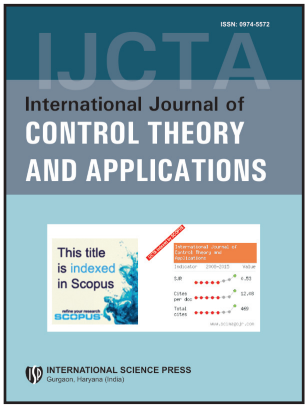

International Journal of Control Theory and Applications

ISSN : 0974-5572

Volume 10 • Number 12 • 2017

Economic Load Dispatch with Optimal Power Flow Using Modified PSO

A. Parthasarathy[a] and R. Dhanasekaran[b]

[a]*Research Scholar, Syed Ammal Engineering College, Ramanathapuram, India. E-mail: eoskaps@gmail.com*
[b]*Director - Research, Syed Ammal Engineering College, Ramanathapuram, India. E-mail: rdhanashekar@yahoo.com*

Abstract: The paper proposes a new optimization technique in the economic dispatch with optimal power flow problem. The main objective is to allocate the power generators, the total load demand at minimum operating cost while satisfying all equality and inequality constraints. The proposed method is able to determine the output generation for all of the power generating units. The MPSO algorithm is tested in 30 bus system. These results prove that the proposed method is capable of getting higher quality solution including mathematical simplicity, fast convergence and robustness to solve the hard optimization problems.

Keywords: Economic load dispatch, Optimal power flow, Modified Particle Swarm Optimization (MPSO).

1. INTRODUCTION

In an electrical power systems are used to produce electric power for the range of load demand. To minimize the total generation cost is the main objective of this problem. The economic load dispatch is applied for allocating power generation among the committed units [1-4]. We use the optimization techniques have been employed to approach the economic load dispatch problem [5-7]. The total generation cost of the system and transmission power losses are minimized. In deregulated electricity area power utilities try to achieve high operating efficiency to produce cheap electricity power. Under de-regulation the generation patterns resulting from market activities can be quite different from the traditional one [8,9]. In any non-utility generator in the system can sell all part of its output. The single and multiple buyers located anywhere within the network have made the problem is very much complicated. NUGs include both independent power producers (IPPs) and co-generators.

There is an optimal system, which may balance the needs of energy providers, the resellers, the residential consumers and large industrial customers [10-13]. Some methods and mathematical models have been reported in literature survey for solving above the mentioned problems. The economic load dispatch problem is solved by using mathematical programming based on optimization techniques, such as dynamic programming, mathematical linear programming, nonlinear programming and equal increment method also [14-17]. The modified PSO method is used, to set of particles called individuals. Which are able to follow a certain algorithm to obtain the best solution for an optimization technique. These particles define the search space with different velocities and positions. Each particle of swarm gives a potential solution for the optimization problem. The performance of individuals, evaluated by a fitness function. The modified particle swarm optimization algorithm is able to get the located optimum points for the multiple optimization problems in economic dispatch. The results show that MPSO is robust and efficient. Optimal operation of power system operation can be divided into two sub- problems.

A. Real Power Optimization Sub Problem

It is the traditional economic load dispatch problem, which is done for minimizing generation cost while maintaining set of equality and inequality constraints. While the generator cost functions are modeled as smooth and convex quadratic function of generator power. The economic dispatch problem can be solved using a variety of optimization techniques starting from recent evolutionary programming methods and lagrangian multipliers method.

B. Reactive Power Optimization Sub-Problem

Reactive powers in the optimization problem should be optimized to provide better voltage profile as well as to reduce total system transmission loss. Thus the objective of reactive power optimization problem can be minimized of real power transmission loss. Nowadays large integrated power systems are being operated under heavily stressed conditions, which imposes threat to voltage stability with increase in loading the voltage at the load bus may drop quickly which may led to voltage instability. Voltage collapse occurs when a considerable part of the system attains such a low voltage profile. The proposed method uses a voltage stability index and assessed how far the system from voltage instability is. This method is based on the fact that with increase in load at a particular load bus, diagonal elements of the Jacobean reduces and reaches to zero at voltage instability point. In the proposed method, we optimize the real power sub-problem and then reactive power sub-problem. As the two objectives are difficulty, finally we got a solution where both the objectives are optimized.

2. PROBLEM FORMULATION

The optimization problem is to obtain a particular set of points, including all outputs of the power generation units, such that all equality and in equality constraints indicate the real power balance and limitation of the power generation of each unit respectively.

Test Case (Optimal Generation)

In a power system, the total fuel cost is an equal summation of all generation units cost functions,

$$C = \min \sum_{i=1}^{Ng} f_i(P_{Gi})\,\$/\text{hr} \tag{1}$$

where,

C = Optimal cost of generation when the utility supplying its own load.

$f_i(P_{Gi})$ = Generation cost function of the i^{th} generator for P_{Gi} generation.

P_{Gi} = Power generation by the i^{th} generator.

Ng = Number of generator connected network.

The operating cost function of the power producer is optimized with the following power system constraint

$$\sum_{i=1}^{Ng} P_{Gi} = p_d + p_l \tag{2}$$

where,

P_d = Total load of the system

P_l = Transmission losses of the system (when the utility supplying its own load)

The power flow equation of the power network

$$g(|v|, \phi) = 0 \tag{3}$$

where, $|v|$ and ϕ is a voltage magnitude and phase angle of different buses.

The inequality constraint on real power generation P_{Gi} of each generation i

$$P_{Gi}^{min} \leq P_{Gi} \leq P_{Gi}^{max} \tag{4}$$

where, P_{Gi}^{min} and P_{Gi}^{max} are respectively minimum and maximum value of real power generation allowed at generator i.

The inequality constraint on voltage of each PQ bus

$$V_i^{min} \leq V_i \leq V_i^{max} \tag{5}$$

where, V_i^{min} and V_i^{max} are respectively minimum and maximum voltage at bus i.

Power limit on transmission line

$$\text{MVA } f_{p,q} \leq \text{MVA } f_{p,q}^{max} \tag{6}$$

where, MVA $f_{p,q}^{max}$ is the maximum rating of transmission line connecting bus p and q.

3. MODIFIED PARTICLE SWARM OPTIMIZATION

In PSO algorithm is an adaptive algorithm based on a social psychological behavior, the particle has the ability to know the best position of the group particles have been searched by it. In optimization problem we need one particle to find the global best position rather than all the particles. Based on these ideas, we propose some modifications with the standard PSO algorithm, a new versatile algorithm called modified particle swarm optimization. The modified PSO algorithm chooses the particle with maximum fitness when it is iterating, initializes its position randomly for increasing the chaos ability of particles. By this means, the particle can search more domains. We are referring the ideas of the simulated annealing algorithm and using neigh-borhoods to achieve the guaranteed convergence in PSO. It is hoped that the fitness of the particle which has the best value in last iteration would be smaller than last times, and it is acceptable the fitness is worse in a limited extent. We calculate the change of fitness value of two positions f, and accept the new position if f is smaller than. Otherwise, a new position is assigned to the particle randomly from its neighborhood with radius r.

The procedure of modified PSO is as following:

(a) Initialize the position and velocity of each particle.

(b) Calculate the fitness of each particle.

(c) Concern the particle with the biggest fitness value, reinitialize its position and evaluate the particle with the smallest fitness value whether its new position is acceptable.

(d) For each particle, compare its current fitness value with the fitness of its pbest, if the current value is better, and then update pbest and its fitness value.

(e) Determine the best particle of group with the best fitness value, if the current fitness value is better than the fitness value of gbest, and then update the gbest and its fit-ness value with the position.

(f) Check the finalizing criterion, if it is correct, quit the iteration.

4. CONVERGENCE OF MPSO

It is based on the stochastic theorem, the global convergence property of MPSO is initialized and the sufficient condition for convergence is created. Accordingly, the sufficient condition of that MPSO has the global convergence property is independent of the initialization.

A. Solution Coding

Let $X_i = (x_1, x_2, ..., x_{Ng})$ be a vector denoting the i^{th} particle of the swarm.

where, N_g is the number of units.

X_i is the generated power output of unit i.

At the initialization stage, X_i is selected randomly from the feasible region S.

B. Objective Function and Feasible Region

To minimize the objective function of economic dispatch is defined by the constraints must be subject to linear/nonlinear and equality/inequality constraints. If we use penalty function to transform those constraints difficult to be deal within the feasible region S.

5. RESULTS

The modified PSO Algorithm was applied to the IEEE-30 Bus standard test system.

Base Case (Optimal Generation of 6 Generating Plants)

For the base case the optimal generation of the generating units of the utility are presented in the table1.The total cost of generation for the base case optimal schedule is C = 788.316 $/hr

Table 1
Base Case

	OUTPUT	
Total Power Demand		290 MW
Power Generated	P1	193 MW
	P2	25 MW
	P5	24 MW
	P8	20 MW
	P11	14 MW
	P13	34 MW
Total Fuel Cost		788.316 $/hr.
No of Iterations		100
Execution Time		1.4850 Seconds

APPENDIX

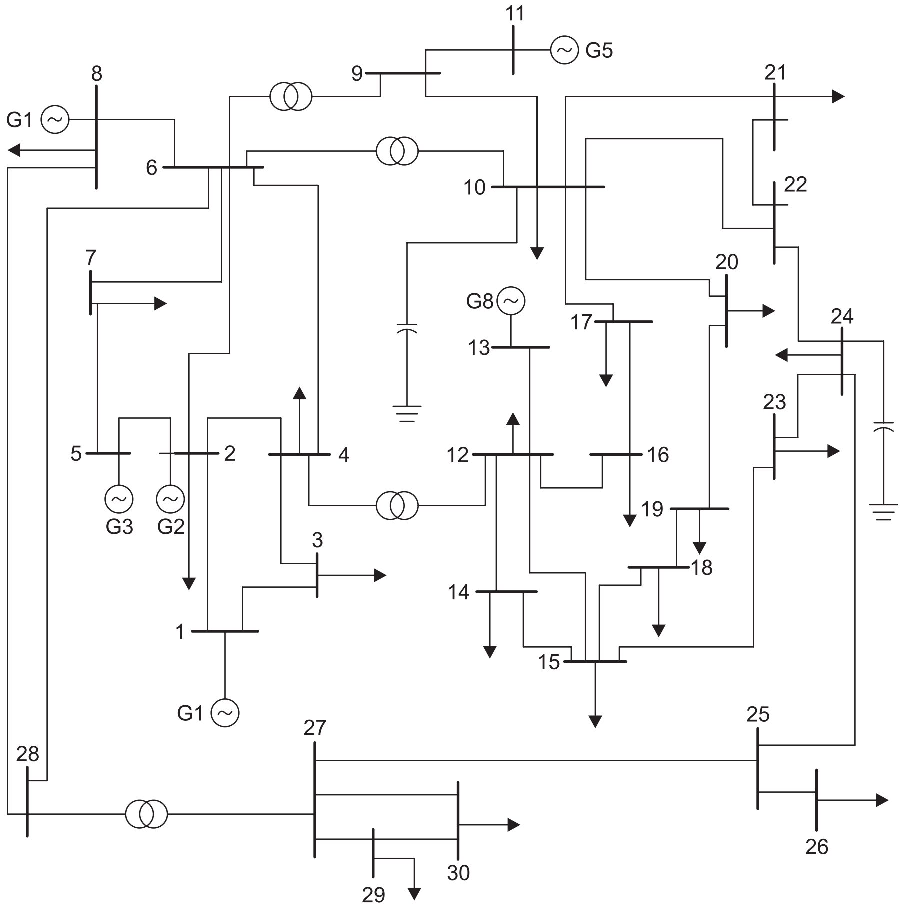

Figure 1: Single line diagram of IEEE-30 bus test system

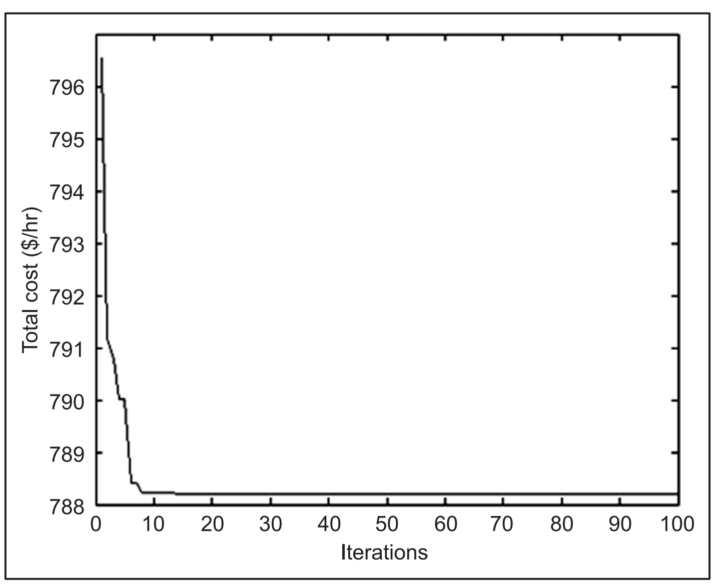

Figure 2: Iteration vs. Fuel cost

6. CONCLUSION

This paper presents a global convergent PSO Algorithm called Modified particle swarm optimization algorithm (MPSO) for solving optimal power flow which aims at minimizing fuel cost. Based on the stochastic analysis theorem, it is proved that MPSO has the global convergence. Our proposed approach finds global optimal solution within a small no of iteration. Several system constraints are taken care of and also stability index for each load bus is tested and included in the reactive power optimization. In these cases, MPSO can provide accurate results in the reasonable time and fitness.

REFERENCES

[1] O. Alsac and B. Stott, "Optimal Load flow with steady state Security", IEEE Transactions on power Apparatus and Systems, Vol. PAS-93, No. 3, May/June 1974, pp. 745-751.

[2] L. Coelho and C.S. Lee, "Solving ELD problems in power systems using chaotic and Gaussian particle swarm optimization approaches," Electric Power and Energy Systems, Vol. 30, pp. 297-307, 2008.

[3] Q.H. Wu, and J.T. Ma, " Power system optimal reactive power dispatch using evolutionary programming," IEEE Transactions on Power systems, Vol. 10 (3), pp. 1243-1249, 1995.

[4] J. Yuryevich and K.P. Wong, " Evolutionary programming based optimal power flow algorithm," IEEE Transactions on Power Systems, Vol. 14 (4), pp. 1245-1250, November, 1999.

[5] R.Eberhart and Y. Shi, "Comparing inertia weights and constriction factors in particle swarm optimization", Proceedings Of Congress on Evolutionary Computation (CEC 2001), Seoul, Korea, and Piscataway, NJ: IEEE Service Center, 2001.

[6] Z.L Gaing, "Particle swarm optimization to solving the economic dispatch considering the generator constraints"IEEE Transactions on Power System, Vol. 18, No. 3, pp. 1187-1195, Aug. 2003.

[7] P. Venkatesh, R. Gnanadas and Narayana Prasad Padhy, "Comparison and Application of Evolutionary Programming Techniques to combined Economic Emission Dispatch with line flow constraints". IEEE Transactions on power systems, Vol. 18, No. 2, pp. 688-697, May 2003.

[8] Richard D. Christie, Bruce F. Wollenberg and Iyar Wangensteen, "Transmission Management in the Deregulated Environment" proceedings of the IEEE transactions, Vol. 88, No. 2, Feb 2000, pp. 170-195.

[9] Olav B. Fasso, etl., " Generation scheduling in a de regulated system: The Norwegian case ", IEEE Transactions on Power systems, Vol. 14, No. 1, Feb 1999, pp. 75-81.

[10] L. Chen, Y. Tada, H. Okamoto, R. Tanabe and Ono, "Optimal operation solutions of power systems with Transient stability constraints," IEEE Transactions on Circuits and Systems – I Fundamental theory and applications, Vol. 48, No. 3, March 2001.

[11] J.A. Momoh, M.E. El-Hawary and A. Ramababu, "A review of selected optimal power flow literature in 1993 Part I and Part II," IEEE Transactions on Power Systems, Vol. 14, No. 1, pp. 96 -111, 1999.

[12] D. Gan, R.T., Thomas, R.D. Zimmerman, "Stability – constrained optimal power flow," IEEE Transactions on Power Systems, Vol. 15 (2), pp. 535-540, May 2000.

[13] H.W. Dommel and W.F. Tinney, "Optimal Power Flow Solutions," IEEE Transactions on Power Apparatus and Systems, Vol. PAS-87, pp. 1866-1876, 1968.

[14] R. Shoults and D. Sun, "Optimal Power Flow based on P-Q decomposition," IEEE Transactions on Power Apparatus and Systems, Vol. PAS-96, pp. 841-854, 1977.

[15] C.A. Poa-Sepulveda and B.J. Pavez-Lazo, "A solution to the optimal power flow using simulated annealing," International Journal on Electric Power Energy systems, Vol. 25 (1), pp. 47-57, 2003.

[16] "Analysis of Mathematical attack on RSA algorithm using factoring a prime number by Division algorithm method" AICTE sponsored National Conference Recent Research Trends in Network Security NCRTNS-2012 organized by Srinivas Institute of Technology, Valachil, Farangipet Post, Mangalore, 19th and 20th April 2012.

[17] "Wireless sensor network Attacks and Key Management Authentication". Presented in National conference on Networking and computing Technologies Organized by Dept of MCA, CSE & IT, Vel Tech MultiTech Dr. Rangarajan Dr. Sakunthala Engg college, Chennai on 10.08.2012.