J Electr Eng Technol Vol. 8, No. 1: 53-63, 2013
http://dx.doi.org/10.5370/JEET.2013.8.1.053

ISSN(Print) 1975-0102
ISSN(Online) 2093-7423

A Study on Multi-objective Optimal Power Flow under Contingency using Differential Evolution

Belkacem Mahdad† and K. Srairi*

Abstract – To guide the decision making of the expert engineer specialized in power system o peration and control; the practical OPF solution should take in consideration the critical situati on due to severe loading conditions and fault in power system. Differential Evolution (DE) is one of the best Evolutionary Algorithms (EA) to solve real valued optimization problems. This paper presents simple Differential Evolution (DE) Optimization algorithm to solving multi obje ctive optimal power flow (OPF) in the power system with shunt FACTS devices considering v oltage deviation, power losses, and power flow branch. The proposed approach is examined an d tested on the standard IEEE-30Bus power system test with different objective functions at cr itical situations. In addition, the non smooth cost function due to the effect of valve point has been considered within the second practical network test (13 generating units). The simulation results are compared with those by the other recent techniques. From the different case studies, it is observed that the results demonstrate the potential of the proposed approach and show cl early its effectiveness to solve practical OPF under contingent operation states.

Keywords: Differential evolution, Multi objective function, Optimal power flow, Valve point effect, FACTS, SVC, Contingency.

1. Introduction

The optimal power flow (OPF) problem is one of the important tools in operation and control of large modern power systems based FACTS technology and Renewable energy. The main objective of a practical OPF strategy is to determine the optimal operating state of a power system by optimizing a particular objective while satisfying certain specified physical and security constraints. In its most general formulation, the optimal power flow (OPF) is a nonlinear, non-convex, large-scale, static optimization problem with both continuous and discrete control variables. It becomes even more complex when more than one objective function is considered with various types of practical generators constraints (prohibited zones, valve point effects and ramp rate limits), this type of problem well known as multi objective OPF problem. Over the last several years many mathematical optimization techniques have been applied to solve the OPF problem such as; linear programming (LP), nonlinear programming (NLP), quadratic programming (QP), and interior point methods [2-5]. All these techniques rely on the initial condition and convexity to find the global optimum; the methods based on these assumptions do not guarantee to find the global optimum solution when considering the practical generators constraints (Prohibited zones, valve point effects and ramp rate limits), authors in [1] provide a valuable introduction and surveys the classical optimization techniques. To overcome the drawbacks of the mathematical methods related to the initial condition and to the form of the objective function, a new category of global optimization techniques is developed, this category based on stochastic and heuristic aspect includes; Genetic algorithm (GA) [6, 7], Tabu search (TS) [8], Simulated annealing (SA) [9], Evolutionary programming (EP) [10], Particle swarm optimization (PSO) [11], Differential evolution (DE) [12], Harmony search (HS) [13], Artificial bee colony (ABC) [14], Biogeography based optimization method (BBO) [15, 16], A modified Artificial bee (MABCA) [17], Shuffled frog leaping algorithm (SFL) [18], and Gravitational search algorithm (GSA) [19]. All these methods applied with success to solving various problems related to power system operation and control. Authors in [20] provide a significant and valuable introduction and surveys the non-deterministic and hybrid optimization methods.

Differential Evolution (DE) is a population-based, direct stochastic search algorithm and one of the most prominent new generation EAs, proposed by Storn and Price [21], for optimization problems over a continuous domain. The main advantages of DE are: simple to program, few control parameters, high convergence characteristics. DE has been applied to several engineering problems in different areas. In power system area, DE has received great attention to solving the multi objective optimal power flow considering the integration of multi FACTS devices in a practical electrical network. This paper presents a differential evolution (DE) algorithm adapted for the solution of the multi objective optimal power flow under contingent operation states considering multi shunt FACTS devices.

† Corresponding Author: Dept. of Electrical Engineering, Biskra University, Algeria.(bemahdad@mselab.org)
* Dept. of Electrical Engineering, Biskra University, Algeria. (k.srairi@mselab.org)
Received: July 6, 2011; Accepted: July 31, 2012