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ADAPTIVE TIME VARIENT PSOAC FOR SOLVING ECONOMIC LOAD DISPATCH

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Abstract- A Modified Adaptive Time Variant Particle Swarm Optimization with Acceleration Coefficient that called ATV-PSOAC is present to solve Economic Load Dispatch (ELD). The ELD problem plays an important role in the operation of power system, and several models by using different techniques have been used to solve this problem. To achieve a practical simulation, considered practical generator constrains, many nonlinear constraints of the generator, such as ramp rate limits, prohibited operating zone, generation limits, transmission line loss and non-smooth cost functions. The ATV-PSOAC method is applied to find out the advantages of application of the proposed algorithm in particular to the economic load dispatch problem. Here, an attempt has been made to find out the minimum cost by using ATV-PSOAC using the data of six and forty generating units.

Keywords: ATV-PSOAC Optimization, ELD Problem, Valve Point Effect, Practical Constrains.

I. INTRODUCTION

An engineer is always concerned with the cost of products and services, the efficient optimum economic operation and planning of electric power generation system have always occupied an important position in the electric power industry. With large interconnection of the electric networks, energy tension in world and continuous rise in prices, it is very indispensable to reduce the running charges of the electric energy. A saving in the operation of system of a small percent represents a significant reduction in operating cost as well as in quantities of fuel consumed.

The classic problem is the Economic Load Dispatch (ELD) of generating systems to achieve minimum operating cost [1]. The basic object of economic load dispatch is the distribution of total generation of power in the network such that the cost of power delivered is minimum. By economic load dispatch we mediocre to find the generation of the different generators or plants so that the total fuel cost is minimum and at the same time the total demand and the losses at any instant must be met by the total generation. In case of ELD, the generations are not fixed however, they are allowed to take values again within certain limits so as to meet a particular load demand with minimum fuel consumption.

This alternative economic load dispatch problem is really the solution of large number of load flow problems and choosing the one, which is optimum in the sense that it needs minimum cost of generation. The ELD problem is to find the optimal scheduling the generating plants to meet the demand at minimum operating cost while satisfying all equality and inequality constraints [1-6]. Accordingly, many classical methods, such as gradient-based method, Linear Programming (LP), Quadratic Programming (QP), and Lagrange Relaxation (LR) [7] have been applied to solve the economic load dispatch problems by approximating the cost function of each generator by a single quadratic function.

However, duo to the valve point effects, ramp rate limits, and multi-fuel optimization, the propose problem is a nonlinear one with many local optima and multiple constraints in nature, which prevents the classical methods from obtaining the global optima. Although dynamic programming [8] can be used to solve the ELD problem, it suffers from the curse of dimensionality and thus it is not practical for many real-world applications. Kit Po Wong has presented [9] the Computational Intelligence (CI) methods include techniques in artificial intelligence, fuzzy logic, artificial neural networks, and evolutionary computation [8]. These methods concentrate on recent development of:

A) Artificial-Intelligent based approach
B) Evolutionary-Programming based economic dispatch
C) Genetic-Algorithm based economic dispatch method

For the area in (A), Artificial-Intelligent based learning ability will be described. A corrected Evolutionary Programming method for economic dispatch will be presented for the area in (B). J.C. Silva Chavez have presented a parallel population repair genetic algorithm for power economic dispatch. In the present work, Power Economic Dispatch (ED) technique based on Genetic Algorithms (GA) is presented. The ED with GAs is developed based on real-valued codification. In the developed methodology, only the cost function is evaluated and a global minimum solution is computed, independently of the cost function type. In order to achieve this solution, a novel strategy based on the energy conservative space concept [10].

Particle Swarm Optimization (PSO) is a population based optimization method first proposed by Kennedy and Eberhart [11]. In order to find an optimal or near optimal solution to the problem, PSO updates the current generation of particles (each particle is a candidate solution to the problem) using the information about the best solution obtained by each particle and the entire population. It was developed through simulation of a simplified social system, and has been found to be robust in solving continuous nonlinear optimization problems [3].

The PSO technique can generate high-quality solutions within shorter calculation time and stable convergence characteristic than other stochastic methods. Although the PSO seems to be sensitive to the tuning of some weights or parameters, many researchers are still in progress for proving its potential in solving problems, which are complex. However, we propose higher order cost functions for (a) better curve fitting of running cost, (b) less approximation, (c) more practical, accurate and reliable results, and new enhanced PSO is introduced to calculate the optimum dispatch of the proposed higher order cost polynomials. Constraint management is incorporated in the propose method and no extra concentration is needed for the higher order cost functions of single or multiple fuel units in the proposed method.

II. THE ELD FORMULATION

The optimum load dispatch problem involves the solution of two different problems. The first of these is the unit commitment or pre dispatch problem wherein it is required to select optimally out of the available generating sources to operate to meet the expected load and provide a specified margin of operating reserve over a specified period time. The second aspect of economic dispatch is the on line economic dispatch whereas it is required to distribute load among generating units actually paralleled with the system in such manner as to minimize total cost of supplying minute-to-minute requirements of system.

The objective of this work is to find out the solution of nonlinear on line economic dispatch problem by using ATV-PSOAC algorithm [3]. Essentially, the adjustments of the power output are instantaneous that is one of the unpractical assumptions. Accordingly, generators are constrained because of ramp rate limits where, generation may increase or decrease with corresponding upper and downward ramp rate limits [9]. Therefore, the operating range of all online units is restricted by their ramp rate limits, which are, defines as:

- Power generation increasing, $P_i - P_i^0 \le UR_i$
- Power generation decreasing, $P_i^0 - P_i \le DR_i$

where, P_i is the current is output power of ith unit, P_i^0 is previous output power, UR_i is the up ramp limit of the ith generator, DR_i is the down ramp limit of the ith generator.

According to this fact that, the prohibited operating zones in the input/output curve of generator are due to vibration in a shaft bearing/steam valve operation it should be noted that, finding the actual prohibited zone by actual performance testing/operating records is really difficult. That leads to getting the best economy by avoiding operation in areas [7].

Therefore, adjustment of the generation output of a unit must avoid operation in the prohibited zones. For this purpose, the feasible operating zones of generators are described as:

$$A_{ai} = \begin{cases} P_i^{\min} \le P_i \le P_{i,1}^l \\ P_{i,j-1}^u \le P_i \le P_{i,j}^l \qquad j = 2,3,...,n_i \;,\; i = l,...,m \\ P_{i,ni}^u \le P_i \le P_i^{\max} \end{cases} \qquad (1)$$

where, A_{ai} is feasible operating zones of ith unit.

Due to minimizing fuel cost is the primary concern of operation planning, the objective of ELD problem in this study is to minimizing total generator fuel cost. That can be expressed as:

$$F_t = \sum_{i=1}^{m} F_i(P_i) \qquad (2)$$

$$F_i(P_i) = \sum_{i=1}^{m} (a_i P_i^2 + b_i P_i + c_i) \quad , \quad i = 1,...,m \qquad (3)$$

where, F_t is the total generation cost and F_i is the cost function of the ith generator, a_i, b_i and c_i present the cost coefficients in ith generator. In addition, the electrical output of the ith generator is shown by P_i and m is the number of generators committed to the operating system.

This constrained ELD problem is subjected to a variety of constraints depending upon assumptions and practical implications [6-7]. These constraints are discussed as follows.

A. Power Balance

This constraint is based on the principle of equilibrium between total system generation (P_t) and total system loads (P_D) and losses (P_L) that is:

$$P_t = P_D + P_L \quad , \quad i = 1,...,m \qquad (4)$$

$$P_t = \sum_{i=1}^{m} P_i \qquad (5)$$

where, P_L is obtained using B coefficients, given by:

$$P_L = \sum_{i=1}^{m}\sum_{j=1}^{m} P_i B_{ij} P_j + \sum_{i=1}^{m} B_{0i} P_i + B_{00} \qquad (6)$$

B. Generator Operation Constraints

$$\begin{cases} P_i^{\min} \le P_i \le P_i^{\max} \\ \max(P_i^{\min}, P_i^0 - DR_i) \le P_i \le \min(P_i^{\max}, P_i^0 + UR_i) \\ P_i \in A_{ai} \end{cases} \qquad (7)$$

where, $P_i^{\min}$ and $P_i^{\max}$ are lower and upper bounds for power outputs of the ith generating unit.

C. Line Flow Constraints

$$\left| P_{Lf,k} \right| \le P_{Lf,k}^{\max} \quad , \quad k = l,...,L \qquad (8)$$

where, $P_{Lf,k}$ is the real power flow of line k, $P_{Lf,k}^{\max}$ is the power flow up limit of line k and L is the number of transmission lines.

III. PARTICLE SWARM OPTIMIZATION WITH TIME VARYING ACCELERATION COEFFICIENTS

A. Particle Swarm Optimization

Classic PSO (CPSO) is one of the optimization techniques and a kind of evolutionary computation technique, which is launched by the Aberhart Rasel. The method has been found to be robust in solving problems featuring nonlinearity and non-differentiability, manifold optima, and high dimensionality through adaptation, which is isolated from the social-psychological theory. The characteristics of the method are as follows [12]:

- The method is improved from research on swarm such as fish schooling and bird flocking.
- It is based on a simple concept. Therefore, the time of calculation is short and requires few memories [13].
- It was originally developed for nonlinear optimization problems with continuous variables. It is simple expanded to treat a problem with discrete variables.

CPSO is basically improved through simulation of bird flocking in two-dimension space. The location of each agent is represented by *XY* axis position and the velocity is expressed by V_x (the velocity of *X* axis) and V_y (the velocity of *Y* axis). Correction of the agent position is realized by the position and velocity information [14]. Bird flocking optimizes a certain objective function. Each agent knows its best value so far (p_{best}) and its *XY* position.

This information is deduction of personal experiences of each agent. Moreover, each agent knows the best quantity so far in the group (g_{best}) among p_{best}. This information is analogy of knowledge of how other agents around them have performed. Videlicet, each agent tries to modify its position using following information [15]:

- The current positions (x, y)
- The current velocities (V_x, V_y)
- The distance between the current position and p_{best}
- The distance between the current position and g_{best}

This modification can be represented by the concept of velocity and the place of that. Velocity of each agent can be modified by the following equation:

$$V_i(t+1) = wv_i(t) + c_1 r_1(t)[p_{best,i}(t) - x_i(t)] + c_2 r_2(t)[leader_i(t) - x_i(t)] \quad (9)$$

where, x_i is position of agent i at iteration k, v_i is velocity of agent i at iteration k, w is inertia weighting, $c_{1,2}$ is tilt coefficient, $r_{1,2}$ is rand random number between 0 and 1, $leader_i$ is archive of unconquerable particles, $p_{best,i}$ is p_{best} of agent i, g_{best} is g_{best} of the group.

Convergence of the PSO strongly depended on w, c_1 and c_2. While $c_{1,2}$ are between 1.5 till 2, however the best choice to these factors is 2.05. Also, $0 \le w < 1$ whereas this value is really important factor to the system convergence and this is better that this factor define dynamically. While it should be between 0.2 and 0.9 and it should decrease linear through evolution process of population. Being extra value of w at first, provides appropriate answers and small value of that help the algorithm to convergence at end [16].

B. PSO with Time-Varying Inertia Weight (PSO-TVIW)

The PSO-TVIW method is capable of locating a good solution at a significantly faster rate, when compared with other optimization techniques; its ability to fine tune the optimum solution is comparatively weak, mainly because of the lack of diversity at the end of the search [16]. In addition, in PSO, problem-based tuning of parameters is a key factor to find the optimum solution accurately and efficiently. The main concept of PSO-TVIW is similar to CPSO. However, for PSO-TVIW the velocity update equation is modified by constriction factor C and inertia weight w is linearly decreasing as iteration grows [16].

$$V_i(t+1) = C\{\omega v_i(t) + c_1 r_1(t)[p_{best,i}(t) - x_i(t)] + c_2 r_2(t)[leader_i(t) - x_i(t)]\} \quad (10)$$

$$C = 2 / \left| 2 - \phi - \sqrt{\phi^2 - 4\phi} \right| \quad , \quad 4.1 \le \phi \le 4.2 \quad (11)$$

C. PSO with Time-Varying Acceleration Coefficients (PSO-TVAC)

Consequently, PSO-TVAC is extended from the PSO-TVIW. All coefficients including inertia weight and acceleration coefficients are varied with iterations. The equation of PSO-TVAC for velocity updating can be expressed as [17]:

$$V_i(t+1) = C\{wv_i(t) + ((c_{1f} - c_{1i})\frac{k}{k_{\max}} + c_{1i}) \times r_1(t)[p_{best,i}(t) - x_i(t)] + ((c_{2f} - c_{2i})\frac{k}{k_{\max}} + c_{2i}) \times r_2(t)[leader_i(t) - x_i(t)]\} \quad (12)$$

The procedure of PSO-TVAC for tuning the parameters is described in Figure 1. The simulation operated with multi objective with PSO-TVAC algorithm and the objective functions for optimization as follow.

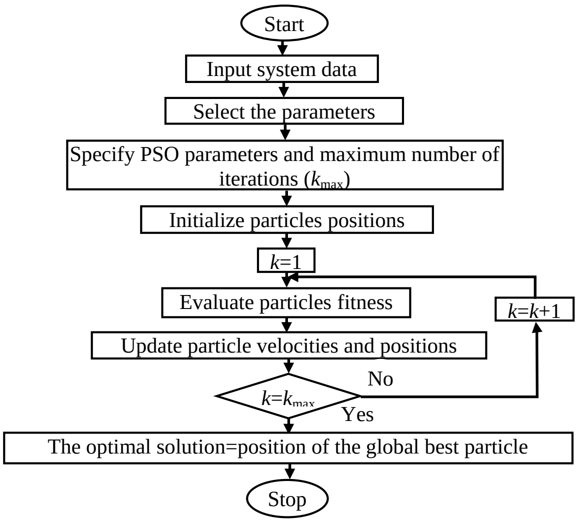

Figure 1. Flowchart of the PSO-TVAC [18]

IV. SIMULATION AND RESULTS

The different methods discussed earlier are applied to two cases to find out the minimum cost for any demand. In this part, the two test systems as, IEEE 6-generator 30-bus and 15 unit system with prohibited operating zones tested with valve-point loading effects without transmission loss.

Table 1. Best simulation results of 6-unit system

Unit power output (MW)	GA	PSO	CPSO1	CPSO 2	SOH_PSO	IPSO	PSOTVAC
P_1	474.8066	447.8066	434.4236	434.4295	438.21	440.5711	442.5245
P_2	178.6363	173.3221	173.4385	173.3231	172.58	179.8365	173.1656
P_3	262.2089	263.4745	274.2247	274.4735	257.42	261.3798	260.5522
P_4	134.2826	139.0594	128.0183	128.0598	141.09	131.9134	154.1444
P_5	151.9039	165.4761	179.7042	179.4759	179.37	170.9823	162.5562
P_6	74.1812	87.1280	85.9082	85.9281	86.88	90.8241	85.2654
P_{Total} (MW)	1276.03	1276.01	1276.0	1276.0	1275.55	1275.5072	1278.208
Minimum cost ($/h)	15459	15450	15447	15446	15446	15444	15443
P_{Loss}	13.0217	12.9584	12.9583	12.9582	12.55	12.548	12.1156
Mean cost ($/h)	15469	15454	15449	15449	–	15446.3	15445
Maximum cost ($/h)	16441.8	16215.3	15546.2	15546	–	15466.4	15463
Tolerance	0.0083	0.0516	0.0417	0.0418	0.0000	0.0408	0.0000

Table 2. Best simulation results of 15-unit system, P_D = 2630 MW

Unit power output (MW)	PSO	Hybrid GAPSO	CPSO1	CPSO 2	SOH_PSO	IPSO	PSOTVAC
P_1	439.1162	436.8482	450.05	450.02	455.00	455.00	455.0000
P_2	407.9727	409.6974	454.04	454.06	380.00	380.00	370.8335
P_3	119.6324	117.0074	124.82	124.81	130.00	129.97	130.0000
P_4	129.9925	128.2705	124.82	124.81	130.00	130.00	129.8452
P_5	151.0681	153.3361	151.03	151.06	170.00	169.93	227.2245
P_6	459.9978	457.4078	460	460	459.96	459.88	460.0000
P_7	425.5601	424.4400	434.53	434.57	430.00	429.25	460.7731
P_8	98.5699	101.1949	148.41	148.46	117.53	60.43	140.6221
P_9	113.4936	116.1186	63.61	63.59	77.90	74.78	63.5521
P_{10}	101.1142	102.2243	101.13	101.12	119.54	158.02	21.3657
P_{11}	33.9116	35.0317	28.656	28.655	54.50	80.00	58.6254
P_{12}	79.9583	78.8482	20.912	20.914	80.00	78.57	70.5245
P_{13}	25.0042	27.1292	25.001	25.002	25.00	25.00	20.6453
P_{14}	41.414	37.1594	54.418	54.414	17.86	15.00	25.2455
P_{15}	35.614	37.0390	20.625	20.624	15.00	15.00	18.3542
Total power output	2662.4	2661.75	2662.1	2662.1	2662.29	2660.8	2652.611
Minimum cost ($/h)	32858	32724	32835	32834	32751.39	32709	**32679.356**
P_{Loss}	32.4306	31.75	32.1302	32.1303	32.28	30.858	**29.673472**
Mean cost ($/h)	33039	32984	33021	33021	32878	32784.5	**32707.487**
Maximum cost ($/h)	34562.4	34865.9	33451	33450.1	33001.1	32954.4	**33250.2458**

A. IEEE 30-Bus System

In the first case study, the IEEE 30-bus system with 6 generators and 41 lines is used. The system configuration of the proposed case study is shown in Figure 2 and the system data can be found in [15]. The line data and bus data of the system are referenced in [15]. The load of the IEEE 30-bus system was set to 2.834 pu on a 100MVA base. In order to demonstrate effectiveness of the proposed approach on the IEEE 6-generator 30-bus test system. Results of proposed PSO-TVAC algorithm are compared with the MOPSO [17] and MODE [14]. The results of simulation are given in Table 1. In addition, convergence characteristic for this case study is shown in Figure 3.

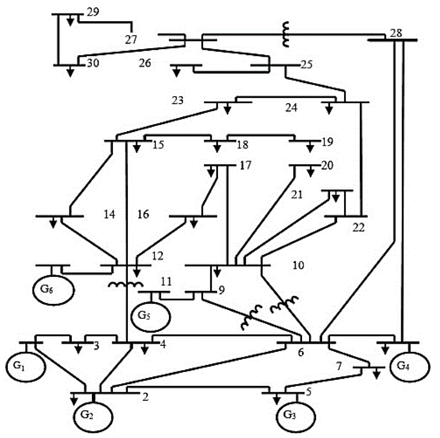

Figure 2. The IEEE 30-bus system configuration [15]

B. 15-Unit Systems

The information of 15-unit system is presented in [20]. The load demand of the system is 2630 MW. The loss coefficients matrix is shown in [19]. The feasibility of the proposed method has been compared in terms of solution quality and computation efficiency with PSO [20], Hybrid GAPSO [13], IPSO [20], SOH-PSO [15]. In addition, convergence characteristic for this case study is shown in Figure 4. In addition, Table 2, shows the numerical results of this case study in comparison with other techniques.

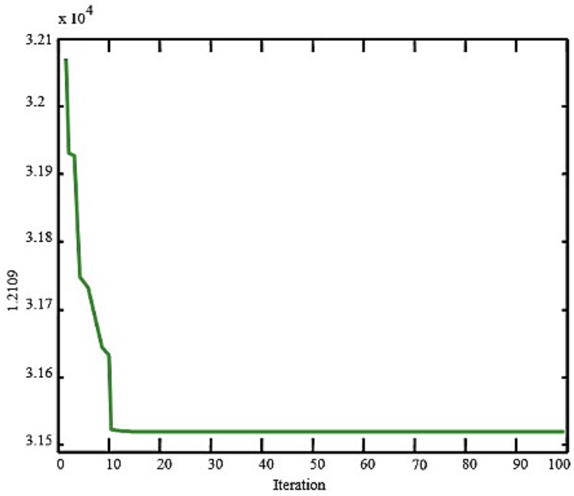

Figure 3. Convergence characteristic of 6-unit system

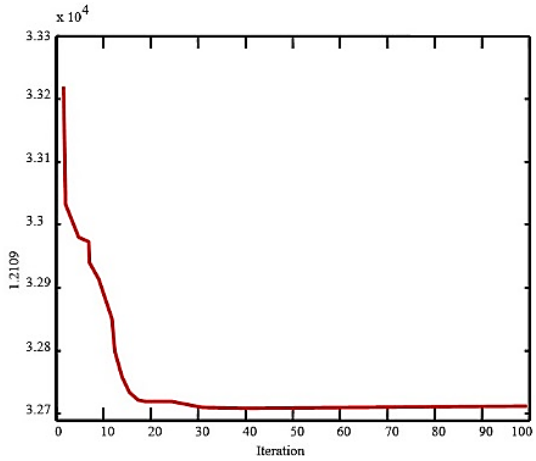

Figure 4. Convergence characteristic of 15-unit system

V. CONCLUSIONS

The Economic Load Dispatch (ELD) is to determine the optimal combination of power outputs of all generating units to minimize the total fuel cost while satisfying the load demand and operational constraints. An optimization technique of Particle Swarm Optimization with Time Varying Acceleration Coefficients (PSO-TVAC) has been presented for the economic load dispatch problem in power system. The proposed algorithm applied to three standard IEEE systems to show advantages of proposed algorithm in EED problem, 30-bus 6-generator IEEE test system and 15 units system with valve point effects.

The convergence speed of this algorithm is higher than other heuristics algorithms such as NSGA, MODE, MOPSO, etc. and thus the high precision and efficiency are achieved. It is clear from the numerical results and convergence curves obtained by different trials that the proposed PSO-TVAC method has good convergence property and can avoid the shortcoming of premature convergence of compared method to obtain better quality solution. Considering the cases and comparative study presented in this paper, PSO-TVAC algorithm appears to be very efficient in particular for its fast convergence to the global optimum and its interesting financial profit.

REFERENCES

[1] O. Abedinia, N. Amjady, K. Kiani, H.A. Shayanfar, A. Ghasemi, "Multi-Objective Environmental and Economic Dispatch Using Imperialist Competitive Algorithm", International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 11, Vol. 4, No. 2, pp. 63-70, June 2012.

[2] D.C. Walters, G.B. Sheble, "Genetic Algorithm Solution of Economic Dispatch with Valve Point Loading", IEEE Trans. Power Syst., Vol. 8, No. 3, pp. 1325-1332, 1993.

[3] H. Shayeghi, A. Ghasemi, "Economic Load Dispatch Solution Using Improved Time Variant MOPSO Algorithm Considering Generator Constraints, International Review of Electrical Engineering (I.R.E.E.), Vol. 7, No. 2, pp. 4292-4303, 2012.

[4] A.J. Wood, B.F. Wollenberg, "Power Generation, Operation, and Control, Second Edition", Wiley, New York, 1996.

[5] W.M. Lin, F.S. Cheng, M.T. Tsay, "An Improved Tabu Search for Economic Dispatch with Multiple Minima", IEEE Trans. Power Syst., Vol. 17, No. 1, pp. 108-112, 2002.

[6] M. Fesanghary, M.M. Ardehali, "A Novel Meta-Heuristic Optimization Methodology for Solving Various Types of Economic Dispatch Problem", Energy, Vol. 34, pp. 757-766, 2009.

[7] A.A. Elkeib, H. Ma, J.L. Hart, "Environmentally Constrained Economic Dispatch Using the Lagrangian Relaxation Method", IEEE Trans. Power Syst., Vol. 9, pp. 1723-1729, 1994.

[8] F.N. Lee, A.M. Breipohl, W.O. Stadlin, "Reserve Constrained Economic Dispatch with Prohibited Operating Zones", IEEE Trans. Power Syst., Vol. 8, pp. 246-254, 1993.

[9] K.P. Wong, "Computational Intelligence Applications in Unit Commitment Economic Dispatch and Load Flow", 4th International Conference on Advances in Power System Control, Operation and Management, APSCOM-97, Hong Kong, November 1997.

[10] D. Walters, G.B. Sheble, "Genetic Algorithm Solution of Economic Dispatch with Valve Point Loading", IEEE Trans. on Power Systems, Vol. 8, No. 3, pp. 1325-1331, 1993.

[11] R. Eberhart, J. Kennedy, "A New Optimizer Using Particle Swarm Theory", 6th International Symposium on Micro Machine and Human Science Nagoya, Japan IEEE Service Centre, pp. 39-43, 1995.

[12] A.T. Al-Awami, Y.L. Abdel-Magid, M.A. Abido, "A Particle Swarm Based Approach of Power System Stabilizer Enhancement with Unified Power Flow Controller", Elect Power Energy Syst., Vol. 29, pp. 251-250, 2007.

[13] M. Sudhakaran, D. Ajay, P. Vimalraj, T.G. Palanivelu, "GA and PSO Culled Hybrid Technique for Economic Dispatch Problem with Prohibited Operating Zones", Journals of Zhejiang University Science A, Vol. 8, No. 6, pp. 896-903, 2007.

[14] L.S. Coelho, V.C. Mariani, "Economic Dispatch Optimization Using Hybrid Chaotic Particle Swarm Optimizer", IEEE International Conference on Systems Man and Cybernetics (SMC), pp. 1963-1968, Montreal, Canada, 2007.

[15] K.T. Chaturvedi, M. Pandit, L. Srivastava, "Self Organizing Hierarchical Particle Swarm Optimization for Non-Convex Economic Dispatch", IEEE Transaction on Power System, Vol. 23, No. 3, pp. 1079-1087, 2008.

[16] L.H. Wua, Y.N. Wanga, X.F. Yuan, S.W. Zhou, "Environmental Economic Power Dispatch Problem Using Multi-Objective Differential Evolution Algorithm", Electric Power Systems Research, Vol. 80, pp. 1171-1181, 2010.

[17] H.A. Shayanfar, A. Ghasemi, N. Amjady, O. Abedinia, "PSO-IIW for Combined Heat and Power Economic Dispatch", International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 11, Vol. 4, No. 2, pp. 51-55, June 2012.
[18] A. Ratnaweera, S.K. Halgamuge, H.C. Watson, "Self Organizing Hierarchical Particle Swarm Optimizer with Time Varying Acceleration Coefficients", IEEE Transactions on Evolutionary Computation, Vol. 8, No. 3, pp. 240-255, June 2004.
[19] Z.L. Gaing, "Particle Swarm Optimization to Solving the Economic Dispatch Considering the Generator Constraints", IEEE Transactions on Power Systems, Vol. 18, No. 3, pp. 1187-1195, 2003.
[20] A. Safari, H. Shayeghi, "Iteration Particle Swarm Optimization Procedure for Economic Load Dispatch with Generator Constraints", Expert Systems with Applications, Elsevier, Vol. 38, Issue 5, pp. 6043-6048, May 2011.

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