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A new MPPT-based ANN for photovoltaic system under partial shading conditions

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Abstract

In solar photovoltaic system, tracking the maximum power point (MPP) is challenging task due to varying climatic conditions. Moreover, the tracking algorithm becomes more complicated under the condition of partial shading due to the presence of multiple peaks in the power voltage characteristics. This paper introduces a novel method to track the global maximum power point under partially shaded conditions. The method combines an artificial neural network controller with a scanning algorithm. The PV system along with the proposed MPPT algorithm was simulated using Matlab/Simulink environment. The simulated system was evaluated under uniform and non-uniform irradiation conditions. For comparison, an improved variable step P&O with global scanning (PO&GS) and incremental conductance controller based on a fuzzy duty cycle change estimator (FLE) with direct control were used and the results show that the proposed approach is effective in tracking the MPP and presents fast response time.

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Keywords: Photovoltaic system;Global maximum power point ;Partiel shading;Artificiel neural network

1. Introduction

For clean environment and a profitable economic gain of the sustainable solar energy source, recently a great importance is given to the generation of electricity across the photovoltaic (PV) system. However, the main weakness of the PV system is low efficiency of conversion of insolation into electricity. Furthermore, the power generated by PV modules depends on environmental factors, i.e. solar radiation and atmospheric temperature [1]. These factors affect the both current–voltage (I-V) and power–voltage (P-V) characteristics of the PV system. Under uniform irradiance, the P-V curve of PV array has one maximum power point (MPP). whereas, with non-uniform irradiance, such as partial shadowing of some PV modules or even some PV cells, the *P–V* characteristics get

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more complex, displaying multiple peaks, only one of which is the global peak (GMPP); the rest are local peaks (LMPPs).Thus, a control technique named Maximum Power Point Tracking (MPPT) is necessary to be applied for optimally exploits the available power in all operation conditions.

To date, numerous MPPT controllers have been presented and implemented in the literature, these controllers have some generic requirements such as low complexity, low cost, minimum output power fluctuation, and the ability to track quickly when operating condition changes. The most widely used algorithms are perturb and observe (P&O) [2,3] and incremental conductance (InC) [4]. These conventional methods achieve moderate performance with an easy implementation and a low cost. For better transient and steady-state performance, artificial intelligence based MPPT techniques have been suggested such as fuzzy logic [5] and artificial neural networks controller (ANN). However, the ANN controller has proved good performance under rapidly varying irradiance, especially in terms of efficiency and response time [6]. In addition, to address the partial shading effect, the ANN controller has been improved by combining it with other MPPT methods. In [7], A MPPT system is proposed for partially shaded PV array by using ANN and fuzzy logic with polar information controller. The ANN is trained to determine the global MPP voltage under several partially shaded conditions. The global MPP voltage as a reference voltage is used in the fuzzy logic with polar information controller to gain the required control signal for the power converter. The main drawback of this method is the high cost and complexity, due to the combination of two smart methods. In [8], an ANN based algorithm in conjunction with incremental conduction is proposed. The ANN is utilized to estimate reference voltage of IncCond algorithm. The similar working procedure is proposed in [9] by combining the ANN with P&O. The performance of these MPPTs is generally good except that they are very slow in tracking.

In order to improve the response time of ANN controller to track the GMPP and reduce the complexity of the controller under PSC , this paper proposes a novel MPPT , it consists of simple algorithm that scans the P-V curve to identify the GMPP, combined to ANN which gives the duty cycle corresponding to the GMPP. The remainder of the paper is organized as follows: a description of the considered PV model and its characteristics are introduced in Section 2; while section 3 describes the proposed MPPT method. Section 4 briefs the results and discussions. Finally, conclusions are reported in Section 5.

Nomenclature

PV	photovoltaic
MPPT	maximum power point tracking
GMPP	global maximum power point
LMPP	local maximum power point
PSC	partial shading conditions
ANN	artificial neural network
STC	standard conditions
SP	shading pattern
THR	threshold
G	irradiance level
V_{GMPP}	corresponding voltage to GMPP (V)
V_{pv}	PV output voltage (V)
P_{pv}	PV output power (W)
P_M	maximum power (W)
D	duty cycle
Inc	incremental conductance
PO&GS	perturb and observe and global scanning
FLE	fuzzy logic estimator