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Solution of Economic Dispatch Problem through Genetic Algorithm

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Abstract

To provide high - quality and reliable power supply at the lowest possible cost while operating to meet the limits and constraints imposed on the generating units is the main objective of electric power utilities. The economic load dispatch (ELD) is essential in the operation of power system. A global optimization technique 'Genetic Algorithm' (GA) is presented. The algorithm utilizes information of candidate solutions to evaluate their optimality. As a case study, this technique is applied to the solution of the economic dispatch (ED) problem of thermal generating units. A smooth quadratic function is used to represent the fuel cost of each generating unit. The B-coefficient method is used to model the transmission losses. Using two different methods "Lambda-Iteration method" and "Genetic Algorithm method" the cost function is derived at different loads. These two different methods proposed to reduce the generation cost using data of different units. GA has been identified as more suitable than LI. It is free from nature of graph of the cost function. It exhibits very good performance on the majority of the problems applied.

Key words: ELD, GA, ED, LI

INTRODUCTION

The economic load dispatch (ELD) is an important function in modern power system like unit commitment, Load Forecasting etc. The operation of generation facilities is to produce energy at the lowest cost to reliably serve consumer, recognizing any operational limits of generation and transmission facilities. Most electric power systems dispatch their own generating units and their own purchased power in a way that may be said to meet this definition. Meaning of "to dispatch" is 'to order to generate (more) energy'. The main aim of Economic Dispatch Problem is : to minimize the total cost of generating real power i.e; 'Production Cost' at various stations while satisfying the loads and the losses in the transmission links. Hence in order to achieve an economic operation of the system, the total demand must be appropriately shared among the units. This will minimize the total generation cost for the system with the voltage level maintained at the safe operating limits.

To minimize total system generating costs we develop cost relationships between power output and operating costs input.

Mathematical relation between fuel cost and output real power is as:

$$C_i(PG_i) = \alpha_i + \beta_i PG_i + \gamma_i PG_i^{\,2}$$

Where

α_i, β_i , and γ_i are the coefficients of the input - output characteristic. The constant α_i is equivalent to the fuel consumption of the generating unit operation without power output.

Let **Ci** is the cost, expressed for example in Rs/hr, of producing energy in the generator unit i. The total production cost therefore will be

$$C = \sum_{i=1}^{N} Ci\,(PGi)\ Rs/h$$

Where **'Ci'** is the cost of ith unit is **Rs/h** as the function of real power generated by it. **N** is the total number of generating units and **'C'** is total generating cost in **Rs/h**.

When the cost function 'C' can be written as a sum of terms where each term depends only upon one independent variable.

APPROACHES TO SOLVE ECONOMIC DISPATCH PROBLEM:

Genetic Algorithms used for optimization are based on the principle of biological evolution. They are very different to many conventional methods in the sense that they simultaneously consider many possible solutions to the problem. By considering many points in the search space, the algorithm simultaneously reduces the chance of getting trapped at a local minimum. It uses a set of probabilistic rules in order to guide their search. It is a method for deriving from one population of "chromosomes" (e.g. strings of ones and zeroes, or bits) a new population. This is achieved by employing "natural selection" together with the genetics inspired operators of recombination (crossover), mutation and inversion. Each chromosome consists of genes (e.g. bits) and each gene is an instance of a particular allele (e.g. 0 or 1). The selection operator chooses those chromosomes in the population that will

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be allowed to reproduce and on average those chromosomes that have a higher fitness factor, produce more offspring than the less fit ones. Crossover swaps subparts of two chromosomes, roughly copying biological recombination between two single chromosome organisms; mutation randomly changes the allele values of some locations in the chromosome and inversion reverses the order of an adjacent section of chromosome. GA is best optimization technique which does not depend on nature of cost function and provides best solution at least time.

DATA ANALYSIS AND RESULT

1.1 Case1 # Three Units System

Here we are considered the three generating units system. Where the value of coefficients of cost functions of the generating units are given as a, b, c. There generation power limits lie between P_{min} and P_{max} are $P_1,\ P_2, P_3$.Value of **a, b, c** and minimum power **(P_{min})** and maximum power (P_{max}) are as

$$B = \begin{bmatrix} 0.0218 & 0.0093 & 0.0028 \\ 0.0093 & 0.0228 & 0.0017 \\ 0.0028 & 0.0017 & 0.0179 \end{bmatrix}$$

$$B_0 = [0.0003 \quad 0.0031 \quad 0.0015]$$

B_{00}=0.00030523

These are B-coefficients as given above.

A	B	c	P_{min}	P_{max}
200	7	0.008	10	85
180	6.3	0.009	10	80
140	6.8	0.007	10	70

All data are on the base of 100 MVAR

1.1.1 Lambda-iteration method

Table 1.1.1 Lambda-Iteration Method with Losses

SL NO.	POWER DEMAND(MW)	P1 MW	P2 MW	P3 MW	COST Rs/hr	EXECUTION TIME Sec
1	50	10.0000	30.4669	10.0000	864.1869	0.02
2	80	10.0000	44.1171	26.8250	1083.800	0.3
3	110	19.7523	52.9218	38.8864	1313.500	0.7
4	140	29.6191	61.7420	51.0039	1552.400	0.06
5	220	75.6001	80.0000	70.0000	2246.500	0.2

1.1.2 GA METHOD

For the solution of problem different parameters of GA are as

Total no. of springs or chromosomes=50

Total no of iteration=500

Crossover probability=0.8

Mutation probability= 0.1

Table 1.1.2 GA Method with Losses

SL NO.	POWER DEMAND (MW)	P1 (MW)	P2 (MW)	P3 (MW)	COST (Rs/hr)	EXECUTION TIME(Sec)
1	50	10.0093	26.0278	14.3812	860.1790	3.548067
2	80	11.2019	44.2540	25.4902	1073.700	2.328065
3	110	20.5169	52.3512	38.6866	1295.000	2.317656
4	140	30.4578	61.3041	50.6002	1522.700	2.327279
5	220	75.6001	80.0000	70.0000	2166.800	2.292908

1.1.3 COMPARISON OF COST OF TWO DIFFERENT METHODS

Lowest generation costs of two different methods at five different loads have been compared.

Table 1.1.3 Comparison of Cost of Two Different Methods

SLNO.	DEMAND (MW)	LI-METHOD COST(Rs/hr)	GA-METHOD COST(Rs/hr)
1	50	864.1869	860.1790
2	80	1083.800	1073.700
3	110	1313.500	1295.000
4	140	1552.400	1522.700
5	220	2246.500	2166.800

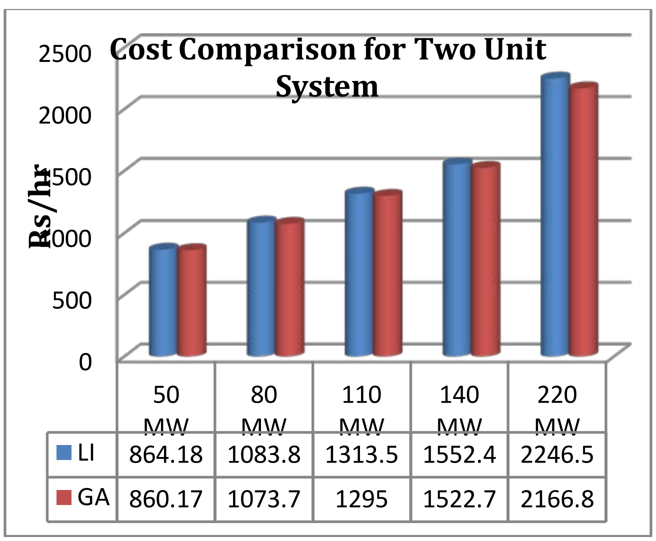

Fig 1.1.3 Comparison of Cost of Two Different Methods

1.2 Case2 # Six Units System

Here we are considered the six generating units system. Where the value of coefficients of cost functions of the generating units are given as a, b, c. There generation power limits lie between $\boldsymbol{P_{min}}$ and $\boldsymbol{P_{max}}$ are P_1, P_2, P_3, P_4, P_5, P_6 .

Its a, b, c coefficients, minimum powers and maximum powers are as

a	b	c	P_{min}	P_{max}
240	7	0.0070	100	500
200	10	0.0095	50	200
220	8.5	0.0090	80	300
200	11	0.0090	50	150
220	10.5	0.0080	50	200
190	12	0.0075	50	120

Its B-coefficients are as B=

0.0017	0.0012	0.0007	-0.0001	-0.0005	-0.0002
0.0012	0.0014	0.0009	0.0001	-0.0006	-0.0001
0.0007	0.0009	0.0031	0.0000	-0.0010	-0.0006
-0.0001	0.0001	0.0000	0.0024	-0.0006	-0.0008
-0.0005	-0.0006	-0.0010	-0.0006	0.0129	-0.0002
-0.0002	-0.0001	-0.0006	-0.0008	-0.0002	0.0150

B_0=1e^-03*

-0.3906	-0.1297	0.7047	0.0591	0.2161	-0.6635

B_{00}=0.00056

1.2.1 LAMBDA-ITERATION METHOD

Table 1.2.1 Lambda-Iteration Method with Losses

SL NO	DEMAND MW	P1 MW	P2 MW	P3 MW	P4 MW	P5 MW	P6 MW	COST Rs/hr	TIME Sec
1	650	297.995	62.8331	148.4478	50.0000	50.0000	50.0000	7913.3	0.25
2	750	329.8321	86.4443	173.0845	50.0000	71.1864	50.0000	9096.8	0.35
3	850	355.9741	105.8036	193.3071	65.0532	91.6917	50.0000	10325	0.7
4	950	380.6955	124.099	212.4163	85.0146	111.0016	50.0000	11593	0.9
5	1050	404.7824	141.9228	231.0439	104.5107	129.7129	52.8078	12903	1

1.2.2 GA METHOD

For the solution of problem different parameters of GA are as

Total no. of springs or chromosomes=50

Total no of iteration=500

Crossover probability=0.8

Mutation probability= 0.1

Table 1.2.2 GA Method with Losses

SL.NO.	DEMAND (MW)	P1 (MW)	P2 (MW)	P3 (MW)	P4 (MW)	P5 (MW)	P6 (MW)	COST (Rs/hr)	TIME (Sec)
1	650	288.505	62.3285	151.447	54.4741	50.1353	52.264	7846.2	9.222 1
2	750	329.637	88.3985	168.687	50.3729	70.8115	52.504	8997.5	3.562 5
3	850	358.141	111.2941	184.808	60.1008	97.0574	50.314	10195	3.504 9
4	950	377.748	120.5377	207.415	86.8363	120.327	50.140	11430	3.568 7
5	1050	404.361	134.9892	234.498	110.264	129.844	50.502	12702	3.476 2

1.2.3 COMPARISON OF COST OF TWO DIFFERENT METHODS

Lowest generation costs of two different methods at five different loads have been compared.

Table 1.2.3 Comparison of Cost of Two Different Methods

SLNO.	DEMAND (MW)	LI-METHOD COST (Rs/hr)	GA-METHOD COST (Rs/hr)
1	650	7913.300	7846.2
2	750	9096.800	8997.5
3	850	10325.00	10195
4	950	11593.00	11430
5	1050	12903.00	12702

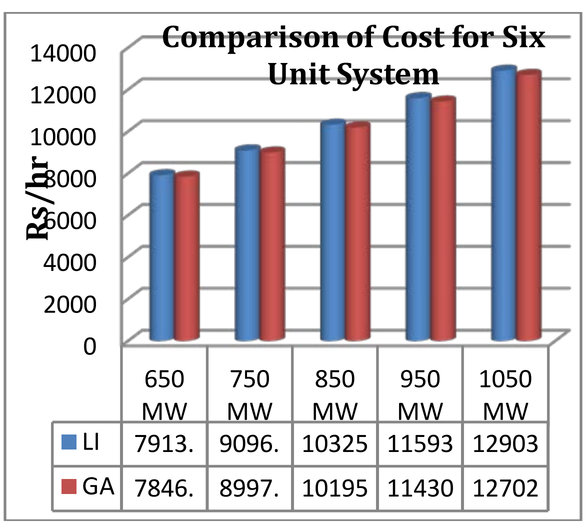

Fig 1.2.3 COMPARISON OF COST OF TWO DIFFERENT METHODS

CONCLUSION:

Here LI method used for solving ELD problem is better, but it suffers the convergence problem when a suitable value of Lambda is not selected. Further when transmission losses are added it takes much number of iteration to converge. Also it has been shown that when ELD problem is made practical by adding different generator constraints and generating limits, the cost function does not remain smooth throughout, in this case LI method does not converge. GA method gives better result when transmission losses are added in the ELD problem. It is free from nature of graph of the cost function. It can be applied to economic dispatch problem with any type of constraints. It can provide better set of power generation at minimum cost. The main focus of our work is to survey and summarize the applications of GA for solving the ELD problems including the advantages and disadvantages of GA based approaches. Now we are considering different generating units (3-Generating units and 6-Generating units) to which GA with different populations have been applied and simulated then compared with the LI method and finally conclude that the GA method is more efficient and reliable.

REFERENCES:

1. A.J. Wood and B.F. Wollenberg, Power Generation Operation and Control, John Wiley & Sons, New York, 1984.
2. LIANG, Z.Z., and GLOVER, J.D. : 'Improved cost functions for economic dispatch', IEEE Trans., 1991, PWRM, (Z), pp. 821-829
3. P.H.Chen and H.C. Chen,'Large–scale economic dispatch by genetic algorithm'. IEEE Trans. Power syst., vol. 10, pp. 1919-1926, Nov 1995.
4. Huijuan Li, "Lagrange Multipliers and their Applications", Department of Electrical Engineering and Computer Science University of Tennessee, Knoxville, TN 37921 USA (Dated: September 28, 2008).
5. T.Yalcionoz, H.Alum, and M.Uzam, "Economic dispatch solution using a genetic algorithm based on arithmetic crossover", in Proc. IEEE Proto Power Tech. Conf., Proto, Portugal, Sept. 2001.
6. Bakirtzis, V. Petrides and S. Kazarlis, "Genetic algorithm solution to the economic dispatch problem," IEE Proc. Gener. Transm. Distrib., vol.141, no. 4, pp. 377-382, July 1994.
7. H.Saadat, "Power system analysis", 2nd Edition, Mcgraw Hill, United States of America,2002.
8. Y. S. Haruna, Comparison of Economic Load Dispatch Using Genetic Algorithm and Other Optimization Methods, M. Eng. Degree Thesis, A.T.B. University, Bauchi, Nigeria, 2003.
9. Benjamin W. Wah, Yi-Xin Chen : Constrained Genetic Algorithm and their Applications in Non-linear Constrained Optimization, Proc. 12th International Conference on Tools Artificial intelligence, November 2000.
10. D.C. Walters and G.B. Sheble, Genetic algorithm solution of economic dispatch with valve point loading, *IEEE Trans. Power Syst.,* 8 (August (3)) (1993), pp. 1325–1332.