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Intelligent control of photovoltaic grid-connected using fuzzy logic based incremental conductance

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Abstract

This paper presents an intelligent control of the output power energy from the three-phase grid connected photovoltaic (PV) array, based on fuzzy logic controller and incremental conductance to optimize and track the maximum power point tracking (MPPT) from the PV under varying temperature and irradiance conditions. The control shown better performances and effectiveness compared to Perturb & Observe (P&O). The fuzzy logic control, enhanced by the algorithm can respond quickly to changes in the external environment and make sure the PV is always working at the MPPT and improve the efficiency and the stability of three-phase photovoltaic grid-connected. The intelligent controller improves the incremental conductance search method by fuzzifying, the rules of such techniques and will find exactly the MPPT. Finally, the results verify the correctness and availability of the PV system under various weather conditions.

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Keywords: Photovoltaic; MPPT; fuzzy logic controller; P&O; Incremental Conductance.

1. Introduction

Many different techniques and algorithm have been presented in the research to track the MPPT, such as perturb and observe, the hill climbing, the incremental conductance, the constant voltage and the short circuit Ripple correlation control, but they are not able to track the MPPT effectively under rapidly changing conditions [1].

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Nomenclature

PV	Photovoltaic
FLC	Fuzzy logic controller
IncCon	Incremental conductance
MPPT	Maximum power point tracking
P&O	Perturb & Observe
V_{MPPT}	Voltage at MPPT
I_{MPPT}	Current at MPPT
V_{OC}	Open-circuit voltage
I_{PV}	Current of photovoltaic
V_{PV}	Voltage of photovoltaic
P_{PV}	Power of Photovoltaic
I_{SC}	Short-circuit current
α_{SC}	Current temperature coefficient
β_{OC}	Voltage temperature coefficient

The hill climbing and perturb and observe are based in perturbing the PV changes the duty cycle and observing its impact on output power and deciding the new direction of the duty cycle to extract the maximum power. Many works have used the both techniques in using duty cycle perturbation in P&O, in [2] the comparison between hill climbing and P&O proves that P&O is more efficient under varying weather conditions. In general the both techniques are used the same concept but with different control structures. The incremental conductance is used because of the simplicity in the implementation and high tracking efficiency, it based on the derivative of power voltage. The tracking time is relatively long since the step size is tuned to be small enough to reach the desired MPPT. The constant voltage used the fact that the ration between the maximum power voltage and the open circuit voltage under different weather conditions are linearly proportional [3] and the approximation of constant ration. The fuzzy logic controller is an intelligent for nonlinear control and it has no complex mathematical. This control depends on the membership functions, their distribution, and depends on careful selection of parameters, involves expert knowledge and experimentation in selecting parameters, membership functions and fuzzy rules.

2. Three-Phase Photovoltaic System

The photovoltaic panel connected to a boost converter to enhance and regulate the output voltage; the converter is connected to the inverter. The block diagram of the proposed system is shown in Fig.1.

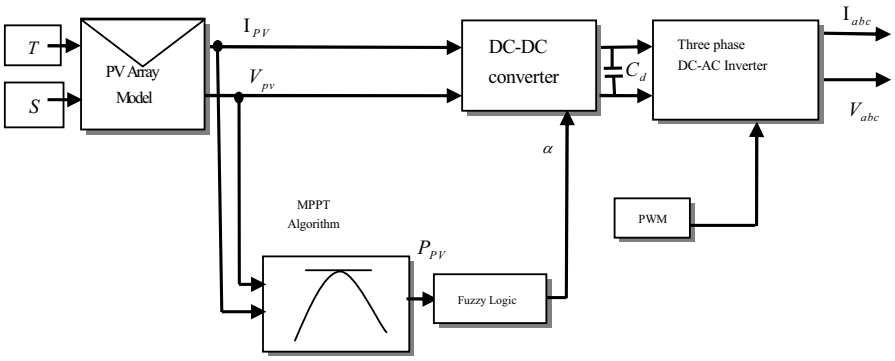

Fig. 1. The block diagram of the proposed system