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Hydro-thermal unit commitment problem using simulated annealing embedded evolutionary programming approach

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ABSTRACT

This paper presents a new approach to solve the hydro-thermal unit commitment problem using Simulated Annealing embedded Evolutionary Programming approach. The objective of this paper is to find the generation scheduling such that the total operating cost can be minimized, when subjected to a variety of constraints. A utility power system with 11 generating units in India demonstrates the effectiveness of the proposed approach; extensive studies have also been performed for different IEEE test systems consist of 25, 44 and 65 units. Numerical results are shown comparing the cost solutions and computation time obtained by conventional methods.

1. Introduction

Hydro-thermal scheduling is concerned with the commitment and dispatch of generating units. The optimal operation planning of hydro-thermal power system is to reduce the operational costs. Because of its complexity, the optimization problem is divided into several tasks with different planning periods. The optimal scheduling of generation in a hydro-thermal system involves the allocation of generation among the hydro-electric and thermal plants so as to reduce total operation costs of thermal plants while satisfying the variety of constraints on the hydraulic and power system network. In tackling this problem, the thermal system may be represented by an equivalent thermal generating unit. In the process of minimizing the fuel cost of the thermal generators in a hydro-thermal system, equality and inequality constraints must be satisfied. The equality constraints are power balance constraint, the total water discharge constraint and the reservoir volume constraints. The inequality constraints are due to the reservoir storage limits and the operation limits of the equivalent thermal generator and those of the hydro plant.

Unit Commitment (UC) can save a lot of money and bring in a large profit. This money can in turn be used to improve the quality of the supply by installing different quality control equipments. Unit commitment in power systems refers to the optimization problem for determining the on/off states of generating units that minimize the operating cost for a given time horizon. The objective of the unit commitment in regulated or state monopoly power markets is to schedule the operation of the generating units in order to serve the load demand at minimum operation costs while observing all plant and system constraints over a given scheduling period, ranging from several hours to days ahead.

Research endeavours, therefore, have been focused on; efficient, near-optimal UC algorithms, which can be applied to large-scale, power systems and have reasonable storage and computation time requirements. A survey of existing literature [1–14] on the problem reveals that various numerical optimization techniques have been employed to approach the complicated unit commitment problem. More specifically, these are the Dynamic Programming method (DP), the Mixed Integer Programming method (MIP), the Lagrangian Relaxation method (LR), the Augmented Lagrangian Relaxation method (ALR), the Artificial Neural Network (ANN), the Simulated Annealing method (SA), the Tabu Search (TS), the TS and Decomposition method (TSD), the Evolutionary Programming (EP) and so on. The major limitations of the numerical techniques are the problem dimensions, large computational time and complexity in programming.

The DP method [1] does not required the discretization of the state and control variables and total required storage and computation time are reduced as compared to those in the successive approximations algorithm. The MIP method [2] can give a near optimal solution for in an acceptable time. It is suitable for regulated environment but also can be easily applied to deregulation applications for decision supports with minor changes in the problem formulation. The LR method [3] is shown that decreasing of the optimal distance function means that the algorithms converge to a near optimal and feasible solution of the primal problem. Both the solution accuracy and convergence performance are better or at least of the same quality as those obtained using the sub gradient method. It solves accurately and it can be used to obtain approximate solutions to short term planning [4].

The ALR method [5] produces feasible schedules and requires no iteration with economic dispatch algorithms. Because of the

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