Solving Economic Load Dispatch Problem using Particle Swarm Optimization and Artificial Bee Colony Optimization Algorithms

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Abstract:
This paper presents a methodology of solving economic load dispatch problem (ELD) to minimize losses and total fuel cost to met the demand. here, 6-unit plant had taken . Different types of algorithms are there for solving ELD different types of algorithms like Particle Swarm Optimization (PSO), Differential Evolution (DE), Artificial Bee Colony (ABC), Genetic Algorithm (GA) , Grey Wolf Optimizer (GWO) etc .but in this paper two types of methods are used first one is Particle Swarm Optimization (PSO) and another Artificial Bee Colony (ABC) algorithms are used. For getting the best result. MATLAB program has to be developed

Keywords - *particle swarm optimization(PSO),artificial bee colony(ABC) algorithms*

I. INTRODUCTION

There are different methods that are used in generating electrical energy. These include, hydro-generation, nuclear, use of fossil fuels and also there is generation through renewable resources such as solar, wind, tidal, biomass etc .our power system is divided into four types generation, transmission, distribution and consumers. We need to satisfy the input power is equal output power i.e., demand. Here losses also consider this difference in the generated and distributed units is known as Transmission and Distribution loss. Transmission and Distribution loss are the amounts that are not paid for by users. in general losses can be classified into two categories: technical and non-technical losses(commercial losses). The technical losses are due to energy dissipated in the conductors equipments like transmission lines, transformer, sub transmission line and distribution line and magnetic losses in transformers. Commercial losses are not due to equipments; these losses occur because of man make mistakes. .

By considering all of these we have to satisfy demand or consumers. It is necessary to give electrical power in a economical way. The way how we giving electrical power in a economical way by considering all type of losses is called Economic Load Dispatch (ELD).here we use two algorithms for solving ELD those are Particle Swarm Optimization (PSO) and Artificial Bee Colony (ABC), by comparing both the results we pick the best one.

A. *Economic Load Dispatch (ELD):*

The generating units have different output capacities and production costs. All generating units are refer to operate together so as to meet demand with losses at minimum generation cost. This problem is called Economic Dispatch. The main aim of the Economic Dispatch Problem is to minimize the total generation cost is to meet the load demand by considering losses and various constraints. In the past decade, many efforts have been focused towards solving the ED problem, various optimization techniques like lambda iteration method, base point and participation factor method, gradient method, Newton based method, Nonlinear programming (NLP), Linear programming (LP). These techniques require incremental fuel cost curves which are linear and monotonically increasing to find the global optimal solution

These methods are overcome by modern methods like e Artificial Neural Networks (ANN), Genetic Algorithms (GA), Tabu Search (TS), Simulated Annealing (SA), Particle Swarm Optimization (PSO),Ant colony optimization (ACO),Artificial immune systems (AIS), Differential Evolution (DE), Bacterial Foraging Algorithm (BFA), Artificial bee colony (ABC) algorithms. they produce near optimal solutions.

The economic dispatch problem can be mathematically expressed as:

$$Min\ F_t = \sum_{i=1}^{n} F_i(P_i)$$

Where Ft=total generation cost(Rs/hr), n=number of generations, Pi=real power generation of i^{th} generator(MW), Fi(Pi)=generation cost for Pi.

The total power generated should be the same as total load demand plus the total line losses

$$P_D + P_L - \sum_{i=1}^{n} P_i = 0$$

Where, Pd=total system demand (MW)

Pl=transmission loss of the system (MW)

Generation output of each generator should be laid between maximum and minimum limits.

$$P_{n,\min} \leq P_n \leq P_{n,\max}$$

Where, Pn,min = minimum power output limit of nth generator (MW), Pn,max = maximum power output limit of nth generator (MW)

The generation cost function is expressed as quadratic polynomial.

$$F_n(P_n) = a_n P_n^2 + b_n P_n + c_n$$

Where a_n, b_n, c_n are fuel cost coefficients

B. Particle Swarm Optimization(PSO):

PSO is a biologically inspired computational search and optimization technique developed by Eberhart and Kennedy, in 1995, which was inspired by the social behavior of bird flocking and fish schooling in search of food without a leaders. This project presents a quick solution to the economic dispatch problem using PSO algorithm [1].

Step 1: give the initial data, minimum and maximum limits of generation power for each unit

Step 2: The state of each particle is defined by its position and velocity .Those values are randomly taken.

$$X_i = P_{gi,\min} + rand\,(P_{gi,\max} - P_{gi,\min})$$

$$V_i = P_{gi,\min} + rand\,(P_{gi,\max} - P_{gi,\min})$$

Step 3: by employing the B-coefficient calculate the transmission loss Pl using the loss formula

$$P_l = \sum_{i=1}^{n} \sum_{j=1}^{n} P_i B_{ij} P_j$$

$$P_D + P_L - \sum_{i=1}^{n} P_i = 0$$

Step 4: Calculate Pg using the populations and loss P using the formula objective function

$$F_n(P_n) = a_n P_n^2 + b_n P_n + c_n$$

Step 5: now we get the fitness values in between the limits. Select the Pbest value among all the fitness values.

Step 6: till now initial values are form now the updated values of position and velocity have to be form.

$$V_i = w * V_i + C_1 * rand\,() * (Pbest_i - P_{gi}) + C_2 * rand\,() * (Gbest_i - P_{gi})$$

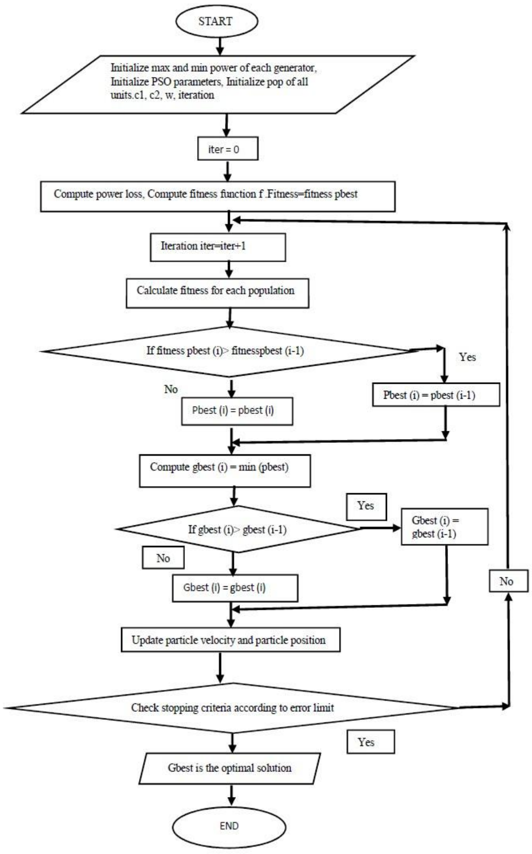
Where, $w = W_{\max} - \left[\frac{W_{\max} - W_{\min}}{iter_{\max}}\right] * iter$

$$X_i = X_i + V_i$$

Step 7: check weather position and velocity updates are in limits are not .if they are not in limits then put them equal to limits.

Step 8: now check the updated values are less than initial values are not .if they are satisfy terminate otherwise again go to Step 6.

Flowchart:



C. Artificial Bee Colony (ABC) Algorithm:

Artificial Bee Colony (ABC) [2][3] Algorithm was published by Karaboga in 2005. Is a swarm based algorithm inspired by the behavior of Honey Bee. n the ABC model, the colony consists of three groups of bees: employed bees, onlookers and scouts. 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. The employed bee whose food source has been abandoned becomes a scout and starts to search for finding a new food source. In the ABC algorithm, the first half of the swarm consists of employed bees, and the second half constitutes the onlooker bees.

The position of a food source represents a possible solution of the optimization problem. The initial parameters of ABC algorithm are the number of food sources (SN). The main aim of this ABC algorithm is also to solve the Economic Dispatch Problem with considering losses and constraints.

D. ABC Algorithm for the ED Problem:

Step 1: control parameters are to be initialize, parameters are colony size (CS), number of food sources (SN=CS/2) is also called as population, the limit for scout (L=SN*D, D is the dimensions of the problem), Maximum Cycle Number (MCN) [2][3].

Step 2: to generate the population i.e., initial position

Xi (i=1,2,3,……….,NS)

Each element in the vector is determined by using

$$X_i = X_i + rand(0,1)*(X_{i\max} - X_{i\min})$$

Step 3: now those randomly generated values are sub statute in the objective function of Economic Dispatch Problem.

Step 4: on basis of those values we have to find the fitness values by using equation

$$Fitness\ (F) = \frac{1}{\sum_{i=1}^{ns}(1+F_i)}$$

Then take the highest fitness value as initial food source. Then set cycle =1. Fit is the fuel cost of each food source.

Step 4: now from this step update values are start each employed bee produces a new solution Vi by using the equation.

$$V_{ij} = X_{ij} + \phi(X_{ij} - X_{kj})$$

Where, k∊ (1, 2, ….., NS) and j∊ (1, 2, ……, NS) are randomly chosen .

ϕ_{ij} is a random number in range [-1,1].

Step 6: then the values of above equation are substitute in the Economic Dispatch problem and then from those values we have to find the fitness, then we pick the maximum value and compare that value with the previous value.

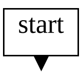
Step 7: if it satisfies then old value replaced by new value. Other wise old one is retained.

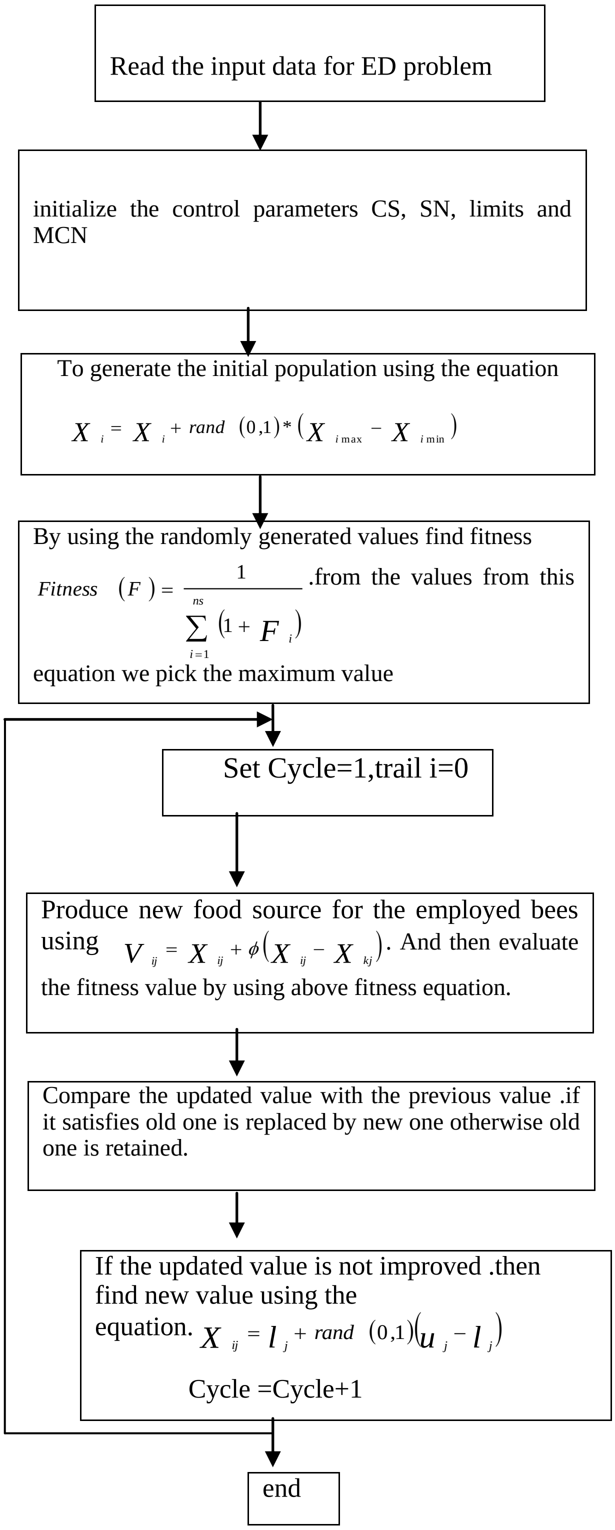
Step 8: if the updated value is not improved .then that food is abandoned. That abandoned will be replaced with new food.

$$X_{ij} = l_j + rand(0,1)(u_j - l_j)$$

Where Li and Ui are lower and upper limits of Xij

E. Flow Chart for ABC Algorithm:





F. Setting parameters for both PSO and ABC:

Table 1:

Parameters	Values
Units	6
Population Size	30
Maximum Iteration	200

Table 2: Cost function coefficients for 6-unit system

Units	1	2	3	4	5	6
ai	240	200	300	150	200	120
bi	7	10	8.5	11	10.5	12
ci	0.0070	0.0095	0.0090	0.0090	0.008	0.0075
Pi,max	500	200	300	150	200	120
Pi,min	100	50	80	50	50	50

Loss coefficients for 6-unit system:

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B=1*10^-6[17    12    7   -1    -5    -2
          12    14    9    1    -6    -1
           7     9   31    0   -10    -6
          -1     1    0   24    -6    -8
          -5    -6  -10   -6   129    -2
          -2    -1   -6   -8    -2   150]
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II. RESULTS

Result of PSO system for 6-unit system

No	PD	P1	P2	P3	P4	P5	P6	PL
1	500	46.7265	74.3379	167.622	105.079	52.1834	57.3190	1.9632
2	700	210.1664	67.6126	145.268	81.8778	113.6250	85.5501	4.1589
3	1000	365.4501	109.8887	195.912	91.6799	148.5290	93.9581	8.2513
4	1200	405.1936	190.8502	272.707	105.015	143.3713	91.0931	11.504

Results for ABC system for 6-unit system:

No	PD	P1	P2	P3	P4	P5	P6	PL
1	500	100.0608	78.7737	80.0234	93.6051	59.5100	90.2098	2.1827
2	700	104.0572	124.812	83.3032	150	122.422	120	4.5954
3	1000	188.3100	200	150.705	150	200	120	9.0153
4	1200	301.1690	200	240.554	150	200	120	11.728

CONCLUISION

In this paper 6-unit system has taken to compare the results of two methods one is PSO and another one is ABC, to get the best results. Simulation results show in solving ED .the obtained results of both PSO and ABC are compared each other, PSO get the best result in reducing losses and total cost. Here different types of loads are demands are applied 500, 700, 1000, and 1200. Also verify the results for 3-Unit and 5-Unit system in this paper those results are not showed but data will be taken from [4].

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