OPTIMIZATION TECHNIQUE FOR THE ECONOMIC DISPATCH IN POWER SYSTEM OPERATION

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***Abstract*—The Optimal economic operation of their electric networks while considering the challenges of increasing fuel costs and increasing demand for electricity. The dynamic economic dispatch (DED) occupies important place in a power system's operation and control. It aims to determine the optimal power outputs of on-line generating units in order to meet the load demand and reducing the fuel cost. The nonlinear and non convex characteristics are more common in the DED problem. Therefore, obtaining a optimal solution presents a challenge. In the proposed system, artificial bee colony (ABC) algorithm – a recently introduced population-based technique – is utilized to solve the DED problem. We demonstrate 3 units and 6 units generating system for simulate the maximize power output and minimize the fuel cost .**

Keywords- ABC-Artificial Bee Colony Algorithm, DED-Dynamic Economic Dispatch, Population based technique

I. INTRODUCTION

The economic dispatch of generation in power systems is one of the most important optimization problems for both the generating companies competing in a free electricity market and the systems operator (SO)[2] in charge with a fair handling of transactions between electricity suppliers and their customers. The fuel cost component is still the major part of the variable cost of electricity generation, directly reflected in the electricity bills.

Economic dispatch aims at allocating the Electricity load demand to the committed generating units in the most economic or profitable way, while continuously respecting the physical constraints of the power system. To obtain the most economic schedule of generation taking into account a number of system limitations, such as the heat rate curves, generation limits or ramping limitations of the generating units, limitations of the transmission lines, or reliability preventive parameters of the system (e.g., the power reserve).Thus, the optimization problem may be stated as a minimization problem [5], when the objective is to minimize the total cost of supplying the load demand. The ultimate goal of power plants is to meet the required load demand with the lowest operating costs possible while taking into consideration practical equality and inequality constraints algorithms. Optimal operation of electric power system networks is a challenging real-world engineering problem. Indeed, the optimal operation of these networks is the result of multiple optimization problems that interact with each other sufficiently and efficiently. Those linked optimization problems are the unit commitment, optimal power flow, and economic dispatch scheduling. The recently introduced meta-heuristic method is the artificial bee colony (ABC) algorithm. It is a population-based technique proposed late in 2005, and inspired by the intelligent foraging behavior of the honeybee swarm. The DED problem was one of the real-world optimization problems that has benefited from the development of the meta-heuristic algorithms. Based on the genetic algorithm (GA), the authors suggested a GA based method to solve the DED problem. The particle swarm optimization (PSO) method is also utilized in [7] to solve the DED problem. An evolutionary programming (EP) technique [8] and is adopted to solve the DED problem. Simulating annealing method (SA), quantum evolutionary algorithm (QEA), and Tabu search approach (TS) have been also designated to solve the DED problem in [12],[13], respectively. In this paper, the ABC algorithm is proposed to solve the DED problem. In addition, the ABC algorithm is utilized to verify the efficiency.

II. OBJECTIVE FUNCTION

The objective function of the DED problem is to minimize the operating fuel's costs of committed generating units to meet the load demand, subject to equality and inequality constraints over a predetermined dispatch period, the result's practical usefulness will be degraded if the units' valve-point effects are neglected. Consequently, there are two models to represent the units' valve-point effects in the literature. The first represents the units' valve in terms of prohibited operating zones which are included as inequality constraints. The second form represents the units' valve-point effects as a rectified sinusoid term which is superimposed on the approximate quadratic fuel cost function. The general mathematical form of the DED problem follows:[1]

A. Minimization of fuel cost

The problem of an Economic Load Dispatch (ELD) is to find the optimal combination of power generation, which minimizes the total fuel cost, under some constraints [14].

The ELD Problem can be, mathematically, formulated as the following optimization problem:

$$\text{Minimizes } F_{cost} = \sum_{i=1}^{n} (a_i + b_i P_{G_i} + c_i F \quad \text{------ (1)}$$

Where

Fcost : the total fuel cost ($/hr)

ai,bi,ci : the fuel cost coefficients of generator i

PGi : the power generated by generator i (MW), and

n : the number of generators

B. Equality constraint

Integration of a renewable source (modifies the equality constraints function to be as follows

$$\sum_{t=1}^{T}\sum_{i=1}^{N} P_i^t = \sum_{t=1}^{T}\left(P_D^t + P_L^t - \sum_{RS=1}^{M} \mu_{RS} P_{RS}^t\right) \quad \text{-----(2)}$$

where pDt and pLt are the load demand and system's loss at a time t respectively. The multiplier µRS is set to a permissible amount of active power injected by RS, PRS. is the forecasted real power from RS

C. Inequality Constraint:

The inequality constraints of the DED problem are the units' ramp-rate limits, i.e., upper rate (URi) and down rate (DRi), are considered as follows:.

$$P_i^t - P_i^{t-1} \le UR_i$$
$$P_i^{t-1} - P_i^t \le DR_i \quad \text{------(3)}$$

Additional inequality constraints are the minimum and maximum power output of each unit:

$$P_{i,min} \le P_i \le P_{i,max} \quad \text{--------(4)}$$

Therefore, to incorporate the constraints of unit's ramp-rate limits in the real power output limit constraints. the modified unit's real power outputs are evaluated as follows:

$$P_{i,min}^t = max\left(P_{i,min}, P_i^{t-1} - DR_i\right) \quad \text{-----(5)}$$
$$P_{i,max}^t = min\left(P_{i,max}, P_i^{t-1} + UR_i\right)$$

III. ARTIFICIAL BEE COLONY

In the ABC model, the colony consists of three groups of bees: employed bees, onlookers and scouts. It is assumed that there is only one artificial employed bee for each food source. In other words, the number of employed bees in the colony is equal to the number of food sources around the hive. Employed bees go to their food source and come back to hive and dance on this area. The employed bee whose food source has been abandoned becomes a scout and starts to search for finding a new food source. Onlookers watch the dances of employed bees and choose food sources depending on dances.

It is clear that the ABC algorithm has the following control parameters: 1) the CS that consists of employed bees (Eb) plus onlooker bees (Ob), 2) the limit value, which is the number of trials for a food-source position to be abandoned, and 3) the maximum cycle number (MCN.) Although the ABC algorithm has three parameters to be tuned, once the CS parameter has been determined by the practitioner, the limit value can be calculated easily as half of the CS multiplied by the problem's dimension. Therefore, technically speaking, the ABC algorithm has only two parameters to be adjusted: CS and the MCN values. Updating these two parameters towards the most effective values has a higher likelihood of success than in other competing meta-heuristic methods.

A. ABC algorithm

1. Initialize the population.
2. Modify positions.
3. Apply selection criterion.
4. Repeat (cycle.)
5. Allow the employed bees to share the food information with onlooker bees.
6. Allow the onlooker bees to choose the best food source based on the probability calculation.
7. Apply selection criterion.
8. Check for an abundant solution, and (if exists) initiate a new food-source position. Otherwise, follow the next step.
9. Retain best solution so far.
10. Until stopping rule.

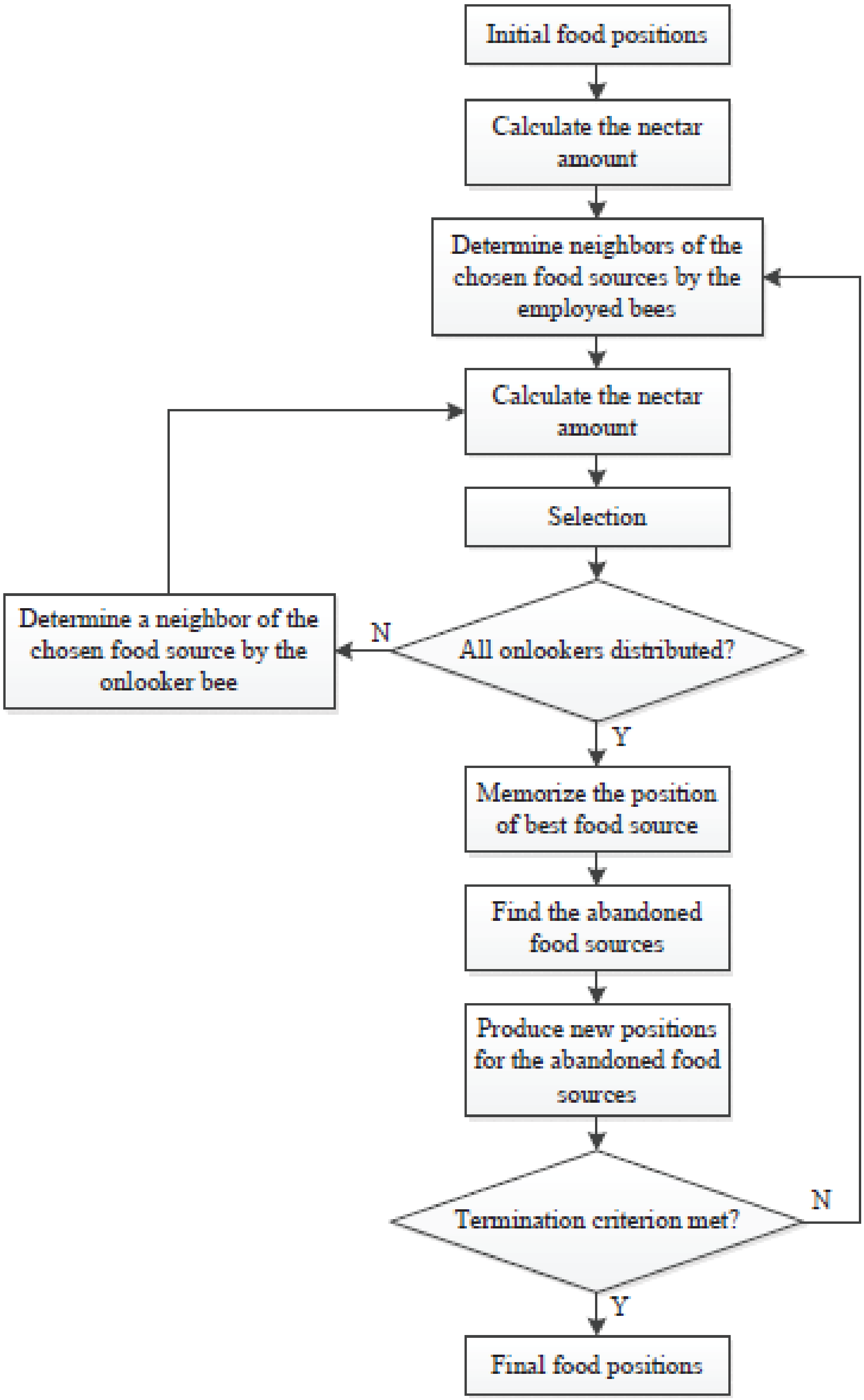

Fig.3.1 Flow chart for ABC algorithm

In ABC, a population based algorithm, the position of a food source represents a possible solution to the optimization problem and the nectar amount of a food source corresponds to the quality (fitness) of the associated solution. The number of the employed bees is equal to the number of solutions in the population. At the first step, a randomly distributed initial population (food source positions) is generated. After initialization, the population is subjected to repeat the cycles of the search processes of the employed, onlooker, and scout bees, respectively. An employed bee produces a modification on the source position in her memory and discovers a new food source position. Provided that the nectar amount of the new one is higher than that of the previous source, the bee memorizes the new source position and forgets the old one. Otherwise she keeps the position of the one in her memory. After all employed bees complete the search process, they share the position information of the sources with the onlookers on the dance area. Each onlooker evaluates the nectar information taken from all employed bees and then chooses a food source depending on the nectar amounts of sources. As in the case of the employed bee, she produces a modification on the source position in her memory and checks its nectar amount. Providing that its nectar is higher than that of the previous one, the bee memorizes the new position and forgets the old one. The sources abandoned are determined and new sources are randomly produced to be replaced with the abandoned ones by artificial scouts.

B. Application to real-world problems

Since 2005, D. Karaboga[11] and his research group have been studying the ABC algorithm and its applications to real world problems. Karaboga and Basturk have investigated the performance of the ABC algorithm on unconstrained numerical optimization problems and its extended version for the constrained optimization problems and Karaboga et al. applied ABC algorithm to neural network training. In 2010, Hadidi et al. employed an Artificial Bee Colony (ABC) Algorithm based approach for structural optimization. In 2011, Zhang et al. employed the ABC for optimal multi-level thresholding, MR brain image classification, cluster analysis, face pose estimation, and 2D protein folding.

IV. RESULT

The proposed coding scheme for the solution of economic dispatch using artificial bee colony algorithm technique has been tested on the six unit system and the numerical results obtained through the Mat lab simulation.

A. SIX UNIT SYSTEM

The six unit generating units considered are having different characteristic. Their cost function characteristics are given by following equations

F1=0.15247P12+38.5397P1+756.79886Rs/Hr

F2=0.10587P22+46.15916P2+451.32513 Rs/Hr

F3=0.02803P32+40.3965P3+1049.9977 Rs/Hr

F4=0.03546P42+38.30553P4+1243.5311 Rs/Hr

F5=0.02111P52+36.32782P5+1658.569 Rs/Hr

F6=0.01799P62+38.27041P6+1356.6592 Rs/Hr

Their operating limit of maximum and minimum power are also different. The unit operating ranges are given:

10MW=P1=125MW

10MW=P2=150MW

35MW=P3=225MW

35MW=P4=210MW

130MW=P5=325MW

125MW=P6=315MW. The Bmn loss

coefficient matrix is given by

0.17	1.4	0.15	0.19	0.26	0.22
0.6	0.17	0.13	0.16	0.15	0.20
0.13	0.15	0.65	0.17	0.24	0.19
0.16	0.19	0.17	0.71	0.30	0.25
0.15	0.26	0.24	0.30	0.64	0.32
0.20	0.22	0.19	0.25	0.32	0.85

This is the example we have taken for the testing this novel coding scheme on the six unit system.

A.1 Simulation Result – Solution of ED Problem

The solution for ED problem of the six unit system considered here is given below.the total demand taken here is about 700MW.

OUTPUT:

S.NO	ALGORITHM	ITER 1	ITER2	ITER3	ITER999	ITER1000	FUEL COST
1	ABC	38945.6	38945.6	38945.6	36912.2	36912.2	**3.6912e+004**

Table 1. Fuel Cost

Table 2: Power generation

S.NO	P1	P2	P3	P4	P5	P6	AVG.POWER
1	28.2955	10.0000	118.9667	118.6801	230.7533	212.7338	19.4315

B.1 THREE UNIT SYSTEM

The three generating units considered for solving the optimal generating output.

Their operating limit of maximum and minimum power are also different. The unit ranges are given below: 100MW=P1=600MW

Table3.Optimal power output

Hour	Lambda	U1	U2	U3	P1	P2	P3	Pload(t)-sum(Pi*Ui)	Pt1	Pt2	Pt3
1	8.5	0	0	1	0	0	200	-30.00	0.00	0.00	170.0982
2	9.9200	0	1	1	0	384	200	-64.00	0.000	320.0627	200.000
3	15.400	1	1	1	600	400	200	-100.00	500.097	400.00	200.00
4	10.700	0	1	1	0	400	200	-270.00	0.000	200.00	200.00

q*=19441.76000,J*=20165.939008,dual_gap=(J*-q*)/q*=0.0372

100MW=P2=400MW 50MW=P3=200MW

V. CONCLUSION AND FUTURE WORK

Power crisis is one of the major issues of concern all over the world today. The production is not enough to meet the demands of consumers. Under these circumstances the power system should be efficient in Economic Load Dispatch which minimizes the total generating cost. A new approach to the solution of artificial bee colony algorithm has been proposed, and proven by a systematic simulation processes. The solution quality, as well as the calculation time, is greatly improved.The proposed approach has been demonstrated by six unit system and proven to have superior features, including high quality solutions, stable convergence characteristics, and good computational efficiency. The generation limits and the demand are considered for practical use in the proposed method. The encouraging simulation results showed that the proposed method is capable of obtaining more efficient, higher quality solutions for ED problems.

In future, to solve the ED problem with the most problematic line flow constraints, PSO Algorithm will be used which leads to more optimized solution. For handling the line flow constraints, in addition to the various optimization techniques, the Newton Raphson method (NR) will be used as well as for handling the security constraints also. Furthermore, the generating cost will be minimized and the maximize the power generation will be targeted.

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