Maximum Power Point Tracking in Solar Energy Conversion Systems Using Machine Learning

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Extended Abstract

In this paper, a new and efficient algorithm is explained to track the maximum power point (MPP) in solar energy conversion systems by the use of machine learning in the pre-existing perturb and observe (P&O) methodology. Solar energy extracted from photovoltaic cells depend on solar irradiance, the solar cell temperature and has variable dependence on the humidity which most algorithms ignore. Perturb and Observe is the most feasible and accurate algorithm. However, the speed of convergence to the MPP varies in different climatic conditions and is usually very slow in this method. This paper describes the application of machine learning in decreasing this perturbation time significantly and increases the performance to predict the accurate MPP much faster. The algorithm presented predicts a MPP based on instantaneous values of solar irradiation, cell temperature, and humidity using a localised linear regression model from a supervised training data. From this estimated power point, the available maximum power is determined by perturb and observe methodology using DC - DC buck converters. This reduces the time taken immensely by conventional P&O methods. With the accurate MPP now resolved from P&O, the value is used to append the current training dataset. This repeats after every iteration of the algorithm and thus a supervised model is ensured. The algorithm learns after each iteration and the estimation becomes much closer to the available power. The simulation was done in python and yielded an efficiency of 99.98% in estimating the MPP after 1000 iterations approximately equal to 3 hours; reducing the P&O time by a large amount. In addition to this capability, the described algorithm overcomes limitations such as overfitting that is prevalent in Neural Networks (ANN), Fuzzy Logics, and other deep learning artificially intelligent (AI) maximum power point tracking algorithms. This is a major limitation which is tackled in this new proposed algorithm. The main advantages of the proposed method are faster and accurate convergence to the MPP, higher efficiency than its AI counterparts (ANN) and its ability to learn from previous data while avoiding overfitting. The system is a modified algorithm of P&O and can be cascaded to the existing P&O equipment with convenient setup.

Keywords

Photovoltaic systems; Solar energy conversion systems; Maximum power point tracking; Perturb and observe; Artificial intelligence; Machine learning.

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