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Research Article

Optimal Reactive Power Flow for Large-Scale Power Systems Using an Effective Metaheuristic Algorithm

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In this paper, stochastic fractal search method (SFS) is employed for solving the optimal reactive power flow (ORPF) problem with a target of optimizing total active power losses (TPL), voltage deviation (VD), and voltage stability index (VSI). SFS is an effective metaheuristic algorithm consisting of diffusion process and two update processes. ORPF is a complex problem giving challenges to applied algorithms by taking into account many complex constraints such as operating voltage from generators and loads, active and reactive power generation of generators, limit of capacitors, apparent power limit from branches, and tap setting of transformers. For verifying the performance, solutions of IEEE 30 and 118-bus system with TPL, VD, and VSI objectives are found by the SFS method with different control parameter settings. Result comparisons indicate that SFS is more favorable than other methods about finding effective solutions and having faster speed. As a result, it is suggested that SFS should be used for ORPF problem, and modifications performed on SFS are encouraged for better results.

1. Introduction

In the power system, optimal reactive power flow (ORPF) is not only one of the best famous optimization problems but also a very complex problem. In the ORPF problem, two variables need to be considered such as control variables and dependent variables. Control variables are voltage of generation buses, on load tap-changer setting of transformers and generated reactive power of capacitor banks, while dependent variables are voltage of load buses, apparent power flow of transmission lines, and reactive power of generators. So, the major objectives of such ORPF problem is to find control variable so that others have values falling into a permitted operating range [1, 2]. Traditionally, the ORPF problem concentrates on reducing three individual objectives such as power losses of transmission lines, voltage deviation, and voltage stability index. So, a power system economically and stably operates when these goals are fully achieved.

In the last decades of the 20th century, the ORPF problem has been successfully addressed by many conventional methodologies called deterministic methodologies such as the Newton method [3], linear programming [4–7], interior point method [8, 9], quadratic programming method [10, 11], and dynamic programming method [12]. With appearance of the mentioned methods, they proved their strong points in dealing with the ORPF problem having linear constraints and differentiable functions for application, but a large system or more complicated constraints and their applicability must be stopped to make rooms for new methods which have a promising ability.

Luckily, developing computer science supported researchers much in creating new population-based methods to handle drawbacks of conventional methods. These