

Optimized Allocation of Lightning Protection System Using PSO-GSA

Abstract

In this paper, the hybrid PSO-GSA, which is a combined algorithm of Particle Swarm Optimization (PSO) and Gravitational Search Algorithm (GSA), is proposed to find the optimum locations for the lightning protection system on the 81-bus radial distribution system. Moreover, the System Average Interruption Frequency Index (SAIFI) is considered as the objective function and will be minimized. The main advantage of this work is the simplicity and convenience of finding an optimal solution using the proposed PSO-GSA algorithm. Additionally, PSO-GSA is also capable of finding the optimal locations for applying a lightning protection system (LPS) in a distribution network, while minimizing SAIFI and maintaining computational efficiency. To validate the effectiveness of the proposed algorithm, numerical simulations are carried out considering the interdependency between lightning phenomena and the distribution feeder characteristics, namely, the flashover rates due to direct and induced lightning. In addition, a comparison between PSO, GSA, and PSO-GSA is made to compare and validate the performance of the algorithms. The results show that the latter is better at escaping from local optima and has a faster convergence than the standard PSO and GSA. PSO-GSA also managed to achieve a higher reduction of 12.10% SAIFI after applying LPS on the optimal feeders, as compared to the 10.79% and 11.77% reduction of SAIFI by GSA and PSO, respectively. PSO-GSA also has a faster convergence speed than PSO.

Keywords

Gravitational Search Algorithm (GSA); Lightning protection system; Optimal location; Particle Swarm Optimization (PSO); SAIFI