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PSO Enhanced Global Search Ability Algorithm for Economic Load Dispatch in Electric Power System

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Abstract – *Economic Load Dispatch(ELD) proves to be a vital optimization process in electric power system for allocating generation amongst various units to compute the cost of generation , the cost of emission involving global warming gases like sulphur dioxide, nitrous oxide and carbon monoxide etc. It is here and now determination of the most ideal yield of various generators units, to meet the power framework stack, at the base conceivable cost, topic to operational requirements and transmissions. In this paper tries to show the numerical detailing of Economic load dispatch issue arrangement utilizing delicate registering method in electric era structure considering different physical and power induced system imperatives which helps to increases the tendency of particles to venture into the solution space to ameliorate their convergence rates. to deal with nonlinear optimization problem emanating out of valve point loading constraints and prohibited operating zones with ramp rates owing to irregular opening and closing of steam valves in huge thermal power plants.*

***Key Words*: Economic load dispatch, Equality constraints, In-equality constraints, PSO enhanced global search ability algorithm**

1. INTRODUCTION

Power system stability is the tendency of a power system to develop restoring forces equal to or greater than the disturbing forces to maintain the state of equilibrium. In this paper, particle swarm optimization (PSO) which is one of the computational algorithm technique is applied successfully to solve the problem of economic load dispatch. The objective function[1][2] considered here is minimization of fuel cost of generators for different bus systems used in thermal power plant.

The entire work of figure and making these evaluations is known as load dispatch. The financial load dispatch implies that the generator's yield is permitted to change inside persuaded restrains so that to take care of a specific load demand contained by least fuel cost. Thus, there is a wide trend of adopting stochastic algorithms which are able to effectively solve the economic dispatch problem. Propitious results have been reported during the past few years and several methods like genetic algorithm (GA) [3], Ant colony optimization[9] and many other methods were successfully implemented in practical ED problems significantly improving the existing results of the problem.

2. PROBELM FORMULATION

The basic ELD problem is formulated in equation (1) and (2) as follows.

$$Z_i = (a_i PG_i^2 + b_i PG_i + C_i) + K_i \sin(l_i(P_i - PG_i)) \quad (1)$$

$$J_i = (h_i PG_i^{\ 2} + g_i PG_i + q_i) \quad (2)$$

Where Z_i and J_i are cost and emission objective functions and a_i, b_i, c_i, K_i, l_i and h_i, g_i, q_i are cost and emission objective function coefficients. It involve combined objective formulation encompassing cost as well as emission objective function vide price penalty factor Pf_i is formulated as (3).

$$S_i = Z_i + Pf_i \times J_i \quad (3)$$

$$Pf_i = Z_{i\max} / J_{i\max} \quad (4)$$

The constraints involved in this work are

(i)Equalityconstraint

$$\sum_{i=1}^{n} PGi = P_D + TransmissionLoss \quad (5)$$

Where P_D = net power demand.

(ii) Inequality constraint

$$P_i \langle PG_i \langle P_j \quad (6)$$

Where PG_i represents the output power of i^{th} generating unit, P_i and P_j are minimum and maximum output Power of i^{th} generating unit respectively.

3. OVER VIEW ON PSO TECHNIQUES

This section describes the proposed Particle Swarm Optimization method. It is an optimization and search

technique based on the principles of social behavior of animals. The method was developed in 1995 by James Kennedy and Russell Eberhart [5][6]. PSO is very good at finding good enough solutions for a large range of problems, such as constrained optimization problems, multi-objective optimization problems, etc.

It is a simple and powerful optimization tool which scatters random particles, i.e., solutions in the problem space. These particles, called swarms collect information from each array constructed by their respective positions. The particles update their positions using the velocity of particles. Position and velocity[8] are both updated in a heuristic manner using guidance from particles' own experience and the experience of its neighbour so obtain position and velocity vectors viz. P_{best} and g_{best} i.e.(P_{1best}, P_{2best} ..... P_{ibest}) and (g_{1best} , g_{2best} ..... g_{ibest}) respectively. The updated values of position and velocity are computed using equation (7) and (8).

$$v_i^{(t+1)} = wv_i^t + c_1 rand\,(p_i^{lb} - x_i^t) + c_2 rand\,(p_i^{gb} - x_i^t) \quad (7)$$

$$x_i^{t+1} = x_i^t + v_i^{t+1} \quad (8)$$

Where C_1, C_2 are acceleration coefficients

W = Inertia weight

V_i^t = Initial i^{th} particle after t^{th} iteration

V_i^{t+1} = Updated velocity of particle at t+1 iteration

X_i^t = Initial i^{th} particle after t^{th} iteration

X_i^{t+1} = Updated position of particle at t+1 iteration

Here w describes inertia weight that controls the momentum of the particle by weighing the contribution of the previous velocity–basically controlling how much memory of the previous flight direction will influence the new velocity.

4. PSO ENHANCED GLOBAL SEARCH ABILITY ALGORITHM

Efforts have also been made to see that it provides convergence[10] to the global or near global optima, irrespective of the nature of discontinuities of the cost function in Electric power system w.r.t.Fig-1.

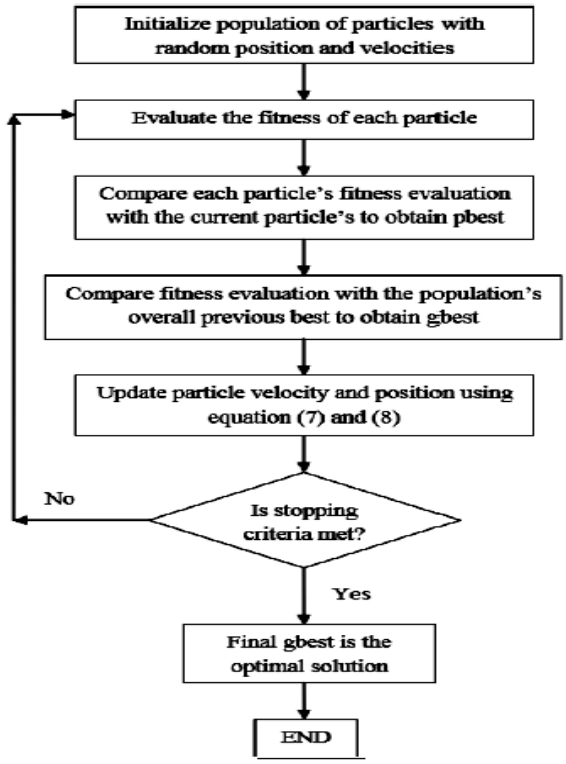

Fig -1: PSO enhanced global search ability algorithm

4. RESULTS AND DISCUSSION

Table -1: Unit Data for Test Case-1

Unit	a_i	b_i	c_i	PD	h_i	g_i	q_i	k_i	l_i
1	623	9.8	0.199	100	334	4.9	0.995	290	0.025
2	563	9.91	0.163	200	284.5	4.955	0.815	180	0.031
3	359	8.7	0.125	250	184.5	4.35	0.525	180	0.032
4	350	8.6	0.222	300	185	4.3	0.561	130	0.053
5	445	10.1	0.104	350	228.5	5.05	0.152	140	0.052
6	617	9.99	0.209	400	313.5	4.995	0.145	140	0.051

Table -2: Comparison between Unit capacity, Cost Coefficients, Emission Coefficients of PSO techniques in Electric Power System

Unit Power Ou	Global Search ability based PSO	PSO	GA	ACO
PG_1 (MW)	252.2674	251.2671	251.2671	262.148
PG_2 (MW)	262.1489	262.1489	262.1489	262.148
PG_3 (MW)	261.3404	261.3404	261.3404	261.340
PG_4 (MW)	268.7295	268.7295	268.7295	268.729
PG_5 (MW)	281.2335	281.2335	281.2335	281.233
PG_6 (MW)	295.0630	295.0630	295.0630	295.063
Loss (MW)	20.98	21.85	23.26	27.92
Total Power output	1621	1621.85	1623.26	1627.92
Operating cost($/hr)	37358	38122	42181	49533
Emission Level(T/hr)	16690	22079	26072	29534

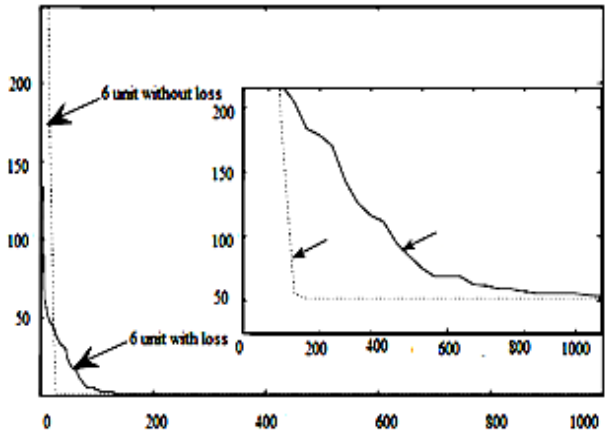

Fig -2: Convergence characteristics of PSO enhanced global Search algorithm

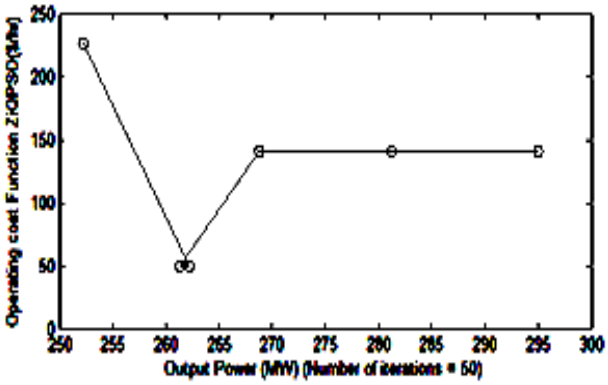

Fig-3: Operating cost function vs output power

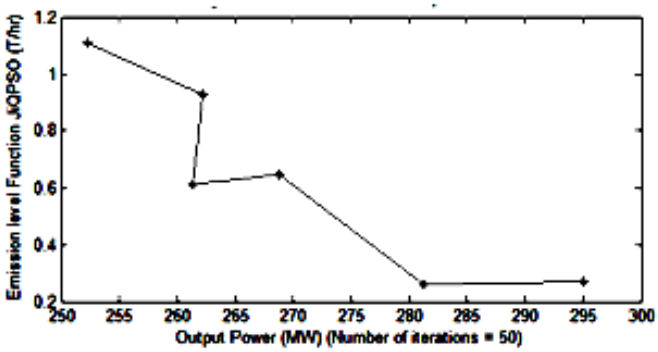

Fig-4 : Emission level function vs output power

5. CONCLUSION

It is extensively used for solving the nonlinear problems with respect to Fig.1, it is associated with the cost function. However, for dealing with constrained convex and non-convex ELD problems various modifications in the basic structure of PSO[4][5] are suggested in the literature in the proposed PSO method. This part of the paper provides a detailed and comprehensive review of PSO and its modified versions with respect to Fig,2, Fig.3 and Fig.4 applied solely to work out the practical ELD problems. With respect to Table 1 and Table 2, it is found from the proposed research that PSO method yields near global solution and gives better performance over the meta-heuristic methods like particle swarm optimization (PSO), genetic algorithms (GAs), ant colony optimization (ACO)etc.

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BIOGRAPHIES

Mrutyunjay Senapati completed his B.Tech degree in EEE from The Techno School in the year 2010 and completed his M.Tech degree in Power system & control Engineering from CUTM, Bhubaneswar in the year 2014. Prior to it he worked as an Asst. Professor in the Dept. of EEE in at KEC, Bhubaneswar from 2010 to 2011.Now he is working as an Asst. Professor in the Dept. of Electrical Engineering at GIET, Ghangapatna, Bhubaneswar since 2011 onwards.A part that he has published so many International journals in the field of Electrical Engineering.