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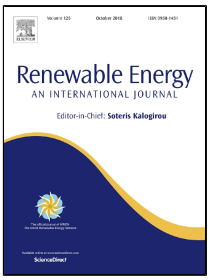

Hybrid maximum power point tracking algorithm with improved dynamic performance

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Hybrid maximum power point tracking algorithm with improved dynamic performance

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Abstract

In light of the low efficiency of photovoltaic (PV) panels and varying environmental conditions, it is necessary to develop methods for maximum power extraction of PV panels in any environmental conditions. Here, a new hybrid method is proposed for maximum power point tracking (MPPT). The fuzzy logic control-based method is very fast and accurate but difficult to implement. In addition, this method depends on PV arrays. The three-point weight method is another MPPT method that does not compromise on the maximum power point under fast transient conditions. The advantages of both methods are utilized in the proposed method. Furthermore, the overall complexity is decreased by simplifying the fuzzy logic part. The three methods were experimentally validated and, in addition, were numerically simulated in Matlab.

Keywords: Photovoltaic; maximum power point tracking; fuzzy logic.

I. Introduction

The increasing energy consumption and reduction of fossil fuel resources on one hand, and the increasing effects of global warming on the other, have led to a global approach to research on renewable energy sources. The use of solar energy, in particular photovoltaic (PV) panels, has recently increased as a result of these devices being environmentally friendly, clean, and noise-free [1]–[7]. The I-V characteristics of PV panels are influenced by environmental conditions such as humidity, radiation, ambient temperature, wind velocity, and age. Among these, ambient temperature and radiation most strongly affect PV panels [8]–[12]. This impact leads to a change in the location of the panels' maximum power point. As a result, power extraction by a resistive or constant load becomes suboptimal, requiring a DC/DC converter between a panel and its load to change the panel's operating point for the maximum power extraction. Each environmental variable is associated with a unique maximum power point, and the location of this point changes with changing the value of the corresponding environmental variable. Given this and the nonlinear I-V characteristics of PV devices, different algorithms have been proposed for determining the maximum power point. It is generally difficult to develop a control algorithm [13], [14]. Many methods have been proposed for maximum power point tracking (MPPT). These methods can be categorized into two main groups: 1) local search methods and 2) global search methods. Local search methods are not suitable for partial shading cases. Methods such as perturb and observe (P&O), incremental conductance, and current sweep belong to this group[2], [15], [16]. Global search methods are based on optimization methods and perform well in partial shading cases. Particle swarm optimization and genetic algorithms-based methods belong to this group. The high speed of tracking, accuracy, and loss reduction are basic requirements for using local search methods [17]–[19]. For faster and more accurate methods less power is lost during energy extraction. Here, we propose a very fast