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ECONOMIC LOAD DISPATCH USING ARTIFICIAL BEE COLONY OPTIMIZATION

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ABSTRACT - In this paper Artificial Bee Colony Algorithm is proposed to seek out the answer of Economic Load Dispatch problem (ELD). The aim of ELD is to attenuate the dispatch cost while satisfying generating unit and system equality and inequality constraints. The ABC is population based metaheuristic algorithm that replicate the behaviour of honey bee swarms. To determine the efficiency and effectiveness of ABC, it's been tested on 6 unit, 18 unit and 20 unit data. The simulation results indicates that the proposed ABC algorithm gives better statistical solution with very high probability to demonstrate its robustness over other intelligent techniques such as differential evaluation (DE), artificial colony optimization (ACO), hybrid swarm intelligent based harmony search algorithm (HHS) and fuzzy adaptive chaotic ant swarm optimization (FCASO). The proposed ABC ensures convergence within least execution time and provides best solutions as compared to other algorithm.

***Key Words*: Economic Dispatch(ED), Artificial Bee Colony Optimization(ABC), Metaheuristic Algorithm, Problem Formulation, Genetic Algorithm(GA).**

1. INTRODUCTION

The power system Economic load dispatch methods gives the output of different generating units so as to meet the demand of the system at minimum cost while satisfying the generation limits as well as other equality and inequality constraints present within the system. This method also increases reliability of the system. Main objective of this method is to minimize the non-linear function which in turn would decrease the cost of operating the power system. Since there is urgent need to conserve fossil fuelsand due to environmental issues these genetic algorithms (GA) are laid importance in this digital era.In this paper Ant Bee Colony (ABC) method has been proposed to unravel economic load dispatch problem. This method is inspired by behavior of honey bees. This method is employed on three cases which consists of 6units, 18 units and 20 units of generating stations. Results show that this method is reliable and may easily handle complex problems of powers system in efficient manner.

2. OVERVIEW ARTIFICIAL BEE COLONY

The technique is meta-heuristic search algorithms utilized in solving numerous combinational optimization problems Swarm based algorithm ABC based a stochastic search algorithm which imitates the scrounging behaviour of honeybees. Feature Selection helps to hurry up the method of classification by extracting the relevant and useful information from the dataset means the colony of artificial bees consists of three groups of bees: employed bees, on lookers and scouts. Some of the bee of colony consists of employed artificial bees and the some includes the on lookers. In other words, the number of employed bees is equal to the number of food sources around the hive. The employed bee whose food source has been abandoned becomes a scout. In ABC algorithm the position of food source determines the solution and the amount of nectar represents the fitness of the respective solution.

2.1 Steps in Algorithm

Step1: Initialization

A randomly distributed initial population solutions (Xi = 1, 2... D) is being dispersed over the D dimensional problem space.

Step 2: Reproduction

An artificial onlooker bee chooses a food source depending on probability value associated with food source, Pi, calculated by following expression

$$P_i = f_i t_i \Big/ \sum_{n=1}^{N} f_i t_n$$

Where ***fiti*** is the fitness value of the solution in which is proportional to the nectar amount of the food source in the position i and N is the number of food sources which is equal to the number of employed bees. In order to produce a candidate food position from the old one in memory, the ABC used the following expression:

$$V_{ij} = X_{Kj} + \emptyset_{ij}(X_{ij} - X_{Kj})$$

Where k = {1, 2… D} and j = {1, 2… N} are randomlychosen indexes. *ij* j, is a random number between [-1, 1]

Step 3: Replacement of bee and selection

In ABC, Providing that a position cannot be improved further through a predetermined number of cycles, then that food source is assumed to be abandoned. The value of pre determined number of cycles is an important control parameter of the ABC algorithm, which is called “limit” for abandonment. Assume that the abandoned source is *Xi* and j= {1, 2… N} then the scout discovers a new food source to be replaced with *Xi.* This operation can be defined as:

$$X_i^j = X_{min}^j \text{rand}(0,1) * (X_{max}^j - X_{min}^j)$$

After each candidate source position *Vij* is produced and then evaluated by the artificial bee, its performance is compared with that of its old one. If the new food has equal or better fitness than the old source, it is replaced with the old one in the memory. Otherwise, the old one is retained in the memory.

3. PROBLEM FORMULATION

The traditional economic dispatch problem has been defined as minimizing of an objective function i.e. the generation cost function subject to equality constraints (total power generated should be equal to total system load plus losses for all solutions) and inequality constraints (generations should lie between their respective maximum and minimum specified values).

Minimize □□p□□□□□□□□□□□ $_t(P_i)$ □ □□ $_i(P_i)$;

Objective function , □(P_i)= $\sum_{i=1}^{n} a_iP_i^2 + b_iP_i +$□$c_i$□□□□□

Where constraints are Equality constraint □ P_i□ P_L □ P_D □ 0;

i□1

and Inequality contraints are $P_i$min □ P_i□ $P_i$max .

3. RESULTS

This ABC algorithm has been applied to three test cases which consisted of 6, 18 and 20 generating units.

3.1 CASE 1

This system consists of 6 generating units and it has quadratic (convex) cost function. Parameters of all generating units are represented in table:1

Table -1:

UNITS	a ($\$/MW^2$)	b ($/MW)	c ($)	P_{min} (MW)	P_{max} (MW)
1	0.15247	38.53973	756.79886	10	125
2	0.10587	46.15916	451.32513	10	150
3	0.02803	40.3965	1049.9977	35	225
4	0.03546	38.30553	1243.5311	35	210
5	0.02111	36.32782	1658.569	130	325
6	0.01799	38.27041	1356.6592	125	315

Table 2: It consists of results of case 1 which is calculated at different population(N.P), at load demand of 1050MW and the cost required to operate all the units at optimal load dispatch.

Table -2:

	Value of cost function ($)			
NP	**min**	**mean**	**max**	**std**
50	55083.51287	55083.51287	55083.51287	7.46497
100	55083.51287	55083.51287	55083.51287	7.46497
150	55083.51287	55083.51287	55083.51287	7.46497

3.2 CASE 2

This system consists of 18 generating units and all its parameters are represented in table3 .

Table -3

UNITS	a ($\$/MW^2$)	b ($/MW)	c ($)	P_{min} (MW)	P_{max} (MW)
1	0.602842	22.45526	85.74158	7	15.0
2	0.602842	22.45526	85.74158	7	45.0
3	0.214263	22.52789	108.98370	13	25.0
4	0.077837	26.75263	49.06263	16	25.0
5	0.077837	26.75263	49.06263	16	25.0
6	0.734763	80.39345	677.73000	3	14.75
7	0.734763	80.39345	677.73000	3	14.75
8	0.514474	13.19474	44.39000	3	12.280
9	0.514474	13.19474	44.39000	3	12.28
10	0.514474	13.19474	44.39000	3	12.28
11	0.514474	13.19474	44.39000	3	12.28
12	0.657079	56.70947	574.96030	3	24.0
13	1.236474	84.67579	820.37760	3	16.20
14	0.394571	59.59026	630.02370	3	36.20
15	0.420789	56.70947	567.93630	3	45.00

16	0.420789	55.96500	567.93630	3	37.00
17	0.420789	55.96500	567.93630	3	45.0
18	1.236474	84.67579	820.37760	3	16.20

Table 4: This table has results of the second case which are calculated at different N.P , for the load demand of 365MW.

Table -4

	Value of cost function ($)			
NP	**min**	**mean**	**max**	**sdt**
50	25566.28405	25659.40465	25732.24286	51.71721
100	25549.12182	25633.98997	25732.03060	54.76525
150	25506.04351	25633.24739	25737.17832	54.55482

3.3 CASE 3

This system has 20 generating units and its parameters are mentioned in the table 5.

Table -5

□□□□□

UNITS	a ($/$MW^2$)	b ($/MW)	c ($)	P_{min} (MW)	P_{max} (MW)
1	0.00068	18.19	1000	150	600
2	0.00071	19.26	970	50	200
3	0.00650	19.80	600	50	200
4	0.00500	19.10	700	50	200
5	0.00738	18.10	420	50	160
6	0.00612	19.26	360	20	100
7	0.00790	17.14	490	25	125
8	0.00813	18.92	660	50	150
9	0.00522	18.27	765	50	200
10	0.00573	18.92	770	30	150
11	0.00480	16.69	800	100	300
12	0.00310	16.76	970	150	500
13	0.00850	17.36	900	40	160
14	0.00511	18.70	700	20	130
15	0.00398	18.70	450	25	185
16	0.07120	14.26	370	20	80
17	0.00890	19.14	480	30	85
18	0.00713	18.92	680	30	120
19	0.00622	18.47	700	40	120
20	0.00773	19.79	850	30	10

Table 6: This table has results of third case at different N.P(population), at load demand of 2500MW, which are required to operate all units at optimal load dispatch.

Table -6

	Value of cost function ($)			
NP	**min**	**mean**	**max**	**sdt**
50	62456.63308	62456.63308	62456.63308	3.73248
100	62456.63308	62456.63308	62456.63308	3.73248
150	62456.63308	62456.63308	62456.63308	3.73248

4. CONCLUSION

In this paper artificial bee colony (ABC) algorithm has been used to solve ELD problem. In order to justify effectiveness of this method three test cases are taken namely, Case 1 which consisted of 6 generating units and uses quadratic (convex) cost function. Case 2 consisted of 18 generating units. And Case 3 consisted of 20 generating units. The results obtained with this method are better than other genetic algorithms(GA) as well as reliable in solving ED problems of power systems.

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