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Daily Hydrothermal Generation Scheduling by a new Modified Adaptive Particle Swarm Optimization technique

Nima Amjady*, Hassan Rezai Soleymanpour

Department of Electrical Engineering, Semnan University, Semnan, Iran

A R T I C L E I N F O

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The fundamental requirement of power system hydrothermal scheduling is to determine the optimal amount of generated powers for the hydro and thermal units of the system in the scheduling horizon of 1 day or few days while satisfying the constraints of the hydroelectric system, thermal plants and electrical power system. Daily Hydrothermal Generation Scheduling (DHGS) is a complicated non-linear, non-convex and non-smooth optimization problem with discontinuous solution space. To deal with this complicated problem, a new Modified Adaptive Particle Swarm Optimization (MAPSO) is proposed in this paper. The inertia weight and acceleration coefficients of the PSO are adaptively changed in the MAPSO owning tree topology. We split-up the cognitive behavior of PSO into the best and not-best parts. The proposed not-best cognitive component, unlike recent methods, retains its dynamic behavior throughout the search process. Personal best position exchanging method is proposed to increase activities of particles to explore broad space. New velocity limiter is also proposed in this paper to enhance exploration capability and convergence behavior of the MAPSO. The proposed MAPSO is tested on six test systems and compared with some recent research works in the area.

1. Introduction

Daily Hydrothermal Generation Scheduling (DHGS) is an important issue in economical operation of power systems. The short-term hydrothermal generation scheduling determines optimal hourly water releases of each reservoir in hydroelectric plants to generate electrical energy for supporting some part of the power demand. In order to satisfy the rest of the power demand, which is not supported by hydropower generation, DHGS schedules thermal generation units so that the total production cost is minimized during the scheduling time horizon. The main objective is focused on the optimal use of water resources for minimizing the production cost of thermal plants considering the practical constraints. In DHGS problem, the constraints are usually divided into three categories related to hydroelectric system, thermal plants and electrical power system (satisfying power demand constraint) [1]. Aside from these constraints, the cascading nature of hydrosystems causes dependency between the performances of hydropower plants. Also, the impact of steam valve loading on operational cost curve of thermal units intensifies non-convexity and non-linearity of the DHGS problem. So, DHGS is a complicated non-linear, non-convex and non-smooth optimization problem with discontinuous solution space.

Several methods, such as dynamic programming (DP) [2], network flow [3], decomposition technique [4], mixed integer linear programming (MILP) [5], and Lagrangian relaxation (LR) [1,6] have been proposed to solve DHGS problem in the recent years. Among the existing methods, DP appears to be the most popular despite the major disadvantage of drastic growth of computational and dimensional requirements with increasing system size and planning horizon [7]. The network flow model of DHGS is often programmed as a linear or piecewise linear one. Linear programming typically considers that power generation is linearly dependent on water discharge, thus ignoring the head change effect, leading to a solution schedule with less power generation [8]. Handling of the various constraints increases the number of dual variables and the complexity of the optimization task in the decomposition technique [9]. Also, the discretization of the non-linear dependence between power generation, water discharge and head, used in the MILP to model head variations, augment the computational burden required to solve DHGS problem. The implementation of LR is complicated and its efficiency heavily depends on the size of the duality gap. Furthermore, solution quality of LR depends on the method to update Lagrange multipliers [8]. As a result, conventional methods require models of hydro as well as thermal plants to be represented as piecewise linear or polynomial approximations of monotonically increasing nature. However, such an approximation may lead to a

* Corresponding author. Tel.: +98 021 88889096; fax: +98 021 88880098.
E-mail address: amjady@tavanir.org.ir (N. Amjady).

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