Maximum Power Point Tracking method based fuzzy logic control for photovoltaic systems

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Abstract: Maximum Power Point Tracking (MPPT) techniques are most famous application in photovoltaic system to track the maximum power of the PV system. Usually, most of maximum power point tracking algorithms used fixed step and two variables: the photovoltaic (PV) array voltage (V) and current (I). Therefore both PV array current and voltage have to be measured. The maximum power point trackers that based on single variable (I or V) have a great attention due to their simplicity and ease in implementation, compared to other tracking techniques. With traditional perturb and observe algorithm based on two variable (I and V) using fixed iteration step-size, it is impossible to satisfy both performance requirements of fast response speed and high accuracy during the steady state at the same time. To overcome these limitations a new algorithm based on single variable method with variable step size has been investigated which has been implemented using fuzzy logic control. The proposed method has been evaluated by simulation using MATLAB under different atmospheric conditions. The experimental results show the high performance of the proposed method compared to P&O method.

Key–Words: Maximum power point; Single sensor; new algorithm; MPPT; Perturb and Observe.

1 Introduction

PV cells are components that convert solar energy directly into electricity by a process called "photovoltaic effect" [1]. The output characteristics of PV cell have become a very important issue in the photovoltaic industry. To harness the energy output of the photovoltaic cell and maximize the effectiveness of these, the photovoltaic cells must work at Maximum Power Point (MPP) all the time [2]. In recent years, many techniques have been proposed for tracking the MPP, the Incremental Conductance method (IncCond) [3, 4], fraction of the short-circuit current [5] fraction circuit voltage open [6]. Neural network [7], fuzzy logic control and other MPPT methods [8, 9, 25, 26]. In practice, the P& O method [10, 12] is the technique most commonly used due to its low cost, ease of implementation and relatively good tracking performance, compared to other techniques. Nevertheless, the P&O method cannot follow the MPP when weather conditions change rapidly. Different techniques of MPPT algorithms has been proposed including variable step size perturb and observe [13, 15], incremental conductance (VINC) [16, 18], P&O algorithms using fuzzy logic control [19, 20, 27] and single variable based variable step size [21]. To improve the performance of the P&O method, this paper presents a novel single variable step size MPPT algorithm using single sensor for PV systems. To further improve speed and regular monitoring. In this paper, A Variable step size technique using fuzzy logic control is proposed to solve tradeoff between fast dynamic response and high efficiency steady-state operation with lower oscillations around the MPP, which may be implemented using a fuzzy logic controller.

The performance of proposed method and P&O algorithm has been tested using a boost converter connected to indoor solar panel . The experimental and simulation results show that the proposed method can effectively improve the system performance compared to P&O method.

2 PV System Modeling

2.1 PV cell characteristics

The PV generator is essentially a PN junction semiconductor that converts solar energy directly into electricity. The equivalent circuit is shown in fig.1 [22]. The equation describes current-voltage relationship of single PV cell is given as [23]:

The relationship between current and voltage relationship of single PV cell is described by the follow-

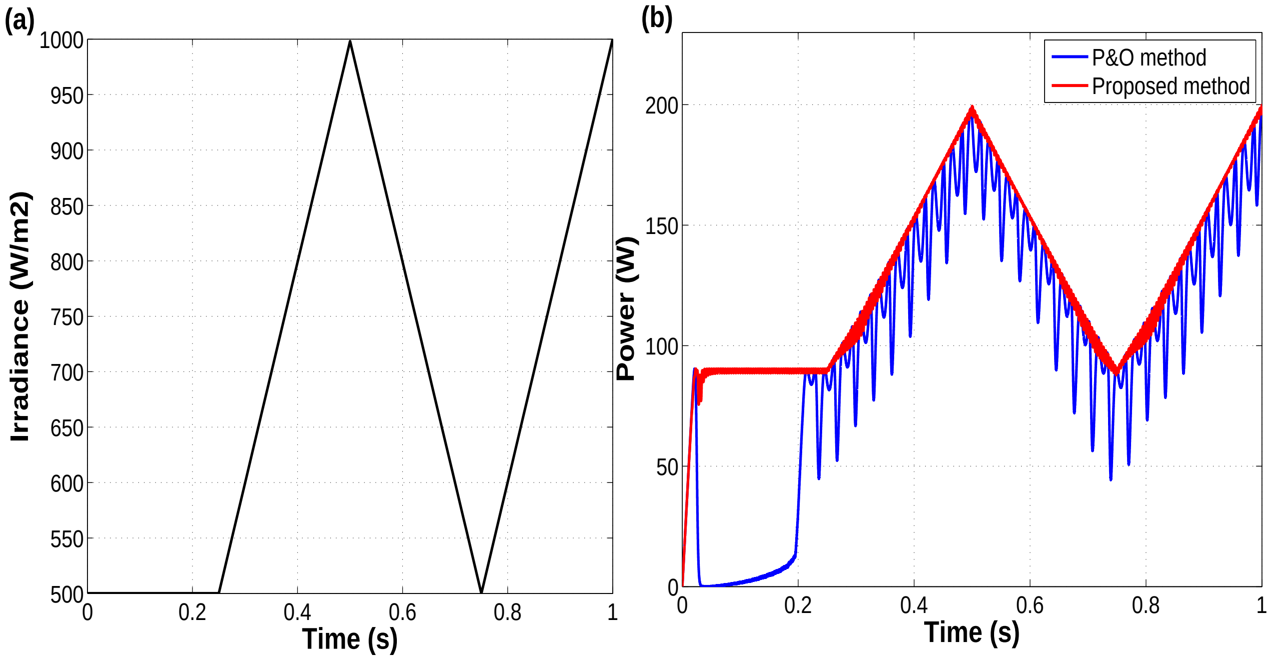

Fig. 10. a) The profile of irradiance , b) The output power of the P&O and proposed method

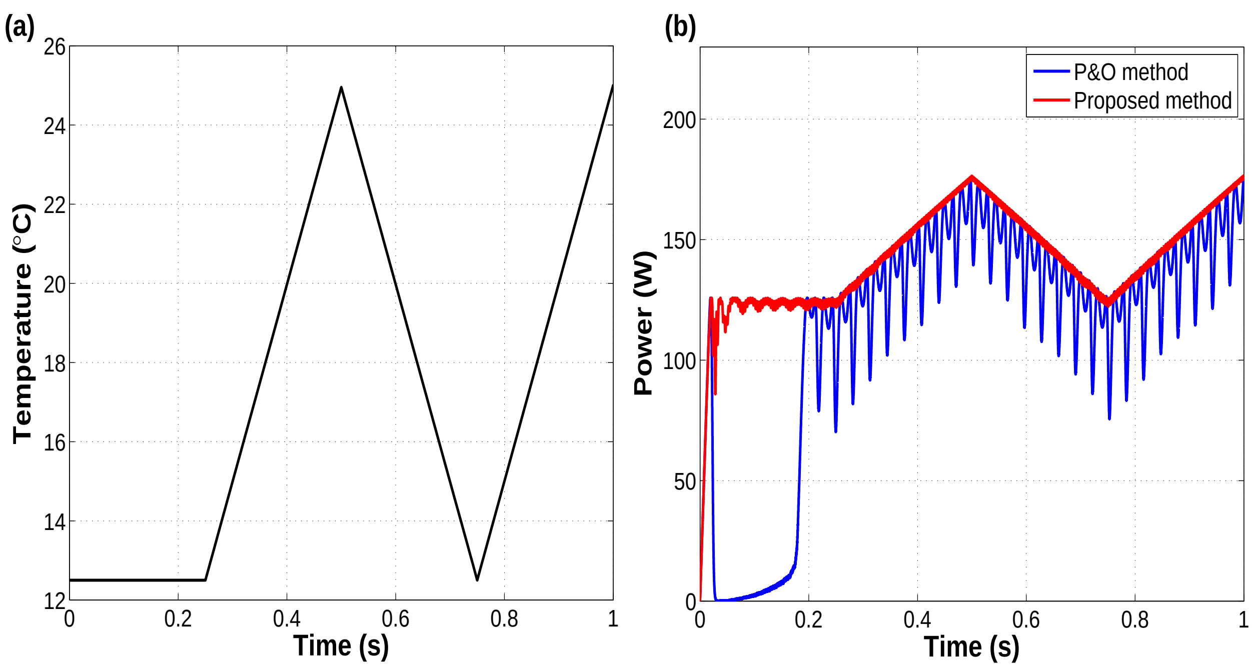

Fig. 11. a) The profile of temperature , b) The output power of the P&O and proposed method

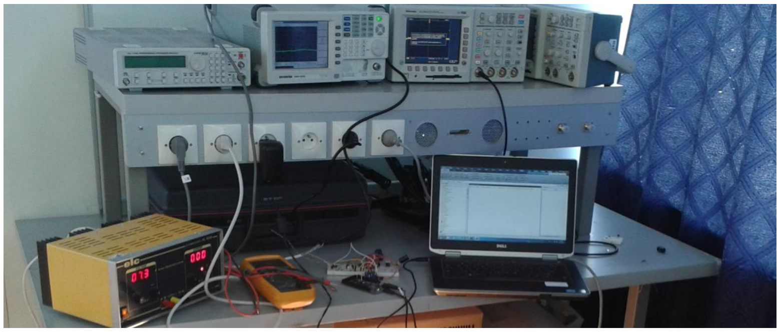

Fig. 12. The experiment platform of PV system.

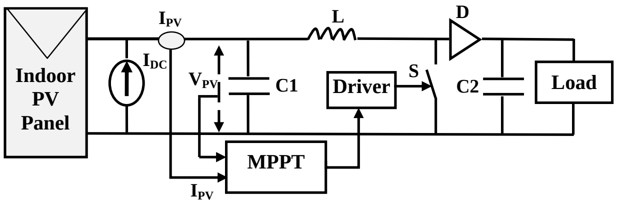

Fig. 13. DC−DC boost converter.

proposed method could convergefinally to MPP at 2s and 17s respectively. Moreover, the ripple power around MPP at steady state for proposed method is very small.

To conclude tests, the tab.5 summarize the comparison of the performances between of P&O and proposed method, under variation of atmospheric conditions.

7 Conclusion

In this paper, we presented new algorithm for extract maximum power point is presented, it is able to improve the dynamic performance of the PV system.The proposed method can converge more rapidly and has good steady state under atmospheric condition changes. The simulation results verify the feasibility and effectiveness of the proposed method.

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Table 6
Summary of performance P&O and proposed method for simulation and experimental results.

Test results	MPPT algorithms	Atmospheric conditions	Response times (s)	Ripple power (W) &Efficiency (%)	
Simulation results	P&O method	Stable conditions (900W/m^2, T=25 °C)	0.34s	7W	98%
	Proposed method	Stable conditions (900W/m^2, T=25 °C)	0.05s	2W	99.43%
Experimental results	P&O method	Same condition	17s	–	–
	Proposed method	Same condition	2s	–	–

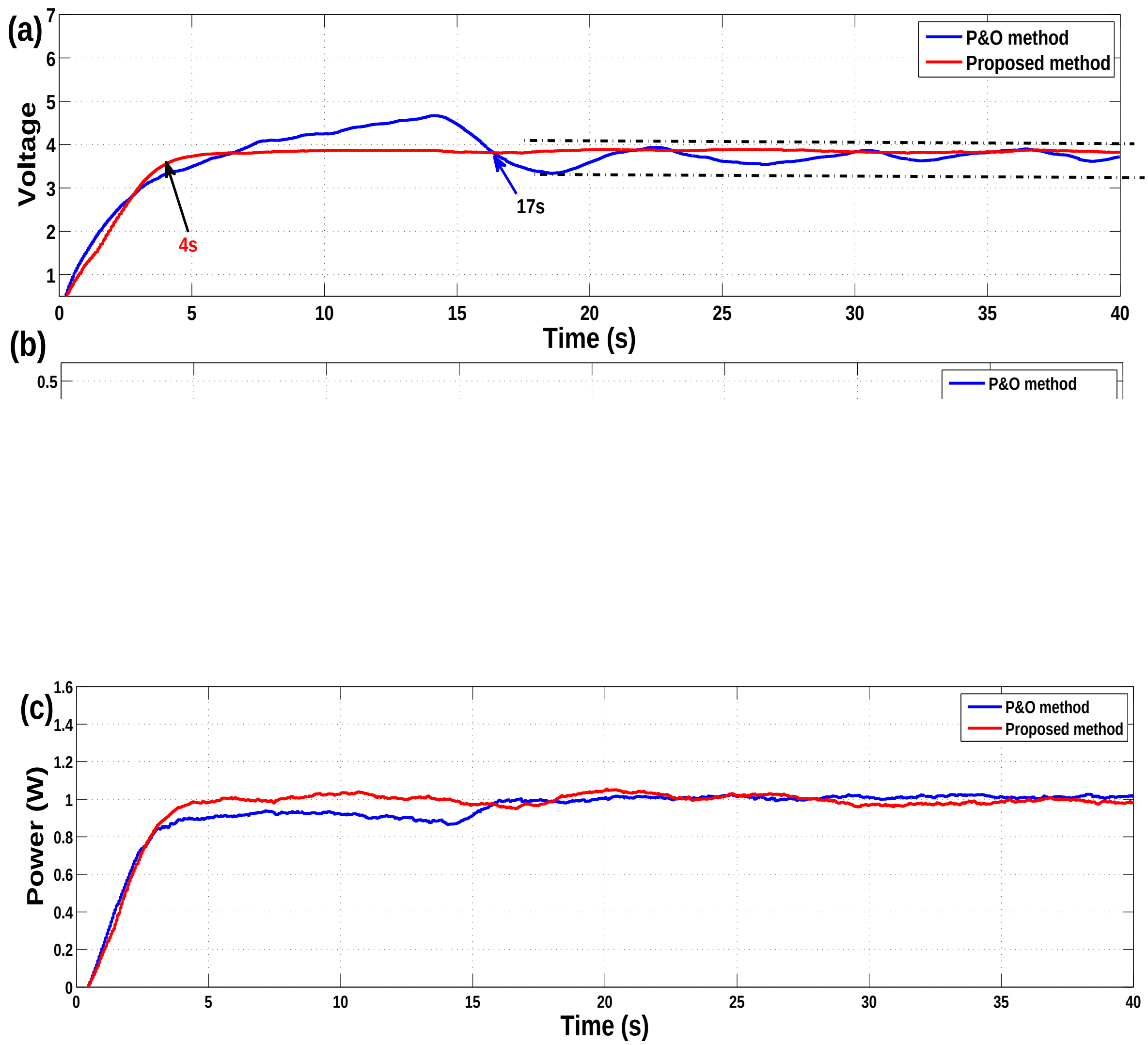

Fig. 14. a) The ouput voltage , b) The output current and c) The output power of the P&O and proposed method.

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