ECONOMIC LOAD DISPATCH CONTAINING LOSS COEFFICIENT

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Abstract - ***The main focus of this research work is on solving the Economic Load Dispatch problem in order to operate an electric thermal power station within estimated load demand limits. The major purpose of economic load dispatch is to maintain the balance between the total generated energy and total energy that is delivered to the load by reducing the fuel cost and transmission loss. The economic load dispatch is achieved by taking in account the various equality and inequality constraints.***

Genetic Algorithm is adopted to attain the solution of Economic Load Dispatch problem. Genetic Algorithm is employed to minimize the objective function. This technique provides accurate and feasible solution within reasonable computational time. Genetic Algorithm is implemented in MAT LAB software. On the basis of GA, programming is done to obtain the desire solution for load dispatch. The effectiveness of the developed program is tested for six generator system. It has been found that GA is giving more accurate and better results than Lambda Iteration Method. GA proves itself as fast algorithm that find out optimum solution to minimize the total generation cost of thermal power plant while meeting the total load demand plus transmission losses within the generation limits. The Economic Load Dispatch problem has been solved successfully with the help of Genetic Algorithm.

Key Words: *Economic Load Dispatch; Genetic Algorithm; Lambda Iteration Method; Fuel cost.*

1. INTRODUCTION

The major purpose of power system operation and control is Economic load dispatch. In order to operate an electric power structure approach most economically within its security limits, Economic load demand is one of the best approach to schedule the generator output over a confirmed period of time with estimated load demands. To minimize the cost of operation Economic load dispatch is the efficient approach which is the process of allocating the indispensable load demand between the accessible generating units. The chief goal of economic load is to transmit the electrical energy from the generating stations to the customers economically. To achieve this goal the electricity must be generated at the lowest cost without any loss.

Economic dispatch is a strategy which tries to maintain the balance between the total generated energy and the total energy that is delivered to the load by reducing the fuel cost and transmission loss.

2. FORMULATION OF ELD PROBLEM

The economic load dispatch problem relates to the perfect power generation scheduling of approachable generators in order to minimize the total cost of generation and at the same time it also satisfies an equality and inequality constraints. The economic dispatch problem also defines the generation extent of each plant, so that the complete generation cost and transmission cost is minimized for an authorized load. In order to minimize the total cost of generator, the equality and inequality constraints should be satisfied. The equality constraint is satisfied when the total power that is generated at the generating station must be equal to the total power that is delivered to the customers plus losses that occur at the time of transmission. The inequality constraint is satisfied when the output of the each unit of generation must be in between its minimum and maximum limits. Specialized computer software is developed to solve the problem of economic load dispatch as it provide optimum values at which the cost of generation is minimized and it also satisfy different equality and inequality constraints. After

that the result of such computer program is implemented into practical model in order to minimize the total cost of generation.

From the literature review it is clear that several already existing techniques faced difficulty in solving Economic Load Dispatch problem. In this present work, this difficulty is eliminated by using genetic algorithm. Genetic algorithm becomes more popular for optimization operations because of its productivity and efficiency.

2.1 Fuel Cost Function

The most simplified fuel cost function of each generator can be show in the given quadratic equation.

$$F_T(Pi) = \sum_{i=1}^{N}\left(a_i + b_iP_i + c_iP_i^2\right) \text{ Rs/h} \qquad (2.1)$$

Where

P_i is the output power of the i^{th} power plant.

a_i, b_i, , c_i, are the cost coefficients of i^{th} generating units.

F is the total fuel cost.

2.2 Equality Constraints

In order to create a balance between supply and demand, the total generated power should be equal to total system demand plus network transmission losses. Therefore, equality constraint can be stated as:

$$\sum_{i=1}^{N} P_i = P_D + P_L \qquad (2.2)$$

Where PD = Total power demand in MW.
P_i = Real power generation by i^{th} generator in MW.
P_L = Transmission losses in the system in MW.
N = Total number of generators.

The loss formula can be written as

$$P_L = \sum_{i=1}^{N}\sum_{j=1}^{N} P_iB_{ij}P_j \qquad (2.3)$$

Where P_i and P_j are source loadings, B_{ij} is the transmission loss coefficient.

2.3 Inequality Constraints

The generating output of each unit should be between its maximum and minimum limits i.e. the following inequality constraint should be satisfied for each generating unit.

$$P_i \min \leq P_i \leq P_i \max \qquad (2.4)$$

Where P_i min, P_i max are the minimum and maximum output of i^{th} generator.

3. GENETIC ALGORITHM

The main approach used in evolutionary process is recognized as genetic algorithm. Genetic algorithms are evolved by Goldberg that was influenced by Darwin's theory regarding evolution.

Darwin's evolutionary theory declares that the existence of creature is influenced from the prescription "the strongest species that survives". He also revealed that the continuation of life of living being can be retained by the process of reproduction, crossover and mutation. This process is also implemented to search the result of several other problems. The result of above declared process is also known as chromosome. Population is basically the cluster of different chromosome which retain any value like binary code, special symbols etc. These can be evaluated for the acceptability of the result produced by the Genetic Algorithm.

Genetic algorithm has been employed to handle the situations which are difficult to solve. One of the examples of such a problem is NP-hard problems. Genetic algorithms are very straightforward and not much difficult to handle as during the implementation of GA, generate a new chromosome in order to solve the problem. Computational time of GA is one of the biggest problem of genetic algorithm. The computational speed of the genetic algorithm is slower than the remaining methods. But in these days with the help of modern computers computational time is not so much considerable problem.

Chromosomes are the essential element of genetic algorithm. From the number of chromosomes the

solutions are extracted which are used to create a new chromosomes. The main role of the process of extracting a solution from the previous population is that there is a perception for getting a better population.

Selection of the population that is recommended for the creation of new population is based on the fitness percentage of the initial population. The best fit solution attains high probability for the reproduction process. The repetition of the whole process is done to find the best result.

3.1 Search Space

When we are observing for some solution, which will be the best in the middle of others solutions for solving some problem then it is recognized as a location where all the economical results are placed in the middle of the other results. Such a location is considered as search space. Example of search space is shown in fig. 1. At this location each spot is a representative of an economical result. This economical result is recognized by some quantity. Searching for result is equivalent to searching for the best value which is either minimum or maximum.

At the time of searching of a result search space is located then after that as the procedure of finding solution continues we are generating other points from it.

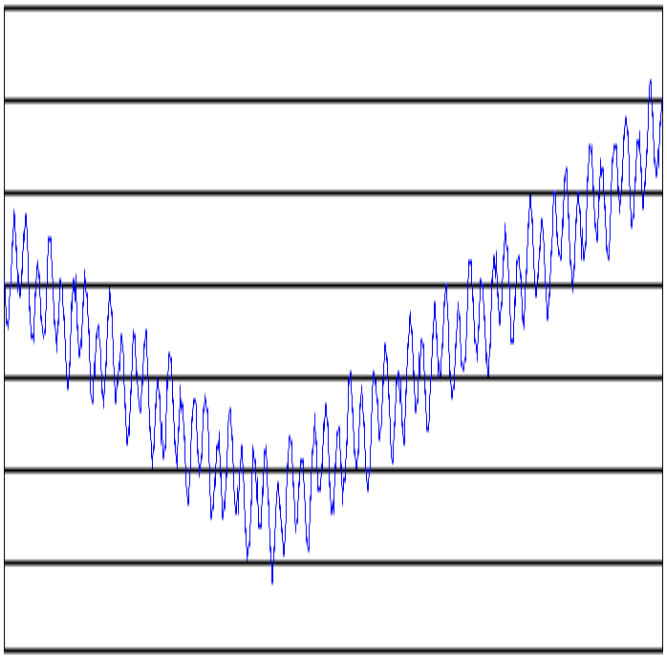


Fig -1: Search Space

At this location it is very hard to find the result because there is no previous knowledge of the starting point that provide information about where to look for the result. So the method of search space for locating the result is very is very complicated.

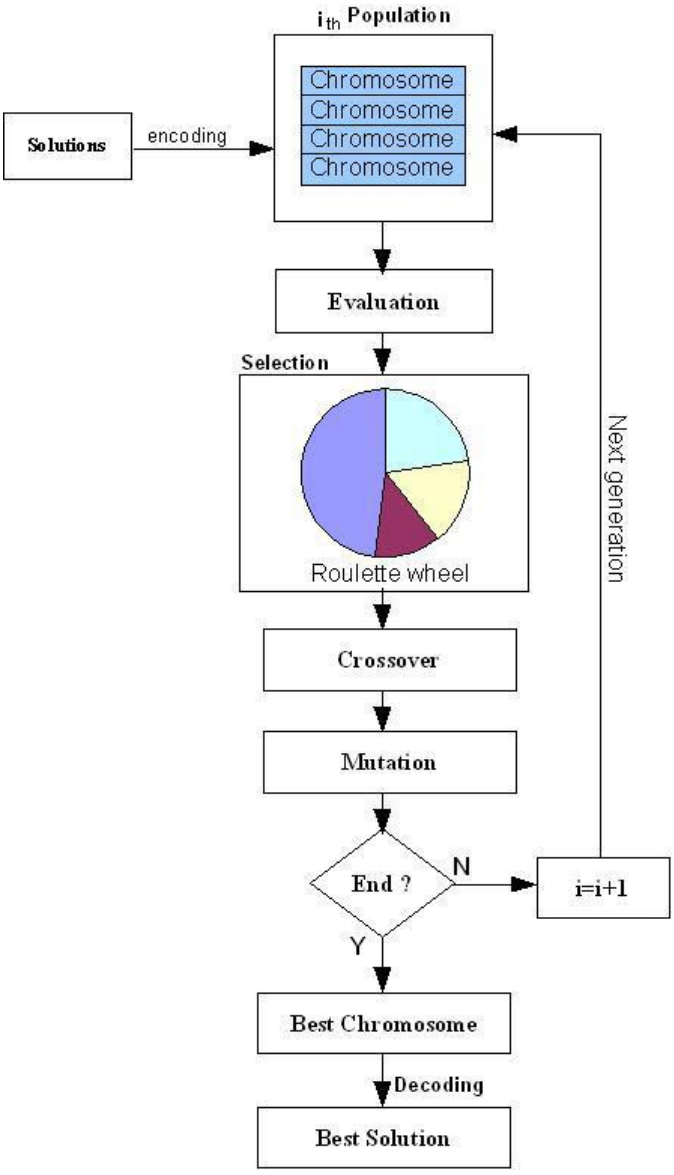


Fig -2: Flow chart of Genetic Algorithm

3. RESULT AND DISCUSSIONS

The solution of ELD after the implementation of GA approach is considered. The advanced algorithm for ELD problem based on GA has been discussed. MATLAB is used

to implement the program. The main purpose of using GA is to reduce the generation cost of power plant. The performance is evaluated by considering losses using six generator experimentation systems, whose input data are given in Table 1.

TABLE -1: Specifications of Experimentation

Unit	a_i	b_i	c_i	P_i min	P_i max
1	0.007	7	240	100	500
2	0.0095	10	200	50	200
3	0.009	8.5	220	80	300
4	0.009	11	200	50	150
5	0.008	10.5	220	50	200
6	0.0075	12	120	50	120

SIX-GENERATOR SYSTEM

The cost function is:

f = F1 + F2 + F3 + F4 + F5 + F6

The six generating units are having different characteristics. The cost functions of each unit are given by the following equations respectively:

F1 = 0.007 P12 + 7 P1 + 240

F2 = 0.0095 P22 + 10P2 + 200

F3 = 0.009 P32 + 8.5 P3 + 220

F4 = 0.009 P42 + 11 P4 + 200

F5 = 0.008 P52 + 10.5 P5 + 220

F6 = 0.0075 P62 + 12 P6 + 120

The operating ranges of the respective generating units are:

100 MW ≤ P1 ≤ 500 MW

50 MW≤ P2 ≤ 200 MW

80 MW ≤ P3 ≤ 300 MW

50 MW ≤ P4 ≤ 150 MW

50 MW ≤ P5 ≤ 200 MW

50 MW ≤ P6 ≤ 120 MW

Power Demand for this problem is taken as, Pd = 700 MW

Bij=1e-4*[0.14 0.17 0.15 0.19 0.26 0.22

0.17 0.6 0.13 0.16 0.15 0.2

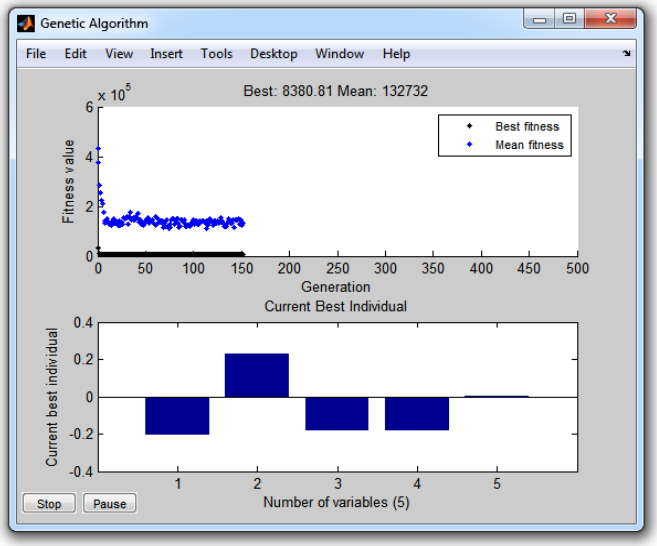
0.15 0.13 0.65 0.17 0.24 0.19

0.19 0.16 0.17 0.71 0.3 0.25

0.26 0.15 0.24 0.3 0.69 0.32

0.22 0.2 0.19 0.25 0.32 0.85];

RESULT



Optimization terminated: average change in the fitness value less than options. Tol Fun.

F =

8.3808e+03

P1 =

304.0544 80.7068 130.2837 68.5099 77.4077 50.0661

Pl =

11.0287

3. CONCLUSION

The present work relates to the implementation of Genetic Algorithm in order to find the optimum result of load dispatch issue. The experimental success of GA for the solution of ELD problem has made them an exceptionally distinctive optimization approach. The operation of this model is based on the correct selection of GA approach, fitness function and the method which is used for the presentation of the problem.

The success of developed program is evaluated for six generator systems. It has been observed that GA is providing more accurate and effective results with fast convergence characteristics than LIM. With the huge change in load with respect to time, it is not possible to serve the load dispatch for every load demand because there is no such technique that finds out the optimum solution of economic load dispatches. This is place where GA plays an important role for providing optimum solution in few seconds. By providing better results than Lambda Iteration method, GA proves itself as fast algorithm that find out optimum generation of both operating cost and transmission losses of the power system.

In this research work, the issue of economic load dispatch has been resolved successfully with the implementation of GA. The experimental conclusion provides the minimum operating cost. GA produces more efficient results as compare to other methods. It was concluded that GA revolution is more capable and effectual to provide the solution for the problem of economic power dispatch.

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