Volume 2, No. 3, May-June 2011
ISSN No. 0976-5697
International Journal of Advanced Research in Computer Science
RESEARCH PAPER
Available Online at www.ijarcs.info

Economic Load Dispatch Using Genetic Algorithm

Jatin Garg*
M.Tech 2nd year
Department of Electrical and Electronics Engineering
Al-Falah, Dhauj
garg_kaithal@yahoo.co.in

Pooja Khatri
M.Tech, 2nd Year
Department of Electrical and Electronics Engineering
Al-Falah, Dhauj
poojakhatri.86@gmail.com

Aziz Ahmad
Department of Electrical and Electronics Engineering
Al-Falah, Dhauj
azizjmi98@gmail.com

Abstract: An efficient optimization procedure based on genetic algorithm is proposed for the solution of economic load dispatch (ELD) problem with continuous and non smooth/non convex cost function and with various constraints being considered. The effectiveness of the proposed algorithm has been demonstrated on different systems considering the transmission losses effect in thermal units. The proposed algorithm is equipped with an effective constraint handling technique, which eliminates the need for penalty parameters. Economic load dispatch is one of the optimization problems in power systems. This paper presents genetic algorithm for economic load dispatch and is expressed as one of the Lagrange function. The proposed GA may be applied to minimize the Lagrange functions with respect to the generator unit output. The effectiveness of the proposed method is illustrated in IEEE 5 bus systems**.**

Keywords: Genetic Algorithm, ELD, thermal units, optimization, GA

I. INTRODUCTION

Today as the demand for power is increasing day by day Economic Load Dispatch method plays an important role as it help to schedule power generator outputs with respect to the load demands and to operate a power system economically, so as to minimize the operation cost of the power system. To solve the economic load dispatch problem many techniques were proposed such as classical techniques, linear programming (LP), nonlinear programming (NLP), Quadratic Programming (QP), swarm optimization, evolutionary programming, tabu search, genetic algorithm, etc. In this work we have used genetic algorithm (GA) technique to solve economic load dispatch problem for IEEE 5 Bus System. Genetic algorithms are search algorithms based on the mechanics of natural selection and natural genetics they combine survival of the fittest among structures with a structured yet randomized information exchange to form a search algorithm with some of the innovative flair of human search.

II. GENETIC ALGORITHM:

A global optimization technique known as genetic algorithm has emerged as a candidate due to its flexibility and efficiency for many optimization applications. It is a stochastic searching algorithm. The method was developed by John Holland (1975). GA is categorized as global search heuristics. These are particular class of evolutionary algorithms that use techniques inspired by genetics such as inheritance, mutation, selection and crossover. GA is search algorithms based on mechanics of natural selection and natural genetics. They combine Darwin's theory of 'survival of the fittest' among string structures with a structured yet randomized information exchange to form a search algorithm with some of the innovative flair of human search. In every generation, a new set of artificial creatures (strings) is created using bits and pieces of the fittest of the old; an occasional new part is tried for good measure. Even though randomized, genetic algorithms are not simple walk algorithms. They efficiently exploit historical information to speculate on new search points with expected improved performance. The individuals in the population then go through a process of evolution. The advantages of the genetic algorithmic approach in terms of problem reduction, flexibility and solution methodology are also discussed. Some of the advantages and disadvantages with assumption are discussed which are used for solving our problem.

A. *Advantages of GA:*

Advantages of GA's are given below as discussed in

[a] Simple to understand and to implement, and early give a good near solution.
[b] It solves problems with multiple solutions.
[c] Since the genetic algorithm execution technique is not dependent on the error surface, we can solve multi-dimensional, non-differential, non-continuous, and even non-parametrical problems.
[d] Is well suited for parallel computers.
[e] Optimizes variables with extremely complex cost surfaces (they can jump out of a local minimum)

.

III. OUTLINE OF SIMPLE GENETIC ALGORITHM

Genetic algorithms (GA) were developed after original Work by Holland (1975). These consist of optimization Procedures based on principles inspired by natural evolution.

Given a problem for which a closed-form solution is unidentified, or impossible to obtain with classical methods, an initial randomly generated population of possible solution is created. Its characteristics are then used in an equivalent string of genes or chromosomes that will be later recombined with genes from other individuals. Each solution is assimilated to an individual, who is evaluated and classified in relation with its closeness to the best, yet still unknown, solution to the problem. It can be shown that, by using a Darwinian-inspired natural selection process, the method will gradually converge towards the best possible solution. As in a biological system submitted to external constraints, the fittest members of the initial population are given better chances of reproducing and transmitting part of their genetic heritage to the next generation.

A new population, or second generation, is then created by recombination of parental genes. It is expected that some members of this new population will have acquired the best characteristics of both parents and, being better adapted to the environmental conditions, will provide an improved solution to the problem. After it has replaced the original population, the new group is submitted to the same evaluation procedure, and later generates its own offspring's.

The process is repeated many times, until all members of a given generation share the same genetic heritage. From then on, there are virtually no differences between individuals. The members of these final generations, who are often quite different from their ancestors, possess genetic information that corresponds to the best solution to the optimization problem.

A. *Genetic Operators*

In this work, the following GA operators are used: The simple GA is one of the fundamental techniques. It is based on n the following routine:

(a) Coding

SGA has typical coding in binary. For example, the coding is directly used for 0-1 integer Program while real Variables are transformed in binary codes for problems with real numbers. In addition, there are several coding ways with alphabets and figures. In generally coding is to use more simplified coding .The complex coding is inclined to have convergence trouble.

(b) Generation of Populations

Populations are generated by random numbers. The larger population size doesn't provide better result and vice versa. So depending on problems we have to select the appropriate size carefully.

[c] Reproductions or Selection

Reproduction is usually first operator applied on a population. Reproduction selects good strings in a population and forms a mating pool. Reproduction operator is also known as the selection operator. There exist a number of reproduction operators in a GA literature, but the essential idea in all of them is that the above average strings are picked from the current population and their multiple copies are inserted in the mating pool in a probabilistic manner. The commonly used reproduction operator is the proportionate reproduction operator where a string is selected for the mating pool with a probability proportional to its fitness. Thus, the ith string in the population is selected with a probability proportional to its fitness value Fi. Since the population size is usually kept fixed in a simple GA, the sum of the probability of each string being selected for the mating pool must be one.

Therefore, the probability for selecting the ith string is where n is the population size. One way to implement this selection scheme is to imagine a roulette-wheel with its circumference marked for each string proportionate to the *n.* The roulette-wheel is spun n times, each time selecting an instance of the string chosen by the roulette-wheel pointer.

(d)Tournament selection

The selection operator is intended to improve the average quality of the population by giving individuals of higher fitness a higher probability to be copied into the next generation. Tournament selection works as choose two individuals randomly from the population and copy the best individual into the intermediate population.

(e)Linear crossover

The most common solution is something called crossover, and while there are many different kinds of crossover, the most common type is single point crossover. In single point crossover, choose a locus at which we swap the remaining alleles from on parent to the other. Crossover does not always occur, however. Sometimes, based on a set probability, no crossover occurs and the parents are copied directly to the new population. The probability of crossover occurring is usually 60% to 70%.

(f) Mutation

After selection and crossover, now have a new population full of individuals. Some are directly copied, and others are produced by crossover. In order to ensure that the Individuals are not all exactly the same, we allow for a small chance of mutation. You loop through all the alleles of all the individuals, and if that allele is selected for mutation, you can either change it by a small amount or replace it with a new value.

The probability of mutation is usually between 1 and 2 tenths of a percent. Mutation is fairly simple. Just change the selected alleles based on what is necessary and move on. Mutation is, however, vital to ensuring genetic diversity within the population Mutation operator plays a secondary role. It allows new genetic patterns to be formed, thus improving the search method.

Occasionally, it protects some useful genetic material loss. During the process, a rate of mutation, **pm**, determines the possibility of mutating one of the design variables.

IV. ECONOMIC LOAD DISPATCH PROBLEM FORMULATION

Table 1: - Line Data or Impedance Data (5 Bus System)

LINE DESIGNATION	*R (p.u.)	*X (p.u.)	LINE CHARGING
1-2	0.10	0.4	0.0
1-4	0.15	0.6	0.0
1-5	0.05	0.2	0.0
2-3	0.05	0.2	0.0
2-4	0.10	0.4	0.0
3-5	0.05	0.2	0.0

* The impedances are based on MVA as 100.

Table 2: - Bus Data or Operating Conditions (5 Bus System)

*Slack Bus

Table 3: - Regulated Bus Data (5 Bus System)

Bus No.	Voltage Magnitude	Minimum Mvar Capability	Maximum Mvar Capability	Minimum Mw Capability	Maximum Mw Capability
1	1.02	0.0	60	30	120
3	1.04	0.0	60	30	120

The nodal load voltage inequality constraints are 0.9<= V_i <=1.05

Cost Characteristics

$C_1 = 50\ P_1$^2 + 351 P_1 + 44.4 \$/hr

$C_3 = 50\ P_3$^2 + 389 P_3 + 40.6 \$/hr

Here for the 5 bus system we have taken, the total load demand of the system is 160 MW. Maximum and minimum active power constraint on the generator bus for the given system is 120 MW and 30 MW respectively. Voltage magnitude constraint for generator bus 3 is 1.04

V. LOAD FLOW PROBLEM FORMULATION IN GA

The Load Flow problem has been formulated as a non linear function and GA has been used to solve this optimization problem. The objective function has been taken as the sum of squares of powers mismatch and voltage mismatch. The load flow solution is obtained when the objective function tends to be minimum (ideally zero). The objective function is as follows:

$$F = \sum_{i=1}^{N} \Delta Pi^{\wedge 2} + \sum_{i=1}^{NG} \Delta Q\ i^{\wedge 2} + \sum_{i=1}^{NG} \Delta Vi^{\wedge 2}$$

Where N= Total no. of buses.

NG= No. of Generator buses.

A. *Problem formulation for IEEE 5-bus system*

Minimize F(x) = - (ΔP^2 + ΔQ^2 + ΔV^2)

Such that Inequality constraints:

0.3≤ P1 ≤ 1.2 0≤Q1≤0.6 0.3≤ P3≤ 1.2 0≤Q3≤0.6

0.9≤Vi≤1.1 -20≤□i≤20

& equality constraint:

V3=1.04

Where $\Delta P = P_{sp} - P_{cal}$

$\Delta Q = Q_{sp} - Q_{cal}$

$$P_{cal} = \sum_1^n \{ep(eqGpq + fqBpq) + fp(fqGpq - eqBpq)\}$$

$$Q_{cal} = \sum_1^n \{fp(eqGpq + fqBpq) - ep(fqGpq - eqBpq)\}$$

P_{sp}= Specified value of active powers.

Q_{sp}= Specified value of reactive powers

VI. RESULTS

In this section GA goes through the ELD problem and the result will be compared with traditional techniques. The proposed method was applied to IEEE5 bus system.

For solving the ELD problem of a IEEE 5 bus system, the cost coefficient data's and generator operating limits are shown in table 1 and 2 respectively. Then the economic dispatch with secure constraints was performed. Simulations are done in TOOLBOX of MATLAB®**7** version. The load low problems are performed using Fast Decoupled method in MATPOER®3.2.

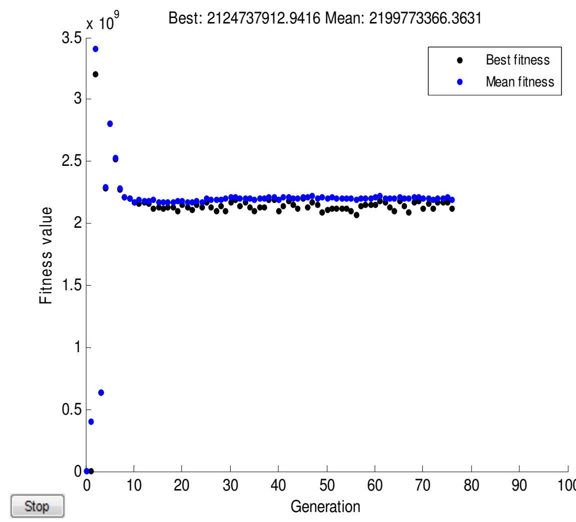

Figure.1 IEEE 5 bus system response

Based on the work carried out in this thesis following conclusion can be made:

A. In this work Genetic Algorithm has been studied and analyzed its parameters like population size, Initial population, Initial Range, Stopping conditions etc in getting the optimal points and final generation calculated for plotting the graphs. We had also noticed that we are not been able to obtain the results of all the population after each generation or iteration. We were only being able to get best fitness value after every generation.
B. Minimization of both constrained and unconstrained functions has been done using Genetic Algorithm to find global optimum point. We can also performe minimization of Multiobjective functions using GA for both constrained and unconstrained using the Weighted Method technique.
C. We have used the above gathered knowledge in the formulation and implementation of solution methods to obtain the optimum solution of Economic Load Dispatch problem using Genetic Algorithm is carried out.

The effectiveness of the developed program is tested for IEEE 5BUS systems.

VII. REFRENCES

[1] Kuhn, H.W., Tucker, A.W. 'Nonlinear Programming', Proc. Of Second Berkley Symposium on mathematical Statistics and Probability, edited by J.Neyman, University of California Press, Berkeley, California, 1951, pp.481-492.

[2] Gass, S., And Satty, T., ' The Computational Algorithm for the Parametric Objective Function,' Naval Res. Logist. Quart., Vol. 2, No.39, 1955.

[3] Steveson,W.D., ' Elements Of Power System Analysis', McGraw Hill Book Co., 1962.

[4] Marglin, S., 'Public Investment Criteria,' MIT Press, Cambridge, Mass., 1967.

[5] Cohon, J. Marks, D., 'Multiobjective Screening Models and Water Resources Investment', Water Resources Res, Vol.9, No.826, 1973 .

[6] Cohon, J.L. Marks, D.H., 'A Review and Evaluation of multiobjective programming techniques,' Water Resource Research, April, Vol. 11, 1975, pp.208-220.

[7] Jared L. Cohon, Multi-objective Programming and Planning, Academic Press New York, 1978.

[8] J.Nanda, D.P.Kothari, K.S.Lingamurthy "Economic-Emission Load Dispatch through Goal Programming Techniques" by. IEEE Transactions on Energy Conversion, Vol. 3, No. 1, March 1988, pp.26-32.

[9] D. E. Goldberg, Genetic Algorithm in Search, Optimization and Machine Learning, Addison Wisely, 1989.

[10] Wadhwa, C.L, Jain,N.K, ' Multiple Objective Optimal Load Flow: a new perspective', IEE Proc.c, Vol.137, No.1, Jan 1990, PP 11-18.

[11] Miller, J.A.; Potter, W.D.; Gandham, R.V.; Lapena, C.N "An evaluation of local improvement operators for genetic algorithms"; Systems, Man and Cybernetics, IEEE Transactions on Volume 23, Issue 5, Sept.-Oct. 1993, pp.1340 - 1351 Digital Object Identifier 10.1109/21.260665.

[12] Nagia, Uma, Jain, N.K, Wadhwa, C.L, ' Multiobjective Load Flow Studies Through Maximisation of Minimum Relative Attainments', Vol 77, Nov 1996, pp.154-159.

[13] Chaiyaratana, N.; Zalzala, A.M.S "Recent developments in evolutionary and genetic algorithms: theory and applications"; Genetic Algorithms in Engineering Systems: Innovations and Applications, 1997. GALESIA 97. Second International Conference On (Conf. Publ. No. 446) 2-4 Sept. 1997, pp.270 – 277.

[14] A.M.S Zalzala & P.J. Fleming, genetic algorithms in engineering systems, Institution of Electrical Engineering, 1997.

[15] Melane Mitchell, an Introduction to Genetic Algorithm, Mit Press, 1998.

[16] Hadi Saadat, Power System Analysis, Mcgraw Hill, 2002.

[17] Ling, S.H.; Lam, H.K.; Leung, F.H.F.; Lee, Y.S "Improved genetic algorithm for economic load dispatch with valve-point loadings"; Industrial Electronics Society, 2003. IECON '03. The 29th Annual Conference of the IEEE Volume 1, 2-6 Nov. 2003, pp.442 - 447 vol.1 Digital Object Identifier 10.1109/IECON.2003.1280021.

[18] D.P Kothari and J.S Dhillon, Power System Optimization, Prentice Hall of India, 2006.

[19] S.S.Rao, Optimization Theory and Application by, Wiley, 2007.

[20] Ling, S.H.; Lu, H.H.C.; Chan, K.Y.; Ki, S.K, "Economic load dispatch: A new hybrid particle swarm optimization approach"; Universities Power Engineering Conference, 2007. AUPEC 2007. Australasian 9-12 Dec. 2007 pp.1 - 8 Digital Object Identifier 10.1109/AUPEC.2007.4548052.

[21] Michael Affenzeller , Stefan Wanger , Stepahan Winkler & Andreas Bahem ; Genetic Algorithm and Genetic Programming, Crc Press, 2009.

[22] C.L.Wadhwa, Electrical Power System, New Age International Publisher Ltd, 2009.