A novel hybrid approach for maximizing the extracted photovoltaic power under complex partial shading conditions

ABSTRACT

The convenient design of a maximum power point tracking (MPPT) controller is key to the success of photovoltaic (PV) system performance in order to maximize the extracted power, which is affected significantly by weather fluctuations, particularly partial shading condition (PSC). This paper proposes a novel hybrid MPPT approach based on a modified Perturb and Observe (P&O) assisted by the Extremum Seeking Control (ESC) strategy, combining the benefits of these simple algorithms and, meanwhile, eliminating their drawbacks. The proposed algorithm is able to track the maximum possible power under any level of weather fluctuation, with comprehensive enhancement on all aspects of high performance, boosting the PV array efficiency to 100%, reducing the convergence time to less than 100 ms, completely eradicating the oscillations around the achieved power, and maintaining the simplicity levels of both involved strategies. More importantly, this algorithm is applicable for any PV array configuration, which enhances the robustness and novelty of the algorithm. The performance is verified using MATLAB/Simulink. A boost converter is used for controlling DC to DC (direct current to direct current) power. The proposed algorithm's performance is compared with the conventional P&O and incremental conductance (IC) algorithms under four different cases of weather conditions. The shortcomings of these algorithms are illustrated and the analysis confirms the effectiveness of the proposed algorithm accordingly.

Keyword: Photovoltaic (PV); Partial Shading Conditions (PSC); Maximum Power Point Tracking (MPPT); Global Maximum Power Point (GMPP); Perturb and Observe (P& O); Extremum Seeking Control (ESC); Incremental Conductance (IC)