

Economic Load Dispatch by Genetic Algorithm in Power System

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Abstract- This paper presents the application of Genetic algorithm (GA) to solve the Economic Load Dispatch problem of the power system. The ascendancy of the introduced algorithm has been demonstrated on two different test systems considering the transmission losses. Economic Load Dispatch (ELD) is one of the major optimization problems dealing with the modern power systems. ELD determines the electrical power to be generated by the committed generating units in a power system so that the total generation cost of the system is minimized, while satisfactory the load demand cumulatively. The objective is to minimize the total generation fuel cost and maintain the power flows within the safety limits. For each case of optimization in genetic algorithm (GA) there are a large number of possible encodings. The use of real valued representation in the GA has a number of advantages in numerical function optimization over binary encoding. The efficiency of the GA is increased as there is no need to convert chromosomes to the binary type, less memory is required, and there is greater freedom to use different genetic operators. The introduced techniques develop the quality of the solution and speeds of convergence of the algorithm. The Coding are written and executed the values are plotted in graph for different values.

Index Terms- Economic load dispatch (ELD), genetic algorithm (GA), fuel cost.

1. INTRODUCTION

Economic load dispatch (ELD) is one of the most important problems to be solved for the economic operation of a power system. Economic load dispatch is to define the production level of each plant so that the cost of fuel is reduced for the prescribed schedule of load. To solve ELD problem some conventional methods are used. Lagrangian multiplier method was introduced to solve the ELD problem. Economic load dispatch (ELD) problem using classical method like Newton Raphson (NR) method, Approximate Newton Raphson (ANR) method.

Genetic algorithm (GA) technique is successfully applied to ELD case. Genetic Algorithm technique is based on the theory of natural genetics and natural selection. One of the advantage of GA is using stochastic instead of deterministic rules to search an extrication. Therefore global optimal of the problem can be approached with possibility high. In modern years, the interest in these algorithms is increase fast and provides robust and adaptive search mechanisms. GA has a large potential for applications in the power system and applied to solve problem such as ELD, unit commitment, reactive power control, hydrothermal scheduling and distribution system planning. So, global optimal of the issue can be approached with possibility high. Another attractive

property of GA is it searches for many optimum points in parallel. The efficient and optimum economic operation and planning of electric power generation systems have always occupied an important position in electric power industry. The main component of power system is transmission lines, distribution systems and generating stations. The economic scheduling based on the actual production cost that includes labor charge, cost of fuel (coal, nuclear material, oil, water etc) and the charges of other accessories and maintenance. The basic economic dispatch problem is to minimize the total generation cost among the committed units satisfying all unit and system equality and inequality constraints. Traditional optimization Techniques such as the, gradient Method, the linear programming method and Newton's Method are used to solve the ELD problem. In our case, GA is used to solve the economic load dispatch problem under some non linear.

In recent years, one of the most promising research fields has been "Evolutionary Techniques (ET)", an area spend analogies with nature or social systems. Evolutionary techniques are search reputation within research community as design tools and problem solvers because of their versatility and ability to optimize in complex multimodal search spaces applied to non-differentiable objective functions.

Several popularity heuristic tools have developed in the last two decades that facilitate solving optimization problems that were previously difficult or impossible to solve.

The efficiency and the robustness of the proposed Genetic Algorithm are proved by test functions. Then the Genetic Algorithm with simulated non uniform arithmetic crossover, elitism and a non uniform mutation are applied to ELD problem.

2. OBJECTIVE

The economic dispatch problem, which is used to minimize the cost of production of real power, can generally be stated as follows:

$$\left[\text{Min} \sum_{i=1}^n F_i(P_i) \right] \quad (1)$$

Subject to:

$$\sum_{i=1}^n P_i = D + P_L \quad (2)$$

$$P_i^{\min} \leq P_i \leq P_i^{\max} \quad (3)$$

Where, generally, $F_i(P_i)$ is a quadratic curve:

$$F_i(P_i) = C_i + b_i P_i + a_i P_i^2 \quad (4)$$

Here:

a_i, b_i and c_i are the known coefficients;

n : number of generators;

P_i : real power generation;

D : real power load;

P_L : real losses.

F_i : fuel cost

3. GENETIC ALGORITHM

A genetic algorithm (or short GA) is a search technique used in computing to find true or approximate solutions to optimization problems. GA are classify as global search heuristics. GA is a special class of evolutionary algorithms that use techniques inspired by evolutionary biology such as genetic algorithm parameters. GA is well-known stochastic methods of global optimization based on the evolution theory of Darwin. They have successfully been applied in different real-world applications. GA was originally developed for solving unconstrained problems. Recently, many variants of GA have been developed for solving constrained nonlinear programming. The basic idea behind GA is to mathematically imitate the evolution process of

nature. Albeit binary representation is usually applied to power optimization problems, in this letter we use a Genetic Algorithm switch is a modified Genetic Algorithm employing real valued vectors for representation of the chromosomes. The use of original valued characterization in the Genetic Algorithm has a number of gains in numerical function optimization over binary encoding. The efficiency of the GA is increased as there is no need to convert chromosomes to the binary type, small memory is expected, there is no loss in exactitude by discretization to binary or different values, and there is greater freedom to use different genetic operators. The GA is adequate of solving the constraint ELD problem, explanatory the exact output power of all the generation units. In such a way, Genetic Algorithm minimizes the cost function of the descent units. To model the fuel costs of descent units, a piecewise quadratic function is used and B coefficient method is used to describe the transmission harm. The acceleration coefficients are adjusted intelligently and a novel algorithm is proposed for allocating the initial power values to the generation units. A new population is generated by the genetic operations selection, crossover and mutation. Parents are chosen by selection and new off springs are produced with crossover and mutation. All these manipulation comprise randomness. The success of the optimization process is improved by elitism where the best the old population are copied as such to the next population.

Genetic algorithms are resolution algorithms based on the mechanics of natural selection and naturalistic genetics. They attach survival of the fittest between string fabrication with structured yet randomized knowledge exchange to form a determination algorithm with few of man's efficiency in order to survival. In each generation, a new set of artificial strings is making by using bits and pieces from the fittest of the old; an occasional new part is used for nice scale. While randomized, genetic algorithms are no easy random walk, they efficiently exploit historical information to speculate on new research points with expected improved performance. Genetic algorithms are essentially derived from a simple model of population genetics. The three prime operators associated with the genetic algorithm are crossover, mutation and reproduction. Reproduction is a process by which individual strings are copied according to their fitness values. Duplication strings pursuance to their fitness values means that strings with higher values have a higher probability of contributing one or more offspring in the next generation. Crossover is an important component of genetic algorithms, taking two individuals and producing two new individuals as shown in Fig. 1.

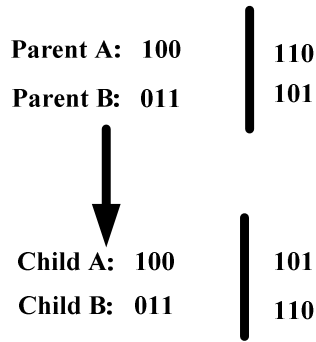


Fig.1. Diagram of simple crossover.

Although reproduction and crossover search and recombine existing chromosomes, they do not create any new genetic material in the population. Mutation is adequate of overcoming this shortcoming. It involves the transformation of one particular to manufacture a single new solution as shown in Fig. 2.

Child A: 100110



New Child A: 100010

Fig. 2. Binary mutation.

Fig. 3 shows the genetic algorithm flow chart used in this study.

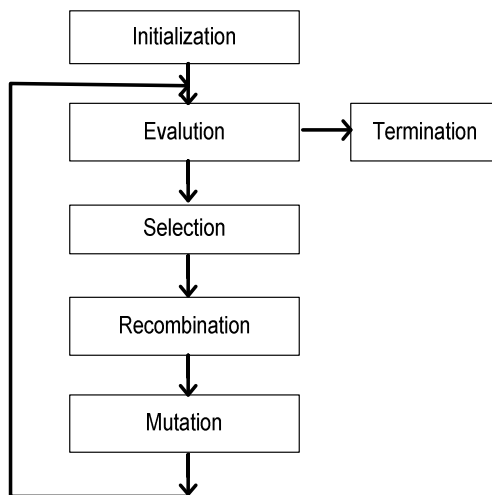


Fig. 3. General flow chart used in this study.

4. GENETIC ALGORITHM SOLUTION

The encoding and decoding techniques, coercible generation output calculation, and the fitness function are described in more detail below.

4.1. Encoding and decoding

In this paper, the proposed approach uses the λ equal system (equal incremental cost system) criterion as its basis. λ^{nm} is the normalized incremental cost system, where $0 \leq \lambda^{nm} \leq 1$. The advantage of using the λ system is that the number of bits of a chromosome will be entirely independent of the number of units. Ten bits, however, represent λ^{nm} . Fig. 4 shows the encoding diagram of λ^{nm} .

d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	d_9	d_{10}
x	x	x	x	x	x	x	x	x	x
2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}

Where $d_i \in \{0, 1\}$, $i = 1, 2, \dots, 10$.

Fig. 4. Encoding diagram of λ^{nm} .

The decoding of λ^{nm} can be expressed as follows:

$$\lambda^{nm} = \sum (d_i x 2^{-i}), \quad (5)$$

Where $d_i \in \{0, 1\}$, $i = 1, 2, \dots, 10$.

The relationship between the incremental cost value λ and the normalized incremental cost system λ^{nm} is

$$\lambda = \lambda_{\min} + \lambda^{nm} (\lambda_{\max} - \lambda_{\min}) \quad (6)$$

Where λ_{\min} and λ_{\max} represent the initially computed minimum and maximum values:

$$\lambda_{\min} = \min \left\{ \frac{dFi(pi, \min)}{dPi} \right\}$$

And (7)

$$\lambda_{\max} = \min \left\{ \frac{dFi(pi, \max)}{dPi} \right\}$$

4.2. Generation Output

If the Lagrange function methods conditions are applied to the constrained optimization, the economic dispatch problem can be reformulated as follows:

$$L(P, \lambda) = \sum_{i=1}^n Fi(P_i) + \lambda(D + P_L - \sum_{i=1}^n P_i) \quad (8)$$

which, after some rearrangement of terms, becomes

$$L(P, \lambda) = \sum_{i=1}^n Fi(P_i) - \lambda(\sum_{i=1}^n P_i - P_L) + \lambda(D) \quad (9)$$

$$PF_i (2a_i P_i + b_i) = \lambda \text{ for } P_{i, \min} \leq P_{i, \max} \quad (10)$$

$$PF_i (2a_i P_i + b_i) \leq \lambda \text{ for } P_i = P_{i, \max}$$

$$PF_i (2a_i P_i + b_i) \geq \lambda \text{ for } P_i = P_{i, \min}$$

where PF_i is the penalty factor of unit i , given by

$$PF_i = \frac{1}{1 - \frac{\partial PL}{\partial P_i}} \quad (11)$$

4.3. Fitness Function

The fitness function for the minimization problem is generally given as the inverse of the motive function. In this paper, the fitness function is given by the relation

$$Fit = \frac{1}{1 + \frac{1}{\sum Fi}} \quad (12)$$

4.4. Parameter Selection

The genetic algorithm has a number of parameters that must be selected. These include population size, Generation, Time Limit, and Stall Time Limit:

Population Size', 50,' Generations', 500,' Time Limit', 200,' Stall Time Limit', 100

5. MATLAB OUTPUT AND GRAPH

MATLAB is a advanced-level language and interactive atmosphere for numerical calculation, visualization, and programming. Using MATLAB, you can examine data, develop algorithms, and generate models and experiment. The language, tools, and manufacture-in math functions enable you to explore various approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java. It has since proceeded into anything much large, and it is used to implement numerical algorithms for a wide range of experiment. The basic language used is very identical

to standard linear algebra notation, but there are some extensions that will likely cause you some problems at first.

Optimal Economic Load Dispatch for Power Generation for three bus system Using Genetic Algorithm

F =

1.6000e+003

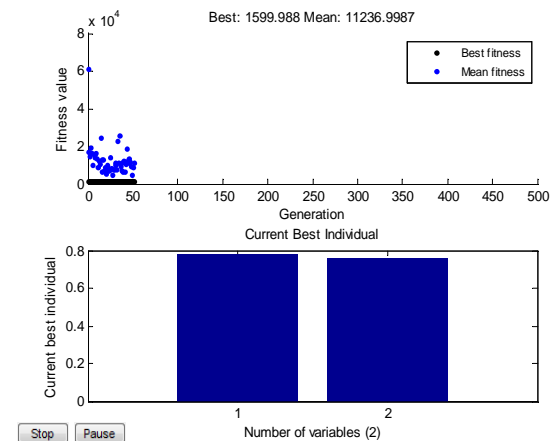
P1 =

32.9257 64.3833 55.3616

Pl =

2.6707

Elapsed time is 2.145056 seconds.



Optimal Economic Load Dispatch for Power Generation for six bus system Using Genetic Algorithm

F =

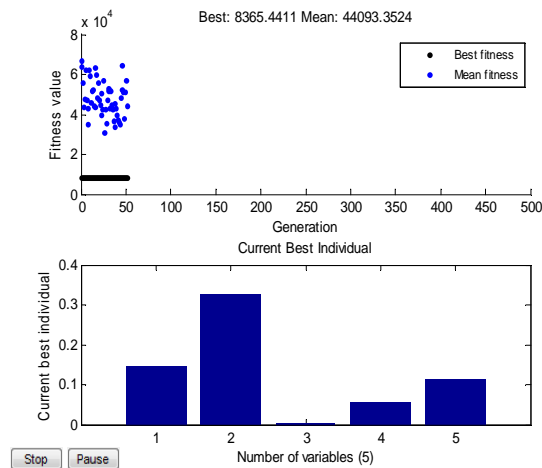
8.3654e+003

P1 =

320.0648 72.1385 151.7440 50.3333 58.6189
57.9479

Pl =

10.8474



6. CONCLUSION

In this paper, an approach based on a genetic algorithm has been successfully presented and applied to the generation cost in electric power network to obtain the optimum solution of Economic Load Dispatch (ELD). Operators are used in lagrangian to generate a set of solutions for this problem. Lagrangian method is most useful for large power systems, it lagrangian have well results and it is much faster and more effective than iterative method. Methods are compared for solving an economic dispatch problem with two generators. Test results have shown GA can provide highly optimal solutions and reduces the computation time than those with the iterative method. An advantage of the GA solution is the flexibility it provides in modeling both time dependent and coupling constants. Another advantage of the GA approach is the ease with which it can handle arbitrary kinds of constraints and objectives.

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REFERENCES

- [1] T.Govindaraj, and M.Vidhya. "Optimal Economic Dispatch for Power Generation Using Genetic Algorithm," International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering, vol.2, no. 1, pp. 808-814, Jan. 2014.
- [2] R. Ouiddir, M. Rahli, and L. Abdelhakem-Koridak. "Economic Dispatch using a Genetic Algorithm: Application To Western Algeria's Electrical Power Network," Journal Of Information Science And Engineering, vol.21, pp. 659-668, 2005.
- [3] Naveen Kumar, K.P. Singh Parmar, and Surender Dahiya, "A Genetic Algorithm Approach for the Solution of Economic Load Dispatch Problem," International Journal on Computer Science and Engineering (IJCSE), Vol. 4 No. 06 pp. 1063-1068, June 2012.
- [4] Tarek Bouktir, Linda Slimani, and M. Belkacemi. "A Genetic Algorithm for Solving the Optimal Power Flow Problem," Leonardo Journal of Sciences, no. 4, pp. 44-58. January-June 2004.
- [5] Bishnu Sahu, Avipsa Lall, Soumya Das, and T. Manoj Patra. "Economic Load Dispatch in Power System using Genetic Algorithm," International Journal of Computer Applications (0975 – 8887) Volume 67, No.7, pp.17- 22, April 2013.
- [6] Priyanka Roy, Umesh Kumar Tiwari, Vikas Singh, Md. Zeeshanullah, and A.Chakrabarti. "Genetic Algorithm Based Transmission Loss Constraint Economic Load Dispatch Solution Considering Valve Point Effect," International Conference on Electrical Engineering and Computer Science Engineering (ICEECS), pp. 9-13, 9 sep, 2012.
- [7] Dharamjit, and D.K.Tanti. "Load Flow Analysis on IEEE 30 bus System," International Journal of Scientific and Research Publications, vol. 2, no. 11, pp. 1-6, November 2012.
- [8] Sevugarathinam MUTHU VIJAYA PANDIAN, and Keppanagowder THANUSHKODI. "Considering transmission loss for an economic dispatch problem without valve-point loading using an EP-PSO Algorithm," Turk J Elec Eng & Comp Sci, vol. 20, no. 2, pp. 1259-1267, 2012.
- [9] G Kalidas Babu, and Rajesh Kumar Samala. "Network and Generator Constrained Economic Dispatch Using Real and Binary Coded Genetic Algorithms," G Kalidas Babu et al Int. Journal of Engineering Research and Applications, vol. 3, no. 5, pp. 1185-1192, sep-oct 2013.
- [10] BOMMIRANI.B, and THENMALARK. "Optimization Technique for the Economic Dispatch in Power System Operation," International Journal of Computer and Information Technology, vol. 2 no. 1 pp. 158-153, jan-2013.



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