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Security optimal power flow considering loading margin stability using hybrid FFA–PS assisted with brainstorming rules

Belkacem Mahdad *, K. Srairi

Department of Electrical Engineering, Biskra University, Algeria

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abstract

This paper presents a new power system planning strategy which combines firefly algorithm (FFA) with pattern search algorithm (PS). The purpose is minimizing total fuel cost, total power loss and reducing total voltage deviation, with the objective of enhancing the loading margin stability and consequently the power system security. A new interactive and simple mechanism, inspired in brainstorming process, is proposed that allows FFA and PS algorithms to explore new regions of the search space. In this study the Static VAR compensator (SVC) is modeled and integrated in an efficient location which is chosen considering the voltage stability index. The proposed algorithm is interactive and tries to optimize a set of control variables at the same time, namely, active power generations, voltage of generators, tap transformers, and the reactive power of shunt compensators to optimize three objective functions such as: fuel cost, total power loss and total voltage deviation. These variables are optimized using a flexible interactive and competitive search mechanism. The proposed planning strategy has been examined and applied to two practical test systems IEEE 14-Bus and IEEE 30-Bus. Simulation results confirm the effectiveness of this hybrid strategy for solving the security optimal power flow.

1. Introduction

The security optimal power flow (OPF) is the most important tool for power system planning, operation and control. The main objective of OPF tool which considered as an important sub problem of power system planning is to determine the optimal operation state of multi dispersed units by optimizing multi control variables related to a specified objective function considering multi practical constraints. Active power loss, voltage deviation and voltage stability are three important tasks which interest expert specialized in power system planning operation and control. The optimization of these objective functions affect directly and indirectly the dynamic performances of practical power system [1]. Many research results confirmed that optimization of these objective functions is a complex multi objective problem which require robust and flexible strategy to enhance the performance of practical power systems under normal and at critical situations. The standard OPF problem has been widely solved using several classical mathematical optimization techniques such as linear and non linear programming (LP, NLP) [2], gradient based method [3], quadratic programming (QP) [4], Newton-based method [5,6], and interior point methods [7]. A recent survey of the major contributions related to this category based mathematical methods is presented in [8]. Based on a large number of papers proposed to solving various problems related to power system planning, operation and control, we can conclude that the deterministic optimization methods converge to local optimal solution and can not guarantee global solution when considering practical generator constraints (Prohibited zones, valve point effect, and multi-fuel options) due to sensibility to initial conditions and to the form of the objective function. These major drawbacks have contributed to the development of new stochastic based optimization techniques such as, evolutionary programming [9], improved evolutionary programming [10], enhanced genetic algorithm (EGA) [11], improved genetic algorithms (IGA) [12], adapted genetic algorithm (AGA) [13], particle swarm optimization (PSO) [14,15], differential evolution (DA) [16–19], improved harmony search algorithm [20], Imperialist competitive algorithm (ICA) [21], gravitational search algorithm (GSA) [22], artificial bee colony algorithm (ABC) [23,24], firefly algorithm (FFA) [25,26], brain storm optimization algorithm (BSA) [27], Application of brainstorming strategy for enhancement dynamic teaching based LMD education system [28]. In general view, we can conclude that the main difference between these methods is related to the robustness of their mechanism search

* Corresponding author. Tel.: +213 665084111.
E-mail address: bemahdad@mselab.org (B. Mahdad).

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