Nonlinear Dynamics and Systems Theory, **25** (2) (2025) 144–152

Hybrid GW-PSO Algorithm for Enhanced Maximum Power Point Tracking under Various Conditions

N. Douifi [1*], A. Abbadi [2,3], F. Hamidia [2,3], N. Rai [1] and A. Tlemçani [2,3]

[1] *Laboratory of Advanced Electronic Systems -LAES, Electrical Engineering Department, Faculty of Technology, University of Medea, Medea, Algeria.*
[2] *Research Laboratory of Electrical Engineering and Automation-RLEA, Electrical Engineering Department, Faculty of Technology. University of Medea, Medea, Algeria.*
[3] *Renewable Energy and Materials Laboratory-LERM, Electrical Engineering Department, Faculty of Technology. University of Medea, Medea, Algeria.*

Received: May 29, 2024; Revised: February 27, 2025

Abstract: Photovoltaic (PV) systems face challenges in maximizing their output potential due to non-uniform sunlight distribution and unpredictable weather conditions, known as partial shading. To address these challenges, hybrid control algorithms have emerged as a promising solution. This paper presents a novel hybrid algorithm called HGW-PSO, which combines the strengths of Particle Swarm Optimization (PSO) and Grey Wolf Optimization (GWO). The hybrid approach utilizes the exploration capabilities of GWO and the convergence capabilities of PSO to achieve faster convergence, reduced oscillations, and improved implementation efficiency. The performance of the proposed HGW-PSO algorithm was evaluated under various scenarios of uniform and non-uniform shading. The results showed that HGW-PSO outperformed PSO, GWO, and Peafowl Optimization Algorithm (POA) in terms of tracking accuracy and convergence speed. Specifically, HGW-PSO achieved an average efficiency of 99.96% and a convergence time of less than 40 milliseconds, compared to 99.51% for GWO, 99.28% for POA, and 99.11% for PSO. These results demonstrate the effectiveness of the HGW-PSO algorithm in maximizing power tracking outcomes under challenging shading conditions.

Keywords: *global maximum power point; Grey Wolf Optimization; maximum power point tracker; partial shading conditions; Particle Swarm Optimization; Peafowl Optimization algorithm; photovoltaic.*

Mathematics Subject Classification (2020): 93C95, 93C10, 49M37, 68T20, 65K10, 37M05, 03D15.

* Corresponding author: mailto:douifi.nadia@univ-medea.dz

© 2025 InforMath Publishing Group/1562-8353 (print)/1813-7385 (online)/http://e-ndst.kiev.ua144