Chapter 8

A Computational Comparison of Swarm Optimization Techniques for Optimal Load Shedding Under the Presence of FACTS Devices to Avoid Voltage Instability

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ABSTRACT

Voltage instability has become a serious threat to the operation of modern power systems. Load shedding is one of the effective countermeasures for avoiding instability. Improper load shedding may result in huge technical and economic losses. So, an optimal load shedding is to be carried out for supplying more demand. This chapter implements bat and firefly algorithms for solving the optimal load shedding problem to identify the optimal amount of load to be shed. This is applied for a multi-objective function which contains minimization of amount of load to be shed, active power loss minimization, and voltage profile improvement. The presence of with and without static VAR compensator (SVC), thyristor-controlled series capacitor (TCSC), and unified power flow controller (UPFC) on load shedding for IEEE 57 bus system has been presented and analyzed. The results obtained with bat and firefly algorithms were compared with genetic algorithm (GA) and also the impact of flexible AC transmission system (FACTS) devices on load shedding problem has been analyzed.

DOI: 10.4018/978-1-5225-5134-8.ch008

INTRODUCTION

Nowadays, voltage instability has been considered as one of the reason for the blackouts all over the world. Blackouts occurs due to contingency, such as the outage of an important transmission line or the outage of a major generator, or insufficient reactive power support at important buses due to a high loading condition or a combination of both the aspects. The requirement for improved efficiency at the same time as maintaining system stability necessitates the development of improved system analysis approaches and the improvement of advanced technologies. The Load shedding is a type of emergency control that is designed to ensure system stability by curtailing system load to match generation. It is an effective corrective control action in which a part of the system loads are disconnected according to certain priority in order to protect the power system. Load shedding is considered as the last resort tool for use in that extreme situation and usually the less preferred action to be adopted, but in this kind of problem it is vital to prevent the system from collapsing (Kundur, 1993). Load shedding schemes are mainly classified into two types those are under frequency load shedding scheme and under voltage load shedding scheme. Under frequency load shedding scheme has been used, to protect the power system stability from major disturbances. However, the analysis of recent blackouts suggests that voltage collapse and voltage-related problems are also important concerns in maintaining system stability. For this reason, voltage also needs to be taken into account in load shedding schemes. This type of scheme is called under voltage load shedding scheme. The load shedding problem is formulated using optimization methods. These methods are used to find the amount of load to be shed based on Optimal Power Flow frame work. The purpose of an Optimal Power Flow (OPF) function is to schedule the power system control parameters which optimize a certain objective function while satisfying its equality and inequality constraints, power flow equations, system security and equivalent operating limits. The equality constraints are the nodal power balance equations, while the inequality constraints are the limits of all control or state variables. OPF has been widely used for both the operation and planning of a power system. Introduced by Tinney (1967) and discussed by Carpentier (1979), the control variables include generator active powers, generator bus voltages, transformer tap ratios and the reactive power generation of shunt compensators.

A wide variety of classical optimization techniques have been applied in solving the OPF problems considering a single objective function, such as nonlinear programming, quadratic programming, linear programming, Newton-based techniques sequential unconstrained minimization technique, interior point methods and the parametric method but unfortunately these methods are infeasible in practical systems because of non-linear characteristics like valve point effects. Hence, it becomes essential to develop optimization techniques which are capable of overcoming these drawbacks and handling such difficulties. Optimization problems have been solved by many population-based optimization techniques in the recent past. These techniques have been successfully applied to non-convex, non-smooth and non-differentiable optimization problems. Some of the population-based optimization methods are genetic algorithm, Cuckoo Search Algorithm (Dung A. Le &Dieu N. Vo, 2016), bat Search Algorithm (Rao & Kumar, 2015), Quasi-Oppositional Biogeography-Based Optimization, Hybridization of Biogeography Based Optimization (HBBO) (Prabhneetkaur and Taranjotkaur, 2014), Anticipatory Multi objective Cuckoo Search (AMOCS) algorithm (SamikshaGoel, Arpita Sharma and V. K. Panchal, 2014),Teaching Learning Based Optimization (Aparajita Mukherjee, Sourav Paul & Provas Kumar Roy, 2015)artificial bee colony optimization (Rahul Khandelwal, J. Senthilnath, S. N. Omkar and Narendra Shivanath, 2016).