

Abstract

Flexible AC Transmission Systems (FACTS) technology finds applications in both power transmission and distribution systems. However, due to the high initial cost attached to FACTS devices, it is necessary to optimally size and locate them – what is known as the FACTS Optimization Problem (FOP). Choosing an efficient algorithm for FOP is critical, and Particle Swarm Optimization (PSO) and Genetic Algorithm (GA) have previously been applied. PSO and GA are known to converge slowly and can stagnate at local minima. To address these shortcomings, enhancements are introduced to improve GA and PSO. The improved versions of PSO and GA are then hybridized to create an effective algorithm named as Improved Genetic Algorithm-Improved Particle Swarm Optimization (IGA-IPSO). The proposed method was tested on 13 standard benchmark functions, 4 CEC 2020 test functions, and two engineering design problems before being applied to solve the FOP. The results were compared with those from other algorithms, namely: PSO, GA, PSO-GA, Grey Wolf Optimizer (GWO), Firefly Algorithm (FA), Quasi-Operational Chaotic Symbiotic Organisms Search (QOCSOS) and Multi-Verse Optimization (MVO). IGA-IPSO outperformed its peers and showed superior global search capabilities on 13 benchmark functions, achieving a top Friedman rank of 1.2308. Further, IGA-IPSO proved its fast convergence by achieving the lowest average execution time of 1.8527 s across the 13 benchmark functions, compared to GA-PSO (4.0083 s), PSO (4.5632 s), and GA (5.1059 s). The superior performance by IGA-IPSO was replicated when solving the other test problems. The proposed method was then applied to optimize Static Synchronous Compensator (STATCOM) location and size on the IEEE 33-, 69-, and 118-bus test systems, resulting in power loss reductions by 21.09 %, 43.34 % and 8.08 % respectively. The voltage profiles were also improved. Distribution system operators can benefit from the proposed method as it offers an effective technique for optimally sizing and placing FACTS devices within power networks to reduce power losses and improve voltage profiles.