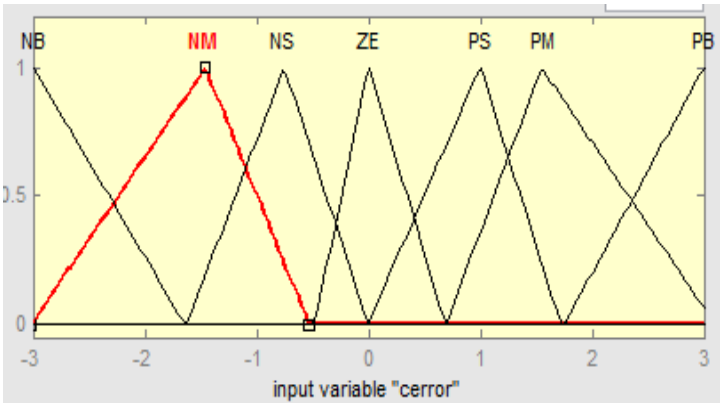


Fig 7 Voltage difference change error

Ce\e	NB	NM	NS	Z	PS	PM	PB
NB	NB	NB	NB	NM	NM	NS	Z
NM	NB	NB	NM	NM	NS	Z	PS
NS	NB	NM	NM	NS	Z	PS	PM
Z	NM	NM	NS	Z	PS	PM	PM
PS	NM	NS	Z	PS	PM	PM	PB
PM	NS	Z	PS	PM	PM	PB	PB
PB	Z	PS	PM	PM	PB	PB	PB

Fig 8 Fuzzy rules

IV. SIMULATION RESULTS AND DISCUSSION

This section discuss about the details of the simulation about PV system along with the proposed controller. The solar system is simulated by using MATLAB/SIMULINK software. Fig 9 shows that Simulation design solar MPPT controller.

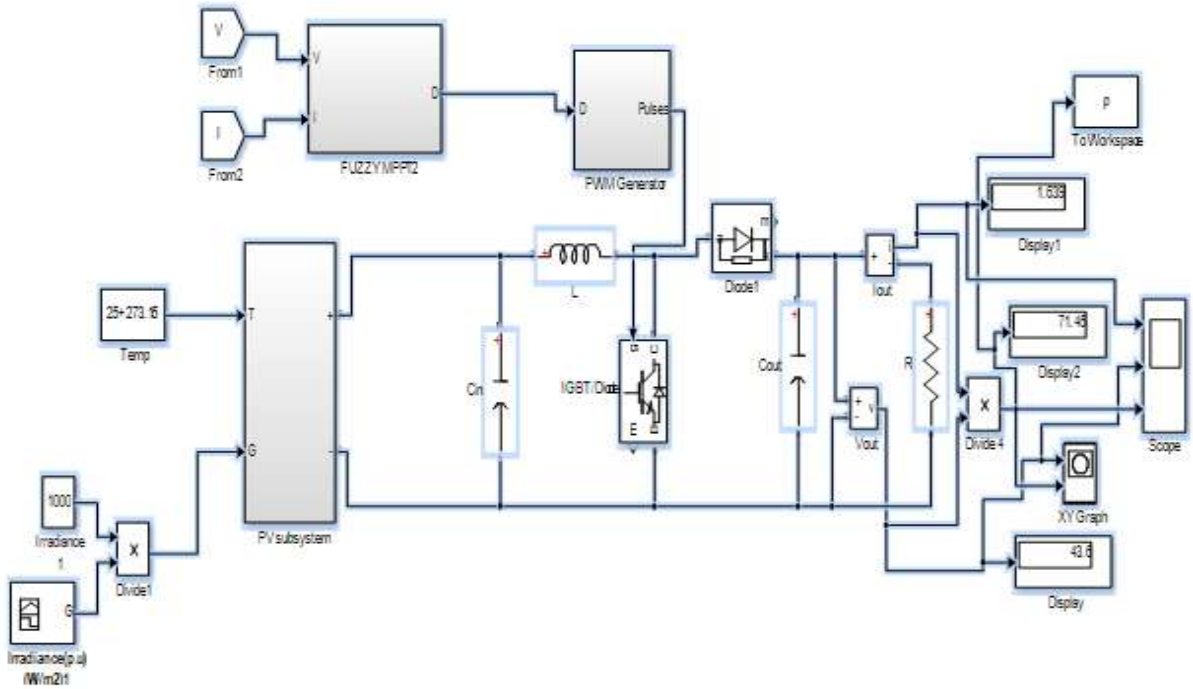
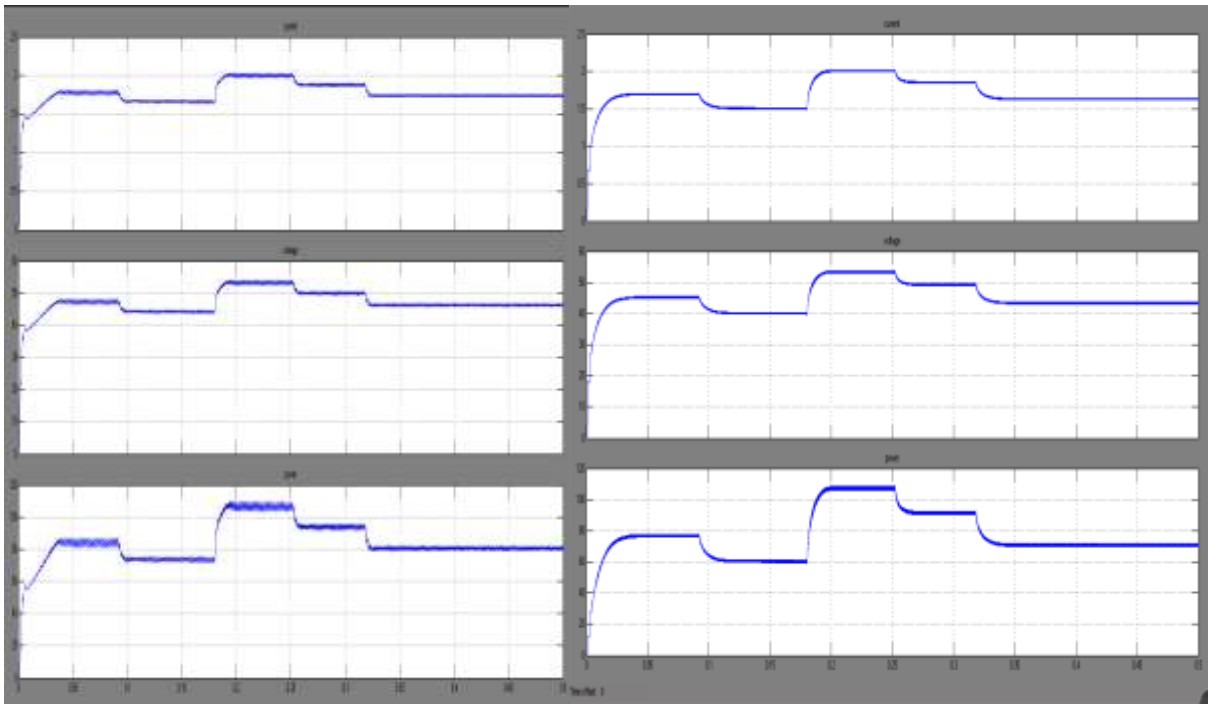


Fig 9 Simulink design of Solar MPPT

Fig 10 shows that Current, Voltage, power of Solar panel with P&O method and Modified Fuzzy controlled P&O method. Form fig 10 shows the modified P&O method generates smooth and less ripples voltage currents.



(a) **(b)**

Fig 10 Current, Voltage, Power Values at different irradiations by (a) P&O method (b) Modified fuzzy controlled P&O method

V. CONCLUSION

In this paper presented a Photovoltaic system under different irradiations and atmospheric conditions has been investigated. The proposed tracking of Maximum power point with modified P&O method with fuzzy logic controller is developed to generate PWM pulse for DC-DC boost converter. The proposed system has been demonstrated through the results of the simulation in MATLAB/Simulink. Form result concludes that P&O method generates some oscillations in generated electricity and modified fuzzy controlled P7O method gives smooth output from the PV cells.

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