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A Survey on Economic Load Dispatch optimization Problem

Ram Denjare
ram.denjare@gmail.com

Subhra Debdas
subhra.debdas@gmail.com

***Abstract* — The economic load dispatch plays an important role in the operation of power system, and several models by using different techniques have been used to solve these problems. Several traditional approaches, like lambda-iteration and gradient method are utilized to find out the optimal solution of non-linear problem. More recently, the soft computing techniques have received more attention and were used in a number of successful and practical applications. This paper presents a review of some methods for solving the economic load dispatch problem.**

***Keywords* — Economic load dispatch, Optimization, GA, PSO, ABC.**

I. INTRODUCTION

The increasing energy demand and decreasing energy resources have necessitated the optimum use of available resources. Economic dispatch is optimization scheme intends to find the generation outputs that minimize the total operating cost while satisfying several unit and system constraints. Traditional economic dispatch methods require the generator cost curve to be continuous. Hence the operating cost function for each generator has been approximately represented by a quadratic function and the effect of valve-point loading was ignored. Due to physical limitations of power plant apparatus generating unit may have prohibited operating zones between their minimum and maximum operating power outputs. Economic-emission load dispatch problem treats economy and emission as competing objective for optimal dispatch which needs some form of conflict resolution to arrive at a final decision. Various optimization techniques have been proposed by many researchers to deal with different kind of economic dispatch problems with varying degree of success. It is of great importance to solve this problem quickly and accurately as possible considering all kind of discontinuity in non-linear search space. Improvement in the scheduling technique of the committed units output can lead to significant cost saving. The conventional methods include the Newton Raphson, lambda iteration method, gradient-based method, etc. [1] whose time of computation increases exponentially with the size. Inorder to overcome the drawbacks of conventional methods, Artificial Intelligent (AI) techniques likes (GA) (Walter *et al.,* 1993), evolutionary programming (EP) (Yang *et al.,* 1996), particle swarm optimization (PSO) (Park *et al.,* 2005), differential evolution (DE) (Coelho *et al.,* 2006) , Artificial Bee Colony Algorithm (ABC) (Hemamalini *et al.,* 2008),Biogeography-Based optimization(BBO) (Bhattacharya *et al.,* 2010), Bacterial foraging-based optimization (BFBO) (Padmanabhan *et al.*,2011) ,Firefly Algorithm (FA) (Yang *et al.*2012) etc. Improved fast evolutionary programming algorithm has been successfully applied for solving the ELD problem (Choudhary *et al.* 1990; Lee *et al.* 1984). Other algorithms like Hybrid genetic/simulated-annealing approach (GA/SA) (Wong et al. 1994), Hybrid particle swarm optimization sequential quadratic programming (PSO-SQP) (Aruldoss *et al.,* 2004), Chaotic particle swarm optimization (CPSO) (Jiejin *et al.,* 2007), new particle swarm with local random search (NPSO-LRS) (Selvakumar *et al.,* 2007), Improved particle swarm optimization (Ning *et al.* 2007), Self-Organizing Hierarchical particle swarm optimization (SOH-PSO) (Chaturvedi *et al.* 2008), Bacterial foraging optimization nelder mead hybrid algorithm (BFONM) (Panigrahi *et al.,* 2008), improved coordination aggregated based PSO (ICA_PSO)(John *et al.,* 2009), quantum-inspired PSO (QPSO) (Meng *et al.,* 2010), and modified group search optimizer algorithm (MGSO) (Zare *et al.,* 2012) have been applied to solve the ELD problem. Simulated Annealing (SA) is a stochastic optimization approach inspired by the natural process of annealing related to thermodynamics proposed by (Kirkpatrick *et al.,* 1983). SA approach has been previously applied to solve ELD problem (Wong *et al.*1993), dynamic economic dispatch problem (Panigrahi *et al.,* 2007) for small large dimensional ELD problems with convex cost characteristics (Vishwakarma *et al.,* 2012) .In this paper the potential of simulated annealing approach has been tested for large dimensional ELD problem with non-convex cost characteristics. One of the test systems used is known be particularly difficult to optimize as it has multiple local minima (Sinha *et al.,* 2003).

II. LITERATURE REVIEW

A. Genetic algorithm

Genetic algorithm (GA) technique is successfully applied to ELD problem. GA technique is based on

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the principle of natural genetics and natural selection [2, 3]. One of the advantage of GA is using stochastic instead of deterministic rules to search a solution. Therefore global optimum of the problem can be approached with high probability [4] .In recent years, the interest in these algorithms is rising fast and provides robust and powerful adaptive search mechanisms. GA has an immense potential for applications in the power system and applied to solve problem such as ELD [5, 6], unit commitment, reactive power control, hydrothermal scheduling and distribution system planning. Therefore, global optimum of the problem can be approached with high probability.

To solve economic load dispatch, two of intelligent search methods are considered by *M. Anuj Gargeya et al*, namely, genetic algorithm and pattern search methods. Economic load dispatch solved for three typical test cases of 5 generator, 13-generator and 40-generator (Tai-power systems) cases. The outcomes shows that pattern search can found best cost but at the cost of more function evaluations than genetic algorithm [7].

Piyush Jain et al present an application of GA to determine the optimal loading of generator in power system where some of the unit have prohibited operating zones for 15 generator test case system. The result obtained using GA are compared with conventional method. The simulation result show that GA method is capable of obtaining optimum solution and show reliable convergence [8].

B. Particle Swarm Optimization

PSO was developed by Kennedy and Eberhart in 1995 motivated by social behaviour of organisms such as fish schooling and bird flocking [9]. It is a meta-heuristic algorithm for solving the non-linear and non-continuous optimization problems. The central idea of the classical PSO relies on the foraging activity of the swarm. Both the cognitive and social behaviour are the constituents of the foraging activity. PSO generates high quality solutions with less calculation time and faster convergence as compared to the other AI techniques [10, 11]. Unlike in GA, its velocity of particle is updated according to its previous best position of its companions. PSO rapidly finds a good local solution but get stuck to it for the rest of iterations [12].

Shubham Tiwari et al present a comprehensive survey of economic load dispatch using PSO for three unit test system and then for six unit generating system for without loss and with loss cases. He conclude that the Classical PSO method gives better result than the Genetic Algorithm method as the cost is reduced [13].

Hardiansyah et al presents an effective and reliable particle swarm optimization (PSO) technique for the economic load dispatch problem using standard 3-generator and 6-generator systems with and without consideration of transmission losses. He found the method reliable, efficient and suitable for practical applications [14].

C. Artificial Bee Colony

Artificial Bee Colony (ABC) is one of the most recently defined algorithms by Dervis Karaboga in 2005, motivated by the intelligent behavior of honeybees. ABC as an optimization tool provides a population based search procedure in which individuals called food positions are modified by the artificial bees with time and the bee's aim is to discover the places of food sources with high nectar amount and finally the one with the highest nectar.

Ganga Reddy Tankasala et al proposed a system for the optimization of fuel cost of coal fired generators in modern power system. They proposed ABC ELD and compared with the other AI techniques. The results show that ABC promises global minimum of the solution while others may land in local minimum [15].

S.Hemamalini et al proposed Artificial Bee Colony (ABC) algorithm for solving economic load dispatch (ELD) problems with valve-point effect. The effectiveness of this algorithm is demonstrated for test cases consisting of 3 and 40 generating units. The proposed algorithm is also used for solving the optimal power flow problem which is validated on IEEE 30-bus system with six generating units. The comparison of the results with other methods shows the superiority of the proposed method and its potential for solving non-smooth ED problems in a power system [16].

D. Shuffled Frog Leaping Algorithm

Shuffled Frog Leaping Algorithm (SFLA) is a heuristic search algorithm presented for the first time by Eusuff and Lansey in 2003. The main purpose of this algorithm is achieving a method to solve complicated optimization problems without any use of traditional mathematical optimization tools. In fact, the SFL algorithm is combination of "meme-based genetic algorithm or Memetic Algorithm" and "Particle Swarm Optimization (PSO)". This algorithm has been inspired from memetic evolution of a group of frogs when seeking for food.

Hamid Falaghi el at proposed a new optimization method based on modified shuffled frog leaping algorithm, for ELD, an important problem in

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production management and power system operation, the Efficiency and validation of which is demonstrated by comparing the simulation results in different test systems. These comparisons reveal the superiority and robustness of the proposed method [17].

Jadhav, H.T. el. at presented a craziness based shuffled frog leaping optimization algorithm to solve the economic load dispatch (ELD) problem for different types of cost functions considering wind power as a negative load. The results are compared with well-established optimization techniques by considering thirteen and forty unit test systems [18].

E. Interactive Artificial Bee Colony

In general, the ABC algorithm works well on finding the better solution of the object function. However, the original design of the onlooker bee's movement only considers the relation between the employed bee, which is selected by the roulette wheel selection, and the one selected randomly. Therefore, it is not strong enough to maximize the exploitation capacity. In order to overcome this defect enhanced Artificial Bee Colony (ABC) optimization algorithm is proposed. An enhanced Artificial Bee Colony (ABC) optimization algorithm, which is called the Interactive Artificial Bee Colony (IABC) optimization. The onlooker bee is designed to move straightly to the picked coordinate indicated by the employed bee and evaluates the fitness values near it in the original Artificial Bee Colony algorithm in order to reduce the computational complexity. Hence, the exploration capacity of the ABC is constrained in a zone. Based on the framework of the ABC, the IABC introduces the concept of universal gravitation into the consideration of the affection between employed bees and the onlooker bees. By assigning different values of the control parameter, the universal gravitation should be involved for the IABC when there are various quantities of employed bees and the single onlooker bee. Therefore, the exploration ability is redeemed about on average in the IABC [19].

III. CONCLUSION

Economic load dispatch in electric power sector is an important task, as it is required to supply the power at the minimum cost which aids in profit-making. As the efficiency of newly added generating units are more than the previous units the economic load dispatch as to be efficiently solved for minimizing the cost of the generated power. In comparison to conventional optimization techniques, PSO has given improved results. This paper summarized the work reported in literature in the field of economic dispatch using many algorithms, but still further improvement in algorithms are required.

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