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Economic Load Dispatch Using Genetic Algorithm

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***Abstract*—This paper presents the application of Genetic Algorithm (GA) to economic load dispatch of the power system. The ELD problem has been solved through many traditional optimization methods including: gradient based techniques, newton methods, linear programming and quadratic programming. The economic dispatch reduces the system cost by allocating the real power among online generating units.**

GA are implemented in a computer simulation programming and modeling in which a population of synopsis representation (called re combination) of candidate solution (called individuals / creatures / phenotypes) to an optimization problematic evolves towards best solutions.

***Index Terms*— economic load dispatch, genetic algorithm**

I. Introduction

In Power System, Economic Load Dispatch (ELD) is generally used for get the optimal total generation cost. Economic Load Dispatch attempts to a temporally organized plan for matters to be attended to the generation with potentiality of minimizing the total operating cost function under unit operating limits. The functional cost can be reducing by employing any optimization technique for solving Economic Load Dispatch (ELD).

Many conventional methods applied to solve ELD problems through mathematical programming and optimization techniques. The main conventional methods are the lambda iteration method, base point and participation factor method, gradient method etc. From all these methods, the lambda iteration method uses frequently and this can be applied easily also.

To reduce the generating cost of power that problem is called Economic Load Dispatch problem. It is short term determination of optimal output of many generation facility. ELD Problem is solved by the specialized computer software like MATLAB.

The introduction of Particle Swarm Optimization (PSO) was given by James Kennedy and Russell Eberhart. It optimizes the nonlinear function. It was inspired by the helping nature of particle (birds, fishes) while searching for food.

II. Cost of Electrical Energy

The total cost of electrical energy generated can be classified into three parts

Fixed cost: This cost is independent to maximum demand and unit generation.

Semi–fixed cost: This cost is depending upon maximum demand but independent it is independent of unit generation.

Running or operational cost: This cost is depending upon the number of units generated.

III. Genetic Algorithm

A Genetic Algorithm (GA) is a search technique, which is used in computing to discover exact or approximate (close together) results to optimization of search difficulties. GA are implemented in a computer simulation programming and modelling in which a population of synopsis representations (called recombination) of candidate solutions (called individuals / creatures / phenotypes) to an optimization problematic evolves toward best solutions

For solving the genetic algorithm there are some genetic operators are used.

1. Selection
2. Crossover
3. Mutation

IV. Methodology

A. Problem Formulation

In Economic Load Dispatch Problem, the main objective is to minimize total fuel cost of the generation.

$$Min\ C_T = \sum_{i=1}^{N} C_i\,(P_i) \quad (1)$$

Subject to,

$$P_D + P_L \le \sum_{i=0}^{N} P_i \quad (2)$$

B. Economic Load Dispatch Problem with Active Power Transmission Losses

Economic load dispatch problem including Active power transmission line losses will be calculated from equation,

$$P_L = \sum_{i=0}^{N} P_i * B * P_i' \quad (3)$$

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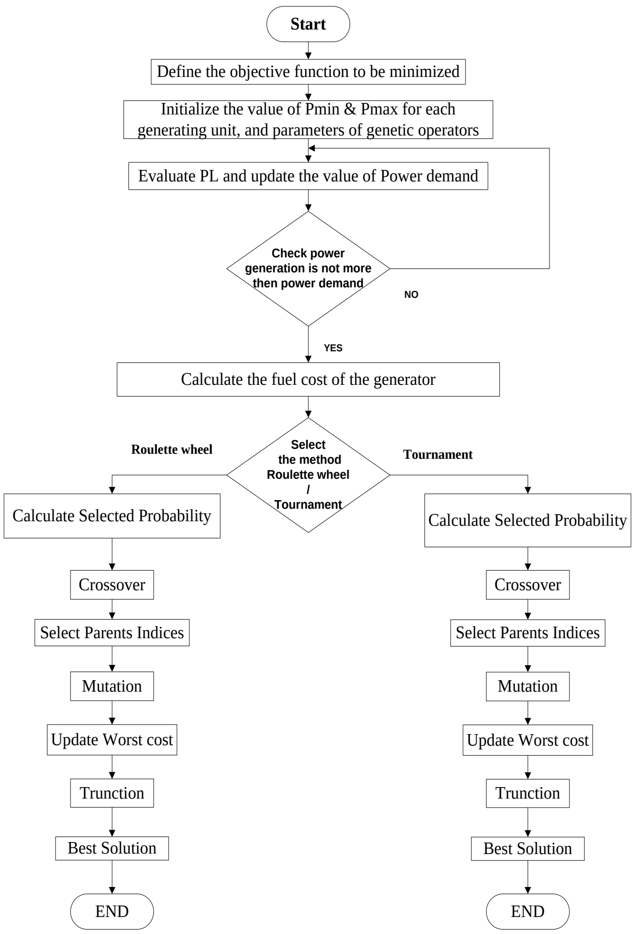

Fig. 1. Flowchart

The cost function of any generation unit is represented by C_i

$$C_i = a_i P_i^2 + b_i P_i + c_i \qquad (4)$$

The cost function of 6 generation units in $/hr is given below.

C1 = 0.15240 * P12 + 38.53973 * P1 + 756.79886
C2 = 0.10587 * P22 + 46.15916 * P2 + 451.32513
C3 = 0.02803 * P32 + 40.39655 * P3 + 1049.9977
C4 = 0.03546 * P42 + 38.30553 * P4 + 1243.5311
C5 = 0.02111 * P52 + 36.32782 * P5 + 1658.5596
C6 = 0.01799 * P62 + 38.27041 * P6 + 1356.6592

The unit operating inequality constraints are:

10 MW ≤ P1 ≤ 125 MW
10 MW ≤ P2 ≤ 125 MW
35 MW ≤ P3 ≤ 125 MW
35 MW ≤ P4 ≤ 125 MW
130 MW ≤ P5 ≤ 125 MW
125 MW ≤ P6 ≤ 125 MW

For Active Power Transmission losses, B – Coefficient matrix are:

B = 1 * exp (-5) *
[14 1.7 1.5 1.9 2.6 2.2
1.7 6 1.3 1.6 1.5 2
1.5 1.3 6.5 1.7 2.4 1.9
1.9 6 1.7 7.1 3 2.5
2.6 1.5 2.4 3.0 6.9 3.2
2.2 2 1.9 2.5 3.2 8.5]

Proposed method for solving Economic Load Dispatch Problem are follows different steps, which is represent in flow chart of Genetic Algorithm.

Step 1 - Define the objective function
Step 2 - Initialize the value of inequality constraints and genetic operators
Step 3 - Calculate transmission losses and Update value of Power demand
Step 4 - Calculate the fuel cost of each generating unit
Step 5 - Choose the selection method
Step 6 - Crossover
Step 7 - Mutation
Step 8 - Update worst cost for selection of minimum cost
Step 9 - Truncation for getting only minimum cost
Step 10 - Get best solution

V. Result

The Table-, shows the cost coefficients and maximum and minimum generation limits of given generating units in IEEE-30 Bus Test System and Table-2, represents the active power transmission losses coefficients of given test system.

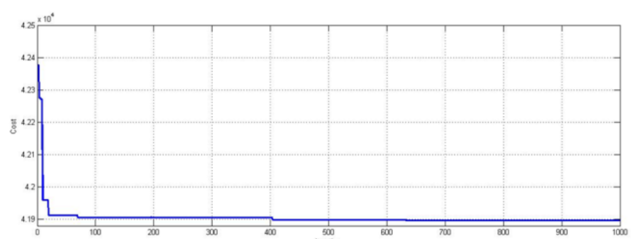
Fig. 2. Binary coded Genetic Algorithm with Roulette wheel selection method (Population Size 50)

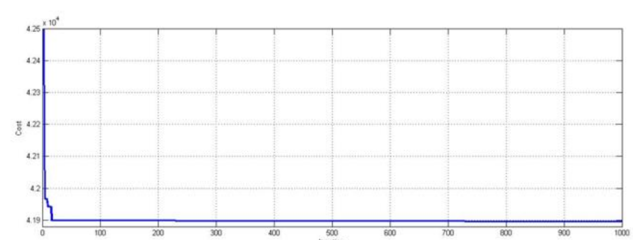
Fig. 3. Binary coded Genetic Algorithm with Roulette wheel selection method (Population Size100)

The Table- 3 is shows the convergence results of different variants and different selection methods for comparison of results.

TABLE I
COST COEFFICIENTS OF IEEE-30 BUS TEST SYSTEM

Test system	Bus	a	b	c	P_{min}	P_{max}
IEEE 30 bus system	1	0.15240	38.53973	756.79886	10	125
	2	0.10587	46.15916	415.32513	10	150
	5	0.02803	40.39655	1040.9977	35	225
	8	0.3546	38.30553	1243.5311	35	210
	11	0.02111	36.32782	1658.5596	130	325
	13	0.1799	38.27041	1356.6592	125	315

TABLE II
ACTIVE POWER TRANSMISSION LOSS COEFFICIENTS OF IEEE-30 BUS TEST SYSTEM

Test system	Loss Coefficients X (10^{-5})					
IEEE 30 bus system	14	1.7	1.5	1.9	2.6	2.2
	1.7	6	1.3	1.6	1.5	2
	1.5	1.3	6.5	1.7	2.4	1.9
	1.9	6	1.7	7.1	3	2.5
	2.6	1.5	2.4	3	6.9	3.2
	2.2	2.0	1.9	2.5	3.2	8.5

TABLE III
CONVERGENCE RESULTS

Minimum Fuel Cost after 1000 iteration				
Population Size	Roulette-Wheel ($/hr.)		Tournament ($/hr.)	
	Binary Coded	Real Coded	Binary Coded	Real Coded
50	41896.3905	41896.4619	41896.4415	41896.3155
100	41896.3075	41896.5892	41896.3192	41896.9999
150	41896.7412	41896.2143	41896.5394	41896.4946
200	41896.3691	41896.3307	41896.3353	41896.4600
250	41896.6364	41896.6505	41896.2346	41896.4869

Result are simulated on MATLAB 8.1.0.604 (R2013a) language on Intel (R) Core (TM) i3-3110M CPU @ 2.40GHz, 4.00 GB RAM.

VI. CONCLUSION AND FUTURE SCOPE

Genetic Algorithm shows superior result including high quality solution and stable convergence characteristics. The solution of Genetic Algorithm is always close to that of the conventional method but gives better solution in case of higher order system.

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