Energy 77 (2014) 372–381

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Solving non-convex economic dispatch problem via backtracking search algorithm

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ARTICLE INFO

Article history:
Received 25 April 2014
Received in revised form
15 August 2014
Accepted 3 September 2014
Available online 5 October 2014

Keywords:
Economic dispatch
Backtracking search algorithm
Valve point effect
Transmission loss
Non-convex
Evolutionary

ABSTRACT

This paper presents BSA (backtracking search algorithm) for solving of ED (economic dispatch) problems (both convex and non-convex) with both the valve-point effects in the generator cost function and the transmission network loss considered. BSA is a new evolutionary algorithm for solving of numerical optimization problems; it uses a single control parameter and two crossover and mutation strategies for powerful exploration of the problem's search space. Four test systems (with 3, 6, 20, and 40 generators) are the case studies verifying the method's robustness and effectiveness. The results confirm that compared with existing well-known methods and especially in large-scale test systems, the proposed algorithm is the better approach to solving ED problems.

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1. Introduction

The problem of ED (economic dispatch) is a basic consideration to optimizing power system operation. ED determines the power shared among the generating units of power system to meet electrical demand while minimizing cost and satisfying system constraints.

In a convex ED problem, the cost function of a generating unit is considered as a quadratic function. Practical and non-convex ED problems, however, contain non-convex cost functions that are due to the valve-point effect of the generating units. Classical methods have been adopted to solve conventional ED problems (i.e., containing convex cost functions) but instead produce non-optimal solutions because of the non-convexity/non-linearity of practical ED problems [1]. Dynamic programming, for example, has been proposed in addressing non-convex ED problems because it does not restrict the form of the cost function; the increased dimension of the problem, however, may demand higher computational efforts [2]. Classical methods include interior point [3], quadratic programming [4], linear programming [5], Lagrangian relaxation algorithm [6], dynamic programming [7], and lambda iteration [8].

Unlike classical methods, metaheuristic methods are better options because they can handle more constraints and are able to explore the search domain effectively in finding the optimum; they include ICA (imperialist competitive algorithm) [9], CS (cuckoo search) [1], DE (differential evolution) [10], ABC (artificial bee colony) [11], PSO (particle swarm optimization) [12], TLBO (Teaching–learning-based optimization) [13], SOA (seeker optimization algorithm) [14], MGSO (modified group search optimizer) [15], GA (genetic algorithm) [16], and HBMO (honey bee mating algorithm) [17]. DE is especially very effective because it does not need derivative information from the cost function; instead it sub-optimally or prematurely converges [17]. Other drawbacks associated with metaheuristics are high sensitivity to the control parameters, long computational time, and slow convergence to approximately optimum solution [18].

Recent hybrid methods overcome those drawbacks, able to handle the high complexities of practical ED problems. One method might be adopted for its high convergence, another for its provision of a suitable initial guess for the problem. The hybrid methods are combinations of either two or more metaheuristic methods or metaheuristic with classical techniques. Combinations of PSO with DE [17], GA with API [19], GA-LI [20], CPSO-SQP [21], and FCASO-SQP [22] perform better as hybrids than individually.

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http://dx.doi.org/10.1016/j.energy.2014.09.009
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