An Application of Cuckoo Search Algorithm for Solving Combined Economic and Emission Dispatch Problem

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***Abstract*—This paper presents the application of Cuckoo Search Algorithm (CSA) in solving the combined economic and emission (CEED) dispatch problem. As been known, CEED can be formulated as a multi-objective optimization problem which is involving two objectives that conflicting each other. The objective is to find the tradeoff between minimizing the costs of fuel as well as minimizing the emission levels simultaneously while satisfying all the constraints. In this paper, this bi-objective function is transformed into a single objective function by introducing the price penalty and weighting factors. In order to show the effectiveness of CSA in solving CEED, two test systems are used: 6-units and 40-units generator systems. The comparison with other recent techniques is also given in this paper.**

Keywords—combined economic emission dispatch; cuckoo search algorithm; multi-objective optimization

I. Introduction

One of the most important issues emerged in power system complexity is economic dispatch (ED) problem. ED is a fundamental issue which aims to find the optimal power generation to match with the demand while satisfying all the systems' constraints. Due to awareness over the environmental considerations, society demands adequate and secure electricity not only at the cheapest possible price, but also at the minimum level of pollution. This brings to the new problem regarding the economic operation of power system, namely combined economic emission dispatch (CEED). The CEED problem is a nonlinear multi-objective optimization problem, which is basically to solve an optimal amount of generating from fossil fuel by minimizing the fuel cost and emission level simultaneously.

Numbers of works on CEED have been reported in literature. A modified bacterial foraging algorithm (MBFA) has been proposed in [1]. The modification has been done in conventional BFA which is the fuzzy based was hybrid in the proposed technique. The combination of different differential evolution (DE) and biogeography based optimization (BBO) to solve CEED has been discussed in [2]. Ref. [3] discusses comparisons of Artificial Intelligence techniques to solve CEED with the line flow constraints. The comparisons have been made among genetic algorithm (GA), evolutionary programming (EP), particle swarm optimization (PSO) and DE. Nevertheless, it is end up without pointing out which method is the best to solve CEED. The implementation of multi-objective differential evolution (MODE) on CEED has been proposed in [4]. The applications of Gravitational Search Algorithm (GSA) [5], Spiral Optimization Algorithm (SOA) [6] and simplified recursive approach [7] into CEED also have been proposed in literature.

In this paper, the usage of Cuckoo Search Algorithm (CSA) [8] has applied in solving CEED problem. The rest of this paper is organized as follows: Section 2 discusses the problem formulation of CEED followed by the brief description of CSA in Section 3. Section 4 presents the CEED via CSA and the simulation results and discussion is reported in Section 5. Finally, the conclusion is stated in Section 6.

II. CEED Problem Formulation

The objective function of CEED is to find the minimum cost of thermal power generation and the minimum level of emission concurrently without violating any constraints. The problem can be formulated as follow:

A. *Cost minimization*

The fuel cost function of thermal power generation which is normally expressed as quadratic function as follows:

$$F_i(P_{Gi}) = \sum_{i-1}^{N} \left(a_i P_{Gi}^2 + b_i P_{Gi} + c_i + \left| d_i \sin\left\{ e_i \left(P_{Gi}^{\min} - P_{Gi} \right) \right\} \right| \right) \tag{1}$$

where P_{Gi} is the real power generation of generator i for dispatched hour, N is the total number of generation units and a_i, b_i and c_i are the coefficients of the fuel cost function for generator i. The coefficients d_i and e_i are used only if the valve loading effect is taken into account.