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Modified Particle Swarm Optimization with Time Varying Acceleration Coefficients for Economic Load Dispatch with Generator Constraints

M.N. Abdullah*,*, A.H.A Bakar*, N.A. Rahim*, H. Mokhlis**, H.A. Illias** and J.J. Jamian*****

Abstract – This paper proposes a Modified Particle Swarm Optimization with Time Varying Acceleration Coefficients (MPSO-TVAC) for solving economic load dispatch (ELD) problem. Due to prohibited operating zones (POZ) and ramp rate limits of the practical generators, the ELD problems become nonlinear and nonconvex optimization problem. Furthermore, the ELD problem may be more complicated if transmission losses are considered. Particle swarm optimization (PSO) is one of the famous heuristic methods for solving nonconvex problems. However, this method may suffer to trap at local minima especially for multimodal problem. To improve the solution quality and robustness of PSO algorithm, a new best neighbour particle called 'rbest' is proposed. The rbest provides extra information for each particle that is randomly selected from other best particles in order to diversify the movement of particle and avoid premature convergence. The effectiveness of MPSO-TVAC algorithm is tested on different power systems with POZ, ramp-rate limits and transmission loss constraints. To validate the performances of the proposed algorithm, comparative studies have been carried out in terms of convergence characteristic, solution quality, computation time and robustness. Simulation results found that the proposed MPSO-TVAC algorithm has good solution quality and more robust than other methods reported in previous work.

Keywords: Economic load dispatch, Particle Swarm Optimization (PSO), Prohibited operating zone (POZ), ramp rate limits, time varying acceleration coefficients (TVAC)

1. Introduction

Economic load dispatch (ELD) is one of the important tasks in power system operation and planning. The main purpose of ELD is to determine the real power output of scheduled generators to meet power demand at minimum cost whilst satisfying the equality and inequality constraints. Optimal combination of generator power output can reduce the cost of power plant operation significantly.

In general, the cost characteristic of generator is assumed to be convex and is represented by a single quadratic function for ELD problems. It was successfully solved by mathematical programming methods based on derivative information of cost function [1]. However, the cost function of a practical generator becomes highly non-linear and discontinuous due to prohibited operating zones (POZ) and ramp-rate limits of the generator [2, 3]. Therefore, ELD problems with equality and inequality constraints are nonconvex and very difficult to solve using a mathematical approach. Conventional methods such as gradient method, lambda iteration, base point participation and Newton methods are unable to solve nonconvex optimization problem [1]. On the other hand, dynamic programming can solve nonconvex ELD problem due to no restriction on the cost function, but suffers from 'curse of dimensionality' when involves with high number of variables [4].

Recently, modern heuristic methods such as genetic algorithm [5, 6], evolutionary programming [7], differential evolution [8], ant colony optimization [9], tabu search [10], simulated annealing [11], neural network [12], and particle swarm optimization (PSO) [13-18] have been successfully applied to nonconvex ELD problems. However, these approaches are not always promising a global optimum solution and sometimes are trapped at local point.

Among these techniques, PSO is widely used for solving nonconvex ELD problem due to its simple implementation, less complexity and most of the time able to find global solution. In classical PSO, premature convergence is always occurring due to the lack of diversity of PSO

† Corresponding Author: UM Power Energy Dedicated Advanced Centre (UMPEDAC), Level 4, Wisma R&D, University of Malaya, Jalan Pantai Baharu, 59990 Kuala Lumpur, Malaysia. ({mnoor, a.halim, nasrudin}@um.edu.my)
* Department of Electrical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia. (hazli, h.illias @um.edu.my)
** Department of Electrical Power Engineering, Faculty of Electrical and Electronics Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, Malaysia. (mnoor@uthm.edu.my)
***Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia. (jasrul@fke.utm.my)
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