Power Loss Minimization Techniques Using Particle Swarm Optimization & Genetic Algorithm (A Review)

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***Abstract*-This paper describes optimal power flow based on particle swarm optimization in which the power transmission loss function is used as the problem Particle swarm optimization (PSO) is well-known and widely accepted as a potential intelligent search methods for solving such a problem. Therefore, PSO-based optimal power flow is compared with genetic-based (GA-based) optimal power flow. For 30-bus IEEE power system are employed. The algorithms for PSO and GA are discussed in this paper for Loss Minimization of Transmission Systems by using either PSO or GA.**

Keywords: PSO, GA, IEEE-bus30, Power transmission loss.

I. INTRODUCTION

Optimal power flow is one of nonlinear constrained and occasionally combinatorial optimization problems of power systems. The various algorithms for solving such problems can be found in the literature. The optimal power flow problem has been developed continually since its introduction by Carpentier in 1962 [1]. It is useful to determine the goals of optimal power flow problems. The primary goal of a generic optimal power flow is to minimize the total production costs of the entire system to serve the load demand for a particular power system while maintaining the security of the system operation. The production costs of electrical power systems may depend on the situation, but in general they normally mean to the cost of generating power at each generating unit of power plants. This operation is subjected to keep each device in the power system within its desired operation range at steady-state. This will include maximum and minimum outputs for generators, maximum MVA flows of power transmission lines and transformers, as well as system bus voltages within specified ranges.

It has taken over decades to develop efficient algorithms for its solution because it is a very large, non-linear mathematical programming problem. Many different mathematical approaches have been applied for seeking its solution. The methods discussed in the literature use one of the following five methods [2]. They are i) lambda iteration method as found in economic dispatch problem solving, ii) gradient method, iii) Newton's method, iv) linear programming and v) interior point method. Apart from analytical approaches, there also exist heuristic search methods.

Heuristic search methods (e.g. simulated annealing [3], genetic algorithm [4], evolutionary programming [5], particle swarm optimization [6]-[9], etc) have been recently released for the optimal power flow problem. The genetic algorithm (GA) based solution methods are found to be most suitable because of their ability of simultaneous multidimensional search for optimal solution. They are well-known and widely used at the beginning period of solving the optimal power flow problems based on heuristic search methods. However, recent literatures show some deficiency of GA-based methods, newly developed heuristic approaches called particle swarm optimization (PSO) has been introduced [10]. This method combines social psychology principles and evolutionary computation to motivate the behavior of organisms such as fish schooling, bird flocking, etc. PSO has been discovered to have better convergence performances than GAs [11]. The PSO based method is based on a metaphor of social interaction. It searches a space by adjusting the trajectories of individual vectors, called 'particles' of a swarm, as they are conceptualized as moving as points in multidimensional space. The individual particles are drawn stochastically towards the positions of their own previous best performances and the best previous performance of the entire swarm.

This paper proposes an application of PSO to solve optimal power flow problems. The controllable system quantities are generator MW, controlled voltage magnitude, reactive power injection from reactive power sources and transformer tapping. The objective use herein is to minimize the power transmission loss by optimizing the control variables within their limits. Therefore, no violation on other quantities (e.g. MVA flow of transmission lines, load bus voltage magnitude, generator MVAR) occurs in normal system operating conditions. The proposed PSO-based method has been tested on a six-bus test system [12] and compared with the GA-based method.

In this paper PSO based power loss minimization is compared with GA method. Power loss minimization for IEEE Bus 30 system is being implemented by using PSO with TCSC placement on a transmission line.

A. Genetic Algorithm (GA)

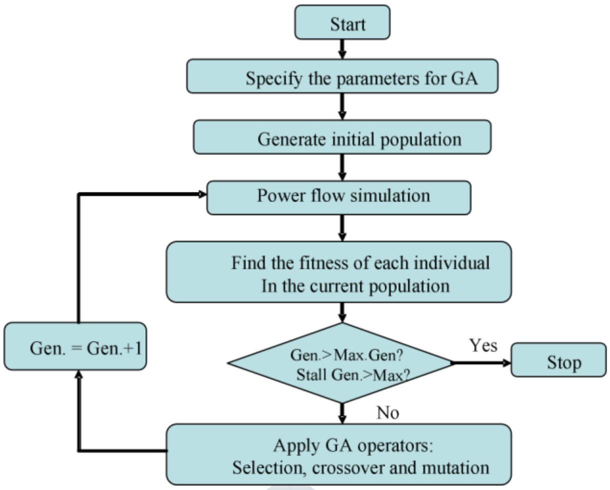

Figure. 1. Flowchart of the GA procedure

There exist many different approaches to adjust the motor parameters. The GA is well-known [14] there exist a hundred of works employing the GA technique to identify system parameters in various forms. The GA is a stochastic search technique that leads a set of population in solution space evolved using the principles of genetic evolution and natural selection, called genetic operators e.g. crossover, mutation, etc. With successive updating new generation, a set of updated solutions gradually converges to the real solution. Because the GA is very popular and widely used in most research areas where an intelligent search technique is applied, it can be summarized briefly as shown in the flowchart of Fig. 1[15].

In this paper, the GA is selected to build up an algorithm to solve optimal power flow problems (all generation from available generating units). To reduce programming complication, the Genetic Algorithm (GADS TOOLBOX in MATLAB [16]) is employed to generate a set of initial random parameters. With the searching process, the parameters are adjusted to give the best result.

B.Particle Swarm Optimization (PSO)

Kennedy and Eberhart developed a particle swarm optimization algorithm based on the behavior of individuals (i.e., particles or agents) of a swarm [17]. Its roots are in zoologist's modeling of the movement of individuals (i.e., fish, birds, and insects) within a group. It has been noticed that members of the group seem to share information among them to lead to increased efficiency of the group. The particle swarm optimization algorithm searches in parallel using a group of individuals similar to other AI-based heuristic optimization techniques. Each individual corresponds to a candidate solution to the problem. Individuals in a swarm approach to the optimum through its present velocity, previous experience, and the experience of its neighbors. In a physical *n*-dimensional search space, the position and velocity of individual *i*are represented as the velocity vectors. Using these information individual *i* and its updated velocity can be modified under the following equations in the particle swarm optimization algorithm.

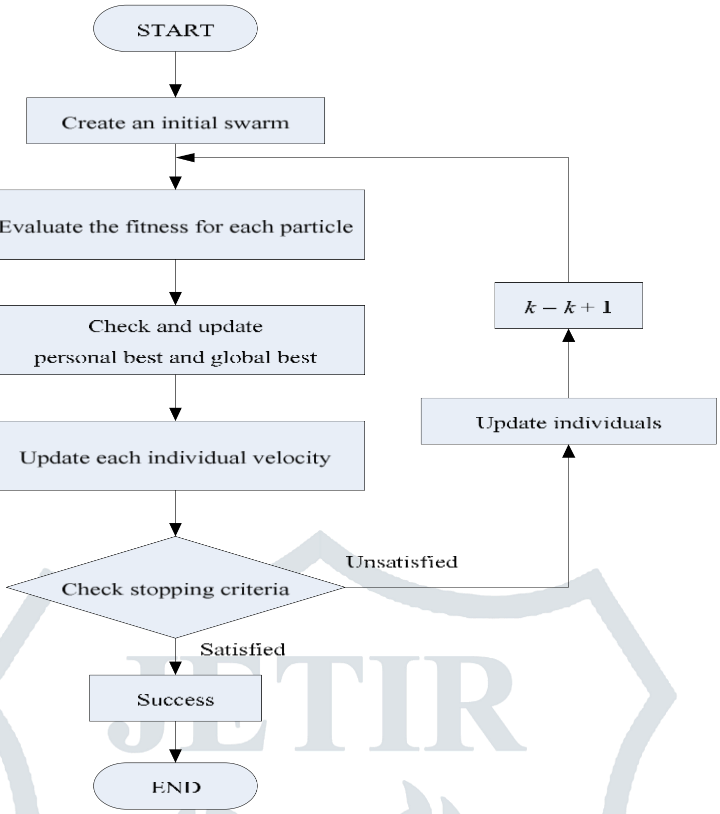

Figure 2. Flowchart of the PSO procedure

$$x_i(k+1) = x_i(k) + v_i(k+1) \qquad \text{(Eq.1)}$$

$$v_i(k+1) = v_i(k) + \alpha_i\left(x_{ilbest} - x_i(k)\right) + \beta_i\left(x^{gbest} - x_i(k)\right)$$

Where $x_i(k)$ is the individual i at iteration k

$v_i(k)$ is the updated velocity of individual i at iteration k α_i, β_i are uniformly random numbers between[0,1] x_i^{lbest} is the individual best of individual i x^{gbest} is the global best of the swarm The procedure of the particle swarm optimization can be summarized in the flow diagram of Fig. 2.

IV. CONCLUSIONS

Solution methods for solving optimal power flow problems with the power transmission loss objective are described in this paper. Some efficient search methods (quasi-Newton method of BFGS, genetic algorithm and particle swarm optimization) are studied. A 30-bus power system was considered as a test case for benchmarking. For Further implementation test data will be used with both the algorithms GA and PSO.

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