Applied Soft Computing Journal 165 (2024) 112030

Contents lists available at ScienceDirect

Applied Soft Computing

journal homepage: www.elsevier.com/locate/asoc

Application of circle search algorithm for solar PV maximum power point tracking under complex partial shading conditions

Dokala Janandra Krishna Kishore [a,b], Mohd Rusllim Mohamed [a,*], Kumarasamy Sudhakar [c,d], Kurukuri Peddakapu [e]

[a] Faculty of Electrical and Electronics Eng. Tech., Universiti Malaysia Pahang Al-Sultan Abdullah, Pekan 26600, Malaysia
[b] Department of Electrical and Electronics Engineering, Sri Vasavi Engineering College, Tadepalligudem, India
[c] Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, 26600, Malaysia
[d] Energy Centre, Maulana Azad National Institute of Technology, Bhopal 462003, India
[e] Centre for Advanced Industrial Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Pekan 26600, Malaysia

HIGHLIGHTS

- Configuration of 4 ×1 PV system is designed & investigated under PSC.
- A new CSA algorithm is proposed to attain maximum power under PSC's.
- The effectiveness of the proposed CSA is compared to SSA, MFO, IGWO, CS, and PSO.
- The proposed CSA shows greater performance in terms of settling time & efficiency.

ARTICLE INFO

Keywords:
Solar photovoltaic (SPV)
Partial Shading Condition (PSC)
Particle Swarm Optimization (PSO)
Salp Swarm Optimization (SSA)
Circle search algorithm (CSA)

ABSTRACT

Solar photovoltaic (SPV) energy exhibits a potential role in the world for generating electricity and avoiding the block out in the power system. However, the hardest task in the PV system is to track the global maxima power (GPP) instead of local peak power (LPP) under partial shading conditions (PSC). To track the GPP, a new circle search algorithm (CSA) is implemented in this paper and is executed in MATLAB/SIMULINK environment. This method is examined at various irradiation conditions and compared their performance with other studied methods in terms of tracking time, settling time and efficiency. The simulation outcome of the CSA method efficiencies 99.96 % in case 1, 99.74 % in case 2, and 99.94 % in case 3. For checking the robustness and stability of the system statistical analysis was done on the proposed methods. It is found that the suggested method exhibits higher performance than the other methods.

1. Introduction

The ever-increasing energy demand is a reminder to every researcher. Especially large industries that need a continuous power supply to run smooth operations. A small interruption of power supply leads to high losses to the industries. To accomplish this problem, in past decades so many researchers focused on non-renewable energy sources however, these resources produce harmful gases to the environment [1]. On another side, the cost of resources also increased due to transportation and the depletion of fossil fuels [2]. From the past decades onwards most researchers focused on renewable energy sources to generate electricity [3]. Renewable sources are solar, wind, hydro, tidal, etc. Solar energy is the best alternative for electricity production because of zero pollution and low maintenance cost [4]. The installation cost of solar i.e. photovoltaic (PV) system is par with coal and gas due to the advancement of manufacturing technology [5]. PV system produces electricity from heat energy. PV systems are used in various applications like street lighting, advertisement boarding, pumping system, and transportation of electric vehicles (EVs) [6]. Although, the PV system does not render the required amount of power on account of the nonlinear nature of the environment i.e. change in temperature and irradiance [7]. During this condition, the PV characteristics produce multiple local peak power (LPP) instead of single global peak power (GPP) [8]. To resolve this problem, maximum power point tracking (MPPT) controllers are required to catch the GPP under partial shading

* Corresponding author.
E-mail address: rusllim@ump.edu.my (M.R. Mohamed).

https://doi.org/10.1016/j.asoc.2024.112030
Received 2 January 2023; Received in revised form 2 July 2024; Accepted 10 July 2024
Available online 19 July 2024