# ECONOMIC LOAD DISPATCH OF THE THERMAL POWER STATION USING PARTICLE SWARM OPTIMIZATION

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## I. INTRODUCTION

The large interconnection of the electric networks, the energy crisis in the world and continuous rise in prices, it is very essential to reduce the running costs of electric energy. A saving in the operation of the power system brings about a significant reduction in the operating cost as well as in the quantity of fuel consumed.The Modern Power System Around The World Has Grown In Complexity Of Interconnection And Power Demand. The focus has shifted towards the enhanced performance. Increased customer focus, low cost, Reliable and Clean Power.

The Particle Swarm Optimization (PSO) Algorithm Is Proposed To Solve The (ELD) Economic Load Dispatch Problems In Power Systems.The Main Aim Of Electric Power Utilities Is To Provide High-quality, Reliable Power Supply To The Consumer At The Lowest Possible Cost While Operating To Meet The Limits And Constraints Imposed On The Generating Units.

## II. LITERATURE REVIEW

1.Economic Load Dispatch of the Thermal Power Stations Using Particle Swarm Optimization. Jagdeesh, G, M. N. Alam& K. kumar(Ijest). ISSN : 0975-5462 Vol. 3 No. 10.

The solving Of Eld Problem Using
PSO algorithm And Simulated Annealing for the Six Generating Units as a Case Study.

The Lambda Iteration Method to Solve the ELD problem using Matlab for the six generating units with and without transmission losses.The Proposed PSO Technique Minimize The Total Production Cost.

2. K. Srikrishna,Economic Load Dispatch of Thermal Power Plants Using Differential Evolution Neglecting Transmission Losses.Pp148-151, Vol.61, Dec 1980, The calculate Electric Power Generation Of Various Units With Different Load Demands, Is Solved By Iterating The Value Of Sum of The Generator Outputs Equals The System Load Demand And Transmission Losses. The Cost Of Power Generation Is Not Same For Every Unit. So, To Have The Minimum Cost Of Generation For A Particular Load Demand, The Load Is Distributed Among The Units Which Minimize The Overall Generation Cost With-in Its Constraints.

3. GaingZwe-lee, M. N. Abdullah & N. A. Rahim. Particle Swarm Optimization For Various Types of Economic Dispatch Problems. IEEE Trans Power System
2003; 18(3):1187–95. This Paper Describes A Successful Adaptation Of The Particle Swarm Optimization (PSO) Algorithm To Solve Various Types Of Economic Dispatch (ED) Problems In Power.

The Pso Method Converges to the Global or near Global Point, Irrespective Of the Shape of the cost function, like Discontinuities In Cost Functions, Cost Functions That Are Not Smooth Or Convex.

The Better Computation Efficiency And Convergence Property Of The Proposed Pso Approach Shows That It Can Be Applied To A Wide Range Of Optimization Problems.

4. Nidul Sinha, R. Chakrabarti, And P. K. Chattopadhyay, Economic Load Dispatch In Thermal power plant Considering Additional Constraints Using curve Fitting And ANN.Vol. 7, No. 1, February 2003. This Paper Presents A New Approach Of Considering Efficiency (Turbine, Boiler And Generator), GCV Value Of Coal As An Inequality Constraint To Solve The Economical Load Dispatch Problem In thermal Power Plants.

The Proposed Method Is Used To Solve Case Study Involving 8 Generating Units. The Proposed approach Is Tested on a Standard Test System. The Initial Particles Are Randomly Generated Within The Feasible Range. Thus Ann Based Computer Programs Developed Is Most Robust And General And Works Dynamically.

5. Wang L, Singh C. Multi-area Economic Dispatch Using Improved Particle
Swarm Optimization. Artificial Intelligence 2009; 22: 298-307. The Proposed Algorithm Is Tested On Four Areas, Generators System Consists Of 1thermal Units In Each Area With Non-convexity In Generator Cost Function Due To Valve-point Loading Effects. The value of maximum And Minimum Bounds of the Inertia Weight Is taken as 0.9 and 0.1, respectively. The Population Size For This SystemIs And The Maximum Iterations Are Considered.

The proposed algorithm has been developed Using MATLAB And The Simulations Have Been Carried On A Personal Computer Of Intel I5, 3.2 GHz, And 4 GB RAM..This Paper Attempts to overcome The Drawbacks of the existing PSO Methods and Presents an improved PSO (IPSO) Method.

Problem formulation:

Economic Dispatch the Complicatedness Of ELD May Be Expressed By Minimizing. The Fuel Cost of Generating Units Under Some Constraints.

$$FC = \sum_{i=1}^{n} a_i p_i^2 + b_i p_i + c_i \ \ \$/hr$$

Where; $a_i$, bi, $c_i$ = cost coefficients of unit i.

$a_i$, bi, $c_i$: fuel cost coefficients of the ith generating Unitn: number of thermal units Subjected to

1.Power balance constraint

$$PD + PL = \sum p_i$$

  

2. Generating capacity limits

$$P_i \min \le p_i \le p_i \max$$

## III. OBJECTIVE

The cost functionsof Majorityof Generating Units Is a Non - Linear Function and It Cannot Be Solved by Analytical Methods, So an Iterative Method Is Proposed Using Differential Evolution Technique. In This Method, the Objective Function of Thermal Power Plant Is Defined As

$$c_i = a_i pG_i 2 + b_i pG_i + d_i \text{K} \; (1)$$

Optimization techniques (PSO)

PSO is initialized with a group of random particles (solutions) and then searches for optima by updating generations. In every iteration, each particle is updated by following two "best" values. The first one is the best solution (fitness) it has achieved so far. This value is calledanother "best" value that is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the population.

This best value is a global best and called

After finding the two best values, the particle updates its velocity and positions according to the following equations.

$$V_i(u+1) w * V_i(u) + c_1 * rand(\ ) * p_{best_i} -$$

$$p(u) + c_2 * rand(\ ) * g_{best_i} - p(u).$$

$$p(u+1) = p(u) + V_i(u+1)$$

Methodology of PSO:

PSO Method to Economic Load Dispatch

Initialize the Fitness Function i.e. Total cost function from the individual cost function of the various generating stations.

Initialize the PSO parameters Population size, C1, C2, $W_{max}$, $W_{min}$, error gradient etc.

Input the Fuel cost Functions, MW limits of the generating stations along with the B- coefficient matrix and the total power demand. At the first step of the execution of the program a large no(equal to the population size) of vectors of active power satisfying the MW limits are randomly allocated. For each vector of active power the value of the fitness function is calculated. All values obtained in iteration are compared to obtain

This final value of the minimum cost and the active power vector represents the economic load dispatch solution.

Input data of thermal power station:

| No of generating cost | Real power (MW) | | Cost coefficients | | |
|---|---|---|---|---|---|
| | Pmax | Pmin | A | B | C |
| 1 | 500 | 100 | 12000.050 | 12000.010 | 0.00410 |
| 2 | 200 | 50 | 9582.211 | 9582.191 | 0.02145 |
| 3 | 300 | 80 | 10458.251 | 10458.011 | 0.24012 |
| 4 | 150 | 50 | 8125.231 | 8125.221 | 0.01425 |
| 5 | 200 | 50 | 9582.211 | 9582.191 | 0.02145 |
| 6 | 120 | 50 | 8001.254 | 8001.211 | 0.04322 |

Case Study: Six Unit Thermal Power System Conventional MethodThe cost characteristics of thesix unitsin Rs/hr are given as:

$F1=0.0070P1^2+7P1+240$

$F2 = 0.0095P2^2+ 10P2 +200$

$F3 = 0.0090P3^2+ 8.5P3+300$

$F4 = 0.0090P4^2+ 11P4+150$

$F5 = 0.0080P5^2+ 10.5P5+200$

$F6 = 0.0075P6^2+ 12P6+120$

The unit operating constraints are:

$100 \text{ MW} \le P1 \le 500 \text{ MW}$;

$50 \text{ MW} \le P2 \le 200 \text{ MW}$;

$80 \text{ MW} \le P3 \le 300 \text{ MW}$;

$50 \text{ MW} \le P4 \le 150 \text{ MW}$;

$50 \text{ MW} \le P5 \le 200 \text{ MW}$;

$50 \text{ MW} \le P6 \le 120 \text{ MW}$;

B-Coefficient Matrix:

B= [0.000140 0.000017 0.000015 0.000019 0.000026 0.000022
0.000017 0.000060 0.000013 0.000016 0.000015 0.000020
0.000015 0.000013 0.000065 0.000017 0.000024 0.000019
0.000019 0.000016 0.000017 0.000071 0.000030 0.000025
0.000026 0.000015 0.000024 0.000030 0.000069 0.000032
0.000022 0.000020 0.000019 0.000025 0.000032 0.000085];

Results:

Comparison of Results between Conventional Method and PSO Method for Six Unit System

| Sr. no | Power Demand (mw) | Lambda-Iteration Method (Rs./hr) | PSO Method (Rs/hr) |
|---|---|---|---|
| 1 | 500 | 6106.21 | 6105.02 |
| 2 | 700 | 8288.81 | 8287.55 |
| 3 | 1000 | 11957.20 | 11930.40 |
| 4 | 1200 | 14559.00 | 14538.10 |
| 5 | 1350 | 16586.10 | 16575.50 |
| 6 | 1450 | 17980.10 | 17975.20 |

Results:

Reliability Evaluation of PSO method.

  

| SR No. | PowerDemand(MW) | Lambda-iteration method | PSO method | StdDeviation (MW) |
|---|---|---|---|---|
| 1 | 500 | 6106.21 | 6105.02 | 0.1902 |
| 2 | 700 | 8288.81 | 8287.55 | 0.2605 |
| 3 | 1000 | 11957.20 | 11930.40 | 0.8014 |
| 4 | 1200 | 14559.00 | 14538.10 | 0.9022 |
| 5 | 1350 | 16586.10 | 16575.50 | 0.6231 |
| 6 | 1450 | 17980.10 | 17975.20 | 0.9235 |

Comparative optimization techniques:

Grey wolf optimization (GWO)

Grey wolves are considered as apex predators, meaning that they are at the top of the food chain. Grey wolves mostly prefer to live in a pack. The group size is 5–12 on average. Of particular interest is that they have a very strict social dominant hierarchy. The leaders are a male and female, called alphas. The alpha is mostly responsible for making decisions about hunting, sleeping place, time to wake, and so on.The social hierarchy is simulated by categorizing the population of search agent into four types of individual based on their fitness.

Level 1 (Alpha)
Level 2 (Beta)
Level 3 (Delta)
Level 4 (Omega)

The main phases of grey wolf hunting are as follows:

1. Tracking, chasing, and approaching the prey.
2. Pursuing, encircling, and harassing the prey until it stops moving.
3. Attack towards the prey.

Results

Reliability Evaluation of GWO method.

| SR No. | PowerDemand(MW) | PSO Method (Rs./Hr) | GWO Method (Rs./Hr) |
|---|---|---|---|
| 1 | 500 | 6105.02 | 6102.3 |
| 2 | 700 | 8287.55 | 8285.0 |
| 3 | 1000 | 11930.40 | 11927.8 |
| 4 | 1200 | 14538.10 | 14536.2 |
| 5 | 1350 | 16575.50 | 16572.7 |
| 6 | 1450 | 17975.20 | 17973.02 |

REFERENCES

[1] Seyedali Mirjalili,Seyed Mohammad Mirjalili, Andrew Lewis, Grey Wolf Optimizer, Elsevier-2013.
[2] Mucherino A, Seref O. Monkey search: a novel metaheuristic search for global optimization. In: AIP conference proceedings; 2007. p. 162.
[3] Yang XS. Nature-inspired metaheuristic algorithms. Luniver Press; 2011
[4] Mirjalili S, Hashim SZM. A new hybrid PSOGSA algorithm for function optimization. In: Computer and information application (ICCIA), 2010 international conference on; 2010. p. 374/77.
[5] Awodiji, O.O., Bakare, G. A., Aliyu, U. O. (2014). Short Term Economic Load Dispatch of Thermal Power Plants Based On Differential Evolution Approach. Ijser. Vol 5 Issue 3.
[6] Hardiansyah, Junaidi And Yohannes, M. S. (2012). Solving Economic Load Dispatch Problem Using Particle Swarm Optimization. Technique, I.J. Intelligent Systems and Applications, Vol. 12, Pp 12-18.
[7] Senthilkumar, S. And Vijayalakshmi, V. J. (2013). A New Approach to the Solution of Economic Dispatch using particle swarm optimization with simulated annealing. International journal on computational sciences & Applications (IJCSA) Vol.3, No.3.
[8] Damoon, R. D., Asef, G. And Seyyed, M. H. (2016). Solving Static Economic Load Dispatch Using Improved Exponential Harmony Search Optimization. Australian Journal Of Electric And Electronics Engineering, Vol. 13, Issue 2.
[9] Saadat, H. (2010). Power System Analysis. Tata Mcgraw Hill International Journal For Research In Applied Science & Engineering Technology (IJRASET), Vol. 4 Issue II, Pp2321-9653.
[10] International Journal Of Engineering Science And Innovative Technology (IJESIT) Volume 2, Issue 6, November 2013
[11] International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 02 | Feb-2018

  