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Identifying and estimating solar cell parameters using an enhanced slime mould algorithm

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ABSTRACT

This study proposed an enhanced slime mould algorithm (ESMA) for identifying the solar cells' parameters for five photovoltaic (PV) models, making two modifications to the original slime mould algorithm (SMA). The first modification was an arbitrary average position among the new individual position of slime and the best individual position of the slime mound currently found to resolve the issue of local optimum. Second, the tangent hyperbolical function of the formula *p* in the original SMA was replaced with an exponential function to create more variations for selecting the updated equation. The proposed ESMA was used to resolve the problem of estimating PV parameters based on the empirical current-voltage (I-V) data. Specifically, ESMA was evaluated on the parameter estimation in several photovoltaic models, i.e., the one-diode model (ODM), dual-diode model (DDM), and PV-module model (PMM). In general, ESMA outperformed the original SMA and other recent algorithms. Also, in order to provide a close approximation of the empirical I-V data of the real PV modules and cells, ESMA was able to determine the optimal parameter values for photovoltaic models.

1. Introduction

The steady depletion of fossil fuels and the rapid rise in power consumption have caused an acute increase in the demand for electrical energy. As a result, the growth of alternative energy resources, particularly solar energy also increases correspondingly [1]. Many nations increased the installed photovoltaic (PV) capacity in 2016, according to a report from the International Energy Agency (IEA), and it appeared that this trend was continuing [2]. The use of PV systems to generate solar energy has drawn considerable attention worldwide since this system is free from emission, readily available, and simple to install [3]. The most crucial component of a PV system is the solar PV cell and module. Therefore, proper modelling of PV modules is essential for maximum performance [4].

In general, modelling the PV cells consists of two steps, starting with the design of its mathematical model, and following with the estimation of its parameter values. When developing a mathematical model, the current-versus-voltage (I-V) parameters that control a solar cell's behaviour are the main focus. To date, the two most commonly used models are the one-diode model (ODM) and the dual-diode model (DDM). ODM comprises five parameters, and DDM has seven. When precisely estimated, these parameters will enhance the quality and performance of controlling the solar cells while effectively identifying the maximum power point to allow the voltage and current of the solar cells to transmit the highest output energy to the load [5]. Meanwhile, the PV-module model (PMM) is created by connecting a group of cells in serial and parallel. Depending on the number of serial and parallel cells, PV modules will generate

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