Chapter 23

Whale Optimization Algorithm With Wavelet Mutation for the Solution of Optimal Power Flow Problem

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ABSTRACT

This chapter proposes whale optimization algorithm (WOA) with wavelet mutation (WOA-WM) for solving optimal power flow (OPF) problem. The proposed WOA-WM algorithm of the present work utilizes wavelet theory to enhance the optimizing performance of basic WOA in exploring the solution space more effectively for getting better solution. Both WOA and the proposed WOA-WM algorithms are tested on four test power systems under different objective functions (that reflects either minimization of fuel cost or that of transmission line loss or improvement of voltage profile) for getting the optimal solutions of the OPF problem. For multi-objective problem formulation, fuel cost, transmission line loss, and voltage deviation are minimized simultaneously. The simulation results are compared to those offered by some recently reported algorithms surfaced in various recent literature. The WOA-WM-based results demonstrate convincing features in solving the OPF problem of the undertaken test power systems.
1. INTRODUCTION

1.1 General

In optimal power flow (OPF) problem, the values of few or complete control variables need to be obtained by optimizing a predefined objective function (Carpentier, 1979). It is also significant that the proper problem definition with clearly declared objectives must be liable for the onset. The accuracy of the model under study determines quality of the solution. Objective function of OPF may be of miscellaneous types, such as minimization of fuel cost ($FC$) or that of transmission loss ($P_{loss}$) or improvement of voltage profile ($TVD$). Generally, the objective function is inclined to minimize the total production cost of the scheduled generating units. This is mostly used in the literature as it reflects current economic dispatch practice and, importantly, cost associated perspective is always given priority among operational requirements in power system. OPF intends to optimize the above objective, subjected to the system power flow equations, system and equipment operating limits. Many optimization procedures have been emerged in the literature so far and these have been applied and tested to interpret OPF problem of power system.

1.2 Background Perspective

In previous days, the basic concept behind finding the solution of OPF algorithms was classical mathematical based programming methods. Gradient method (GM), non-linear programming (Dommel, & Tinney, 1968), linear programming (Abou El Ela, & Abido, 1992; Mota-Palomino, & Quintana, 1986), quadratic programming (QP) (Burchett, Happ, & Vierath, 1984), Newton-based method (NM) (Sun, Ashley, Brewer, Hughes, & Tinney, 1984; Santos, & da Costa, 1995), interior point method (Yan, & Quintana, 1999) etc. have been, successfully, applied to interpret solution of the OPF problem. In the last decades, many population-based optimization methods have been implemented to solve the complex constrained optimization problems. These methods have been, more and more, applied for solving power system optimization problems like economic load dispatch, optimal reactive power flow and OPF problems. Some of the population based metaheuristic techniques like genetic algorithm (GA) (Deveraj, & Yegnanarayana, 2005), improved GA (IGA) (Lai, Ma, Yokoyama, & Zhao, 1997), Tabu search (Abido, 2002), particle swarm optimization (PSO) (Abido, 2002), differential evolution (DE) algorithm (Varadarajan, & Swarup, 2008), simulated annealing (Roa-Sepulveda, & Pavez-Lazo, 2001), evolutionary programming (EP) (Somassundaram, Kuppusamy, & Kumudini Devi, 2004) etc. have been proposed to realize the OPF problem, successfully. Narimani et al. (Narimani, Azizipanah-Abarghooei, Zoghdar-Moghadam-Shahrekhone, & Gholami, 2013) have applied a novel hybrid optimization algorithm to solve multi-objective OPF problem considering generator constraints and multiple fuel option. Niknam et al. (Niknam, Narimani, Aghaei, & Azizipanah-Abarghooei, 2012) have utilized an improved PSO for multi-objective OPF problem. Niknam et al. (Niknam, Narimani, Aghaei, & Azizipanah-Abarghooei, 2012) have solved OPF problems of power system by a new hybrid optimization algorithm considering prohibited operating zones and valve point effect.
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