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Particle Swarm Optimization: Algorithm for an improved computational performance to solving Economic Dispatch Problems

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Abstract*— This paper introduces an effective and reliable particle swarm optimization (PSO) algorithm based method to solving economic dispatch(ED) problems. This PSO method is most efficient because it consumes less computation time. This paper also presents comparative study between the cost in Rs. /hr. and C.P.U. time with equal swarm size and also equal number of iteration for 15 runs. A comparative study of different technique is done and we can see that PSO offer a better result with lesser time. We can also obtain the result for the convergence of the particle in search space to the global best solution point after some iteration. We also find out the C.P.U. time with equal number & different size of iteration. The final result shows that the PSO technique is capable to obtaining efficient and higher quality solution in ED problems with fast computation time.

***Index Terms*—Genetic algorithm, computational efficiency, particle swarm optimization.**

I. INTRODUCTION

Economic dispatch problem is of the important issues in power system. It is an optimization problem and its main purpose to decreases the total generation cost of units. The Particle Swarm Optimization is produce by Kennedy and Eberhard, is one of the best method. PSO are considered as powerful and reliable technique to solve optimization problems with less computational time for different number of iteration [1]. PSO united swarming behaviors observed in flocks of birds, schools of fish and even human social behaviors from which the idea is come by applied PSO technique we can easily to solve various function optimization problem[2]. The PSO technique solving continuous non linear optimization problems with shorter computational time and generate high quality solutions the PSO technique is also used to different field of power system optimization like voltage control and electromagnetic the PSO technique can generate high quality result with stable characteristic and shorter characteristic[1]-[3]. By help of velocity and position equation we can update the value of velocity and position of the particle. PSO considering the power balance equation, system transmission as equality constraint and limit the active power generation of units. The main objective of the PSO technique is solving optimization problem with fast convergence speed [4]. Particle swarm optimization is one of the modern heuristic algorithm techniques and has been found to be strong in solving continuous non linear optimization problems [5]. PSO is one of the evolutionary computation method that can be applied and improve to various problems solutions. The original technique is able to deal with continuous state variable easily [6]. It is a multi-agent search method.PSO system consisting particle fly around in a multidimensional search space [7]. In this technique behavior of birds flocking and fish schooling called particle and agent. In PSO technique each particle represents a potential solution with in search space [8]. Therefore particle position and velocity are representing by multidimensional vectors. As compare to other method PSO is a best technique to solve the ELD problems with efficient computation time [9]. The PSO can solve problems with high quality solution, easily implemented and stable convergence characteristic [10].

II. OVERVIEW OF PARTICLE SWARM OPTIMIZATION

PSO algorithm is initialized with a population of random solution, said particle. The particles have fly in tendency toward better search position over the process of searching. During this process each particle keeps of its coordinates in the space. So that best solution (fitness) has achieved. This value is called $pbest$. There are two important terms known as $pbest$ and $gbest$ value. Best optimization solution in a swarm is known as $gbest$ value. There is some important key defined as

$pbest$ - a particle Individual position

$gbest$ - a particle Individual position for the entire swarm

Particle/agent- In a swarm single individual (bees)

Swarm- the particle entire area covered

v_{max} - The maximum velocity in a given direction

Fitness: The particle goodness value

Location/position- n-dimensional coordinates of the particle The PSO algorithm defined with some steps-

Step 1) The solution space describes.

Step 2) The fitness value defines.

Step 3) Swarm position & velocity initialize.

Step 4) $pbest$ & $gbest$ solution find.

Step 5)The particle velocity & position update.

Step 6) Processes repeat & find the stop criteria

The particle velocity is changed by help of following equation (1) is

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V_n= $\omega v_n + e_1 rand_1 \times (pbest, n - x_n) + e_2 rand_2 \times (gbest, n - x_n)$ (1)

Where,

v_n= Velocity of particle in the n^{th} dimensional search space

ω = Inertia weight

x_n= Particle coordinates in n^{th} dimensional search space

e_1 and e_2 =Two positive acceleration constants

$rand_1, rand_2$ = The random number functions between 0.0 to 1.0. The computed new coordinate for each dimension by following equation (2)

$X_n = x_n + \Delta t \times V_n$ (2)

over the run time inertia weight varying linearly from 0.9 to 0.4.

III. PROBLEM DESCRIPTION

The main purpose of PSO is reducing of generation cost with higher generating output and less computational time. For this we have used some inequality constraints. There are some inequality constraints given by:

$P_n^{min} \leq P_n \leq P_n^{mix} (n = 1, \ldots . n_g)$ (3)

Where

P_n^{min} Minimum generating limit for plant n

P_n^{max} Maximum generating limits for plant n

With B-coefficients the total power losses are given as,

$P_L = \sum_{n=1}^{n_g} \sum_{m=1}^{n_g} P_n B_{nm} P_m$ (4)

The total generating cost is define as,

$F_t = \sum_{n=1}^{n_g} F_n (P_n) = \sum_{n=1}^{n_g} \alpha_n + \beta_n P_n + \gamma_n P_n^2$ (5)

Where

F_n = Cost function

$\alpha_n, \beta_n, \gamma_n$ = Cost Coefficient Of the n^{th} generator

n_g = The Total Generating Plants

P_n= The output of the n^{th} Plant here,

By help of this solution, we find temporary variable so that $pbest$ value storage. PSO algorithm also finds the Elaped time or program runtime. In this paper for less generating cost rate and meet the load demand with satisfying constraints or we can given as:

$Min\ C_t = \sum_{n=1}^{n_g} F_n (P_n) = \sum_{n=1}^{n_g} \alpha_n + \beta_n P_n + \gamma_n P_n^2$ (6)

IV. SIMULATION RESULTS AND COMPARISONS

In this paper, the PSO algorithm is most efficient technique with less computational time. The PSO algorithm is implemented with high speed using MATLAB software. For the multi-dimensional problem solution we can used PSO algorithm. We have set of the acceleration constant e_1&e_2 for standard PSO as e_1=e_2=2.0. By using PSO technique the economic load dispatch problem is solving with less computational time & reasonable iteration. We can also compare the PSO technique with the GA method in CPU iteration / time. The PSO algorithm solves the optimization problem efficiently as compared to the GA

S.NO	No of iteration	Swarm size	C.P.U. Time	Cost in Rs./Hr
1	30	1000	0.400115	15261
2	30	1000	0.422805	15284
3	30	1000	0.423268	15303
4	30	1000	0.406470	15379
5	30	1000	0.381048	15320
6	30	1000	0.414626	15287
7	30	1000	0.419901	15295
8	30	1000	0.401199	15279
9	30	1000	0.413259	15260
10	30	1000	0.420924	15277
11	30	1000	0.422030	15276
12	30	1000	0.411271	15252
13	30	1000	0.421215	15303
14	30	1000	0.420671	15344
15	30	1000	0.395735	15275

Table I. Comparison of Computational Time and Cost for 15 Runs

Iterations	10	20	30	40	50
Generation Cost (Rs. /hr.) for PSO	15,361	15,343	15,334	15,297	15,280
CPU Time (Sec.)for PSO	0.2355	0.2937	0.5187	0.6457	0.7708
CPU Time/ iteration (Sec.)for PSO	0.09	0.09	0.09	0.09	0.09
Generation Cost ($) for GA	15,620	15,615	15,608	15,608	15,605
CPU Time (Sec.)for GA	4.34	10.49	21.31	31.53	42.07
CPU Time/ iteration (Sec.)for GA	0.22	0.22	0.22	0.22	0.22

Table II. Comparison of computational efficiency of PSO and GA

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S.NO.	Swarm Size	Maximum Cost in Rs./Hr
1	2	8.0434e+03
2	4	9.0413e+03
3	6	9.6410e+03
4	8	5.0394e+03
5	10	7.8049e+03

Table III. Comparison of Cost by Varying Swarm Size for PSO

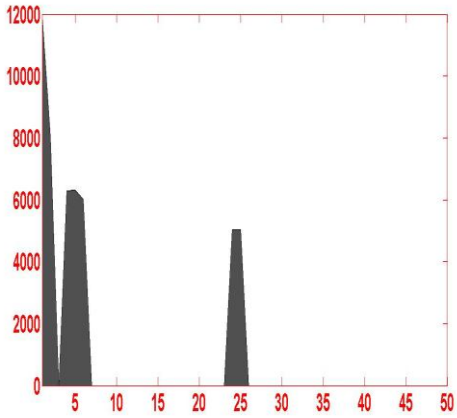

Fig.1 Relation between 50 iteration and cost in Rs. / hr (swarm size = 2)

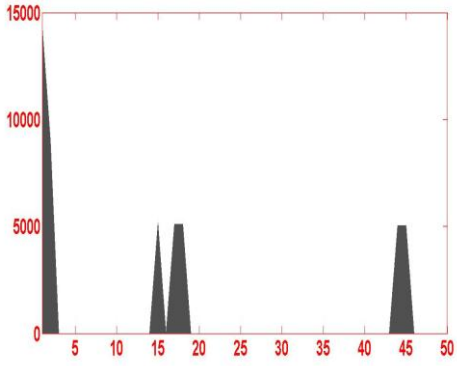

Fig. 2 Relation between 50 iteration and cost in Rs. / hr (swarm size = 4)

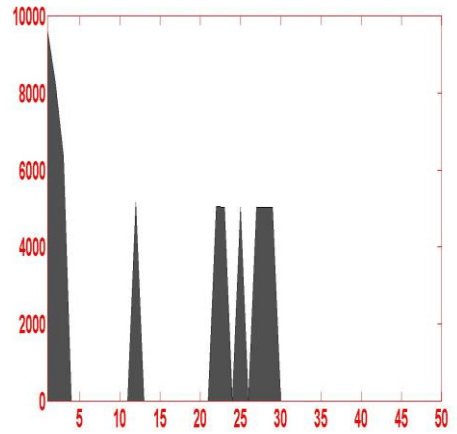

Fig.3 Relation between 50 iteration and cost in Rs. / hr (swarm size = 6)

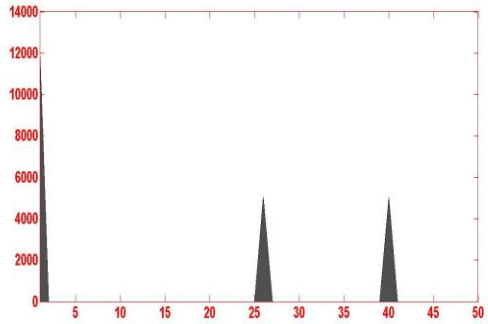

Fig.4 Relation between 50 iteration and cost in Rs. / hr (swarm size = 8)

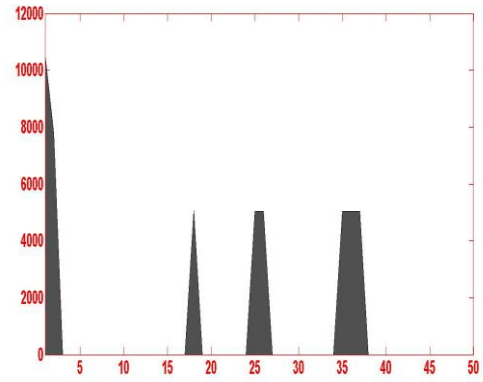

Fig.5 Relation between 50 iteration and cost in Rs. / hr (swarm size = 10)

V. CONCLUSION

The PSO algorithm is also using non-liner, multi model and non–differential problem. The PSO algorithm is simple concept, lower computational time and higher solution quality. The PSO technique improves the computational efficiency, time and convergence. So we can observe that the PSO technique has better convergence efficiency in solving optimization problems.

REFERENCES

[1] Sachin Gopal Soni, Manjaree Pandit and Laxmi Shrivastava‟ Particle Swarm Optimization Technique for Solving Economic Dispatch Problem of Large Power” National Conference on Advances in Power Systems and Energy Management, March 1st – 2nd, 2008.

[2] Sachin Gopal Soni, Dr. M. Pandit‟ Particle Swarm Optimization: An evolutionary approach for optimization of non-linear function” AICTE Sponsored National Conference on Advances in Electrical Engineering (AEE06) pp 524-529, November 29-30, 2006.

[3] Ravinder Singh Maan, Om Prakash Mahela, Mukesh Gupta ‟Economic Load Dispatch Optimization of Six Interconnected Generating Units Using Particle Swarm Optimization” IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) Volume 6, Issue 2 (May. - Jun. 2013), PP 21-27.

[4] Rohit Kumar, Pancholi, K.S.Swamp.‟ Particle Swarm Optimization for Economic Dispatch with Line flow and Voltage Constraints” 0-7803-765l-xi01/$l7.00 Q 2003 IEEE PP-450-455.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 5, November 2014

[5] Zwe-leegaing."Particle Swarm Optimization to Solving the Economic Dispatch Considering the Generator Constraints" ieee transactions on power systems, pp-1187-1193 Volume 18 , 3, august 2003.

[6] Tatsuya Tsukada, Toyokazu Tainura, Shinji Kitagawa, Yoshikazu Fukuyama." Optimal Operational Planning for Cogeneration System Using Particle Swarm Optimization" 0.7803-7914-4/03/$10,00@2~ IEEE PP-138-143.

[7] B. Zhao, C.X. Guo, and Y.J. Cao, Member, IEEE" An Improved Particle Swarm Optimization Algorithm for Optimal Reactive Power Dispatch"PP-1-8, 2008.

[8] Susana C. Esquive, Carlos A. Coello Coello "On the Use of Particle Swarm Optimization with Multimodal Functions" 0-7803-7804-0 /OM1 7.00 0 2003 IEEE PP-1130-1136.

[9] A. Immanuel Selva Kumar, K.Dhanushkodi, Jaya Kumar, C. Kumar Charlie Paul "Particle Swarm Optimization Solution to Emission and Economic Dispatch Problem"U-7803-765i-X/03/ 17.WOZW3 EEE.

[10] M.M. Salama, M.M. Elgazar, S.M. Abdelmaksoud, H.A. Henry" Optimal Generation Scheduling of Cascaded Hydrothermal System Using Genetic Algorithm and Constriction Factor Based Particle Swarm Optimization Technique" International Journal of Scientific & Engineering Research, Volume 4,PP-750-761, Issue 5, May -2013.

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