Chapter 12
Comparison of Artificial Intelligence-Based Solutions Applied to Economic Load Dispatch Problem

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ABSTRACT

The electric power system network is rapidly becoming more and more complex to meet energy requirements. With the development of integrated power systems, it becomes all the more necessary to operate the plant units most economically. More recently, soft computing techniques have received more attention and have been used in a number of successful and practical applications. In the chapter, artificial intelligence-based modern optimization techniques, the genetic algorithm (GA), particle swarm optimization (PSO), and differential evolution (DE), are used to solve the economic load dispatch related problems. In the chapter, the minimum cost is computed by adopting the genetic algorithm, PSO, and DE using the data from 15 generating units. Data has been taken from the published works containing loss coefficients are also given with the maximum-minimum power limits and cost function. All the techniques are implemented in MATLAB environment. Comparing the results obtained from GA, DE, and PSO-based method, better convergence was found in the PSO-based approach.

INTRODUCTION

With the development of integrated power systems, it has become even more necessary to operate the plant units with more better economy. The economic scheduling of generators aims to guarantee the optimum combination of generators connected to the system in order to supply the load demand. The

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economic dispatch (ED) problem involves unit commitment and the on-line economic dispatch. Unit commitment is the selection of units that will supply the anticipated load of the system over a required period of time at a minimum cost and provide a specified margin of the operating reserve. The function of the on-line economic dispatch is to distribute the load among the generating units actually paralleled with the system in such a manner so as to minimize the total cost of supplying the minute to minute requirement of the system.

The basic objective of economic load dispatch (ELD) of electric power generation is to schedule the committed generating unit outputs, so as to meet the load demand at minimum operating cost while satisfying all unit and system equality and inequality constraints.

Economic load dispatch is necessary to be implemented in order to determine the output of each generator so that the total generation cost may be minimized. The generator's output has to be varied within limits so as to meet a particular load demand and losses with minimum fuel cost. ELD thus emerges as one of the important areas to be considered in power system engineering. Solving economic dispatch problems normally involves the optimization process. Artificial intelligence-based solutions are being applied to solve the complex economic load dispatch problem. In the present chapter Genetic Algorithm, Differential Evaluation & Particle Swarm Optimization is implemented for the optimization of economic load dispatch, and the results are compared.

Incremental Fuel Cost

While designing electrical power generating stations and other systems, efforts are made to achieve the overall economy so that the per-unit cost of generation attains the lowest possible value. This will enable the supplier to supply electrical energy to its consumers at reasonable rates. The cost depends on the number of hours the plant is in operation or simply upon the number of units of electrical energy that is generated. Thus it can be said that the operating cost is approximately proportional to the units generated. The total annual cost incurred in the power generation can be represented by the expression:

$$C_i (P_i (t)) = \Sigma(a_i P_i^2 + b_i P_i + c_i) \ (i=1,2,...,Ng) \quad (1)$$

where C_t = total operating cost

$C_i (P_i (t))$ = individual gen. production cost in terms of real power output Pi at time t

a_i, b_i, c_i is cost coefficients

The factors influencing power generation at minimum cost are the operating efficiencies of the generators, the fuel cost, and the transmission losses. The problem is to determine the generation of different plants such that the total operating cost is minimum. The operating cost plays an important role in the economic scheduling. The cost of fuel used for the economics of power generation is specified by the input-output curve of a generating unit. The input to the thermal plant is generally measured in BTU/hr and the output is measured in MW. A simplified input-output curve of the thermal unit known as heat- rate-curve is shown in Figure 1(a). Converting the ordinate of heat-rate-curve from BTU/hr to Rs/hr. results will compile the fuel- cost- curve shown in Figure 1(b).