Invasive Weed Optimization for Combined Economic and Emission Dispatch Problems

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ABSTRACT

In this paper, Invasive Weed Optimization (IWO) algorithm is used to find the optimum solution of Combined Economic Emission Dispatch (CEED) problem. The main objective is to minimize the fuel cost as well as emission level, while satisfying the power demand and associative operational constraints. The bi-objective problem is made to a single objective function using the price penalty factor. Since, the minimize fuel cost and emission are contradictory to each other so to get the optimum compromise solution, weighing factor is used. IWO is applied on three different standard test cases i.e. 6 generators, 10 generators and 40 generators system. To measure the effectiveness and quality of solution, test results have been compared with other existing relevant approaches.

Keywords: *Combined Economic Emission Dispatch, Emission Level, Fuel Cost, Invasive Weed Optimization, Optimization*

INTRODUCTION

In power system operation, the main objective of economic load dispatch is to allocate the generation among generating units so that fuel cost is minimized while fulfilling the associated operational constraints (Wood & Wollenberg, 1984). Due to increased awareness about the pollution caused by thermal generating plants, utilities have modified their design and several operational strategies were used to reduce atmospheric pollution. With the generation, several gaseous pollutants like carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxide (NO_x) are released which not only affects humans but other lives also. This can cause acid rain, agriculture

DOI: 10.4018/ijaec.2014010101

damage and can reduce the visibility of eyes. Therefore objective of minimizing cost is no longer considered alone, it also account to limit the atmospheric pollution. Under the present environmental conditions, both objectives are considered simultaneously to obtain the optimal generation dispatch. Thus the multi-objective problem is converted into a single objective function using the price penalty factor. As both the objectives are conflicting one and give rise to a set of optimal solutions instead of one solution. Therefore no solution can be considered as better than other and it give rise to a set of solutions which are known as Pareto optimal solutions which demonstrates trade-off between the two conflicting objectives.

Traditional optimization technique i.e. goal programming technique have been used by (Nanda et al., 1988) for EELD problem. Other conventional approaches such as analytical solution method based on mathematical modeling (Palanichamy & Babu, 2008), probability security criterion (Yokoyama et al., 1988), interactive search method (Zahavi & Eisenberg, 1985) and heuristic optimization approaches such as genetic algorithm (Guvenc, 2010), particle swarm optimization (Abido, 2009), differential evolution (Abou et al., 2010), BBO (Rajasomashekar & Aravindhababu, 2012), GSA (Guvenc et al., 2012) have been successfully applied to solve the CEED problems. Recently different multi-objective evolutionary algorithm such as fuzzy clustering-based particle swarm (FCPSO) algorithm (Agrawal et al., 2008), non dominated sorting genetic algorithm-II (Ah King et al., 2006), fuzzy based bacterial foraging algorithm (Hota et al., 2010), multi objective harmony search method (Sivasubramani & Swarup, 2011), hybrid of differential evolution and biogeography based optimization (DE/BBO) (Bhattacharya & Chattopadhyay, 2011) are applied successfully to solve this problem.

In this paper, the Invasive Weed Optimization (IWO) technique is applied to solve the CEED problem. The objective function is formulated as nonlinear constrained optimization problem. The effectiveness and performance of IWO algorithm is tested on three different standard test cases. The obtained results are compared with the other existing approaches.

The remaining part of the paper is organized as follows: First we present the problem formulation, then we depict the key steps associated with IWO technique. Implementation of IWO to solve CEED is described in the following section, the results obtained by simulation and comparison with other reported algorithm is illustrated afterwards. Followed by a define Parameter selection approach and finally Conclusion is drawn.

PROBLEM FORMULATION

Economic Load Dispatch

The main aim of ELD is to minimize the fuel cost while satisfying the equality and inequality constraints. The objective function considering the valve point effect is formulated as the sum of quadratic and sinusoidal function given by Equation (1).

$$F\left(P_{Gi}\right) = \sum_{i=1}^{N}\left[a_i P_{Gi}^2 + b_i P_{Gi} + c_i + \mid e_i \sin\left\{f_i\left(P_{Gimin} - P_{Gi}\right)\right\} \mid\right] \tag{1}$$

Where, '$F(P_{Gi})$' is the total fuel cost, 'a_i', 'b_i', 'c_i', 'e_i' and 'f_i' are the fuel cost coefficient of the i^{th} generating unit, 'P_{Gimin}' is the minimum Power of the i^{th} generating unit and 'P_{Gi}' is the Power generated by i^{th} unit and 'i' is given by:

i = 1, 2, 3… N

Where, N is the Number of Generating units. 'e_i' and 'f_i' are not used when valve point effect is neglected as shown in Equation (2).

$$F\left(P_{Gi}\right) = \sum_{i=1}^{N}\left(a_i P_{Gi}^2 + b_i P_{Gi} + c_i\right) \tag{2}$$