MPPT Optimization of a Boost-Converted PV System Using P&O, INC, and Neural Network Methods

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Abstract:

This study focuses on the modeling and simulation of a photovoltaic (PV) energy conversion system that incorporates a Boost DC-DC converter along with multiple Maximum Power Point Tracking (MPPT) algorithms. The primary objective is to enhance solar energy harvesting efficiency under fluctuating irradiance and temperature conditions. Three MPPT strategies are examined and compared: the conventional Perturb and Observe (P&O) method, the Incremental Conductance (INC) algorithm, and a Neural Network (NN)-based technique. The PV system and control strategies are simulated using MATLAB/Simulink. Performance evaluation criteria include tracking accuracy, convergence speed, and response under dynamic environmental changes. The results show that while the P&O and INC algorithms offer simplicity and acceptable performance in steady-state conditions, the neural network approach provides faster tracking and better accuracy during rapid variations in solar irradiance. These findings highlight the potential of artificial intelligence in improving the efficiency and adaptability of PV energy systems.