Environmental Engineering and Management Journal xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
http://www.eemj.icpm.tuiasi.ro/; http://www.eemj.eu

"Gheorghe Asachi" Technical University of Iasi, Romania

BIO-INSPIRED OPTIMIZATION FOR ENHANCED MPPT IN GRID-CONNECTED PHOTOVOLTAIC SYSTEMS

Sureshkumaar Gunasekaran[1*], Manoharan Subramaniam[2], Lal Raja Singh Ravi Singh[3]

[1]Karpagam College of Engineering, Coimbatore, Tamilnadu, India
[2]JCT College of Engineering and Technology, Coimbatore, Tamilnadu, India
[3]KIT-KalaignarKarunanidhi Institute of Technology, Coimbatore, Tamilnadu, India

Abstract

As the global reliance on fossil fuels diminishes, there is an urgent need to transit towards renewable energy resources (RES). Solar Photovoltaic (PV) systems are emerging as a viable choice for end users to meet their energy demands sustainably. In this research, a modified SEPIC converter powered by solar PV is proposed, to provide a more reliable and efficient energy conversion system. Given the variability in solar irradiance, the Wild Spider Foraging (WSF)-based bio-inspired Maximum Power Point Tracking (MPPT) control technique is utilized to ensure maximum power extraction from the solar PV source. The regulated DC output is then inverted using an inverter controlled by a three-dimensional Space Vector Pulse Width Modulation (SVPWM) technique. This inverter output is fed to the grid through a split-inductor.
The effectiveness of the proposed system simulated using MATLAB environment is validated by constructing a prototype model in the laboratory. Thus, both the results demonstrate that the proposed system achieves a maximum efficiency of 94.83%. Furthermore, the performance of this system compared with state-of-the-art systems, revealing that the WSF based MPPT outperforms both Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO) techniques in terms of tracking speed and efficiency, making WSF the optimal choice when both optimization speed and solution quality are critical.

Key words: 3D SVPWM, Modified SEPIC, PV, WSF

Received: November, 2024; Revised final: February, 2025; Accepted: February, 2025

[*] Author to whom all correspondence should be addressed: e-mail: sureshpho@gmail.com