iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: XII Month of publication: December 2022

DOI: https://doi.org/10.22214/ijraset.2022.47977

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue XII Dec 2022- Available at www.ijraset.com

Economic Load Dispatch Using Computational Techniques

Zaineb Nisar Jan[1], Dr. Satish Saini[2]
[1, 2]Post Graduate Student, Dept. Of Electrical Engineering, H.O.D. Electrical Department

***Abstract*: This research paper introduces the importance of economic dispatch in a power system. Economic dispatch was the method used in allocating the output power of each generator to achieve the optimal dispatch to reduce fuel cost to the minimum. The research paper discusses how the economic dispatch problem can be solved by using the methods of Particle Swarm Optimization (PSO) and Lambda Iteration (LI). These methods were applied in IEEE-30 busses systems. The system was tested on a few loads demands to find out the total fuel cost, power losses, and computational time.**
Keywords: Economic Load Dispatch, Lambda Iteration, Particle Swarm Optimization, Fuel Costs, Computational Methods

I. INTRODUCTION

The power saved is power generated, and transmission losses ultimately raise the cost of power transmitted to the end user. Transmission losses account for 5 to 10% of total generation. Reduced transmission losses in the system will result in an improved voltage profile, which will reduce generation costs. In other words, power generation and transmission must be done in such a way that system transmission losses are minimized. Modern heuristic or probabilistic search optimization techniques such as DP (dynamic programming), GA (genetic algorithms), AI (artificial intelligence), and Particle Swarm Optimization (PSO) are required to solve the complex ELD problem.

II. LITERATURE REVIEW

The conventional techniques to solve ELD problems are Simplex linear programming, Steepest descent gradient, Lambda iteration method, Modified lambda iteration method, Merit order reduced gradient, Newton - Raphson method, Interior point method, base point and participation factor method, integer programming etc. However, these methods require the incremental cost curves to be monotonically increasing or piecewise linear. The input/output characteristics of modern units are inherently highly nonlinear due to the valve-point effect, ramp rate limits etc. Consideration of highly nonlinear characteristics of the units requires highly robust algorithms to avoid getting stuck at local optima. J.H.Park, I.K.Eong, Y.S. Kin, and K.Y.Lee [1] proposed the Hopfield (neural network) method to solve the ELD problem with the cost function represented as a piecewise quadratic function instead of a convex function. Po-Hung and Hong-Chan Chang [2] applied genetic algorithms to solve the economic load dispatch problem. Zee-Lee Gaing [3] used PSO to solve ELD. It considers the non-linear characteristics of the generators. T. A. Albert Victoire, A. E. Jeyakumar [4] combined PSO (particle swarm optimization) and SQP (sequential quadratic programming) to solve the economic load dispatch (ELD) problem. PSO acts as the main optimiser and SQP adjusts the refinement in every solution of the PSO. The combination of PSO-SQP offers fast convergence characteristics and high-quality solutions. This method is more practical as it can be employed in prohibited zones and with the consideration of network losses and valve-point effects.

III.ECONOMIC LOAD DISPATCH (ELD)

Economic Load Dispatch (ELD) is the short-term determination of the optimal output of power generation facilities to basically meet the system load at the lowest possible cost while serving power to the demand in a robust and reliable manner [5]. The Economic Load Dispatch problem is an optimization problem in which the total fuel cost of all committed plants is minimised while demand and losses are met. Nonlinear, non-differentiable, and discontinuous problems can occur in real life. Classical optimization techniques cannot be used to solve these [6,7,8,9,10]. Classical techniques tend to settle for local minima rather than global best solutions. The optimal operation of a power system occurs when all the system's objectives, such as cost of generation, system transmission losses, environmental emissions, and so on, are met at the same time. However, these objectives may be incompatible, and conventional single-objective optimization techniques cannot handle them. The best value of the objective under consideration is obtained using single objective optimization techniques, whereas the values of other objectives obtained using multiple objective optimization techniques may not be acceptable at all. Therefore, a multi-objective approach has been used to solve such problems.

IV. LAMBDA ITERATION

The Lambda Iteration method (LI) is used to solve optimization problems such as the ED problem by determining the best fuel cost and generator output power. The condition for optimal dispatch and scheduling is Lambda, also known as the Lagrange multiplier [11]. Hand calculation can solve the (ELD) problem using Lambda Iteration (LI), but if the system is large, hand calculation is impossible [12].

The most common method of solving ELD problems is by using the lambda iteration method, where the procedure converges rapidly. Here the best fuel cost is determined along with optimal generator outputs. The detailed algorithm is given below;

1) Read the given data.
2) Choose the initial value of λ & $\Delta\lambda$.
3) Determine P_{gi} corresponding to incremental fuel cost.
4) For each unit, check the generation limits.
5) The difference in power at all generator buses between consecutive iterations should be less than then prescribed value. If not, go back to step 3.
6) After all P_{gi} values are calculated, find out the loss. Calculate the mismatch between generated power and demand, including losses.
7) If the value of ΔP is less than some specified value s, stop the calculation and calculate the cost of generation with these values of power. Otherwise, go to step 8.
8) Increase the value of λ & $\Delta\lambda$; if $\Delta P <$ 0 or
9) Decrease the value of λ & $\Delta\lambda$; if $\Delta P > 0$
   And repeat from step 4.

III. PARTICLE SWARM OPTIMIZATION

Particle swarm optimization, introduced by Kennedy and Eberhart in the year 1995, is a population-based, heuristic search optimization technique conceptualized by a variety of animal social behavior like flocking of birds and schooling of fishes, etc. In accordance with PSO system, particles move about in a search space which is multi-dimensional. A particle, as time passes through its quest, updates its position based on self-experience and that of its neighboring particles, in view of the best position encountered by it and its neighbors. Everyone in PSO flies in the multidimensional search space with a velocity that is dynamically adjusted based on the flying experience of self and the experience of its companions.

The sequence of steps applied to solve the ELD problem using PSO is as follows.

1) The fitness function i.e., the reciprocal of the cost of generation, is initialized.
2) The parameters of PSO i.e., c1, c2, population size, $wmax$, $wmin$, error gradient, etc. a,re initialized.
3) Input data is fed, which includes cost functions, MW limits of generators, B-coefficient matrix, and load-demand.
4) At the beginning of the execution of the algorithm many active power vectors which satisfy MW limits of generators are allocated at random.
5) The value of fitness function for each vector of active power is evaluated. The values which are obtained in a single iterative step are compared to decide pbest. All the fitness function values for the whole population are compared which decides the gbest. These pbest and gbest values are updated at each iterative step.
6) In each iteration the error gradient is checked and gbest is plotted till it comes within the pre-specified range.
7) The gbest value so obtained is the minimum cost. Active power vector determines the optimum ELD (economic load dispatch) solution.

IV. RESULTS

In Table (I,II), the system lambda was obtained for 6 generators 30 bus system during the analysis using the Lambda Iteration method. Every generator must have the same lambda value to have optimal dispatch. (LI) method using less computational time in every analysis of different power demands during the analysis of economic dispatch using MATLAB programming. From the table below [13], it was shown the dispatched power for each generator, losses in transmission, fuel cost, system Lambda and computational time under different power demands

Table I: ELD using LI

PD (MW)	P1 (MW)	P2 (MW)	P3 (MW)	P4 (MW)	P5 (MW)	P6 (MW)	PL (MW)
500	216.3878	50	85.7029	50	50	50	1.9924
700	312.282	73.420	159.487	50	59.14	50	4.1642
1000	391.5567	132.14	220.812	93.78	122.0434	50	8.127
1300	454.381	178.59	269.624	145.1	171.282	92.4263	13.0854
1450	497.1135	200	300	150	200	120	16.7391

Table II: Computational Time and cost using LI

PD (MW)	Cost $/h	Comp Time/s	Lam $/MWhr
500	6107.1	0.0688	10.21
700	8288.8	0.1576	11.60
1000	11957	0.1609	12.73
1300	15862	0.1576	13.61
1450	17980	0.1637	14.21

In the particle swarm optimization analysis in Table (III), the number of particles was set to 100. Besides, the weight factor was between the ranges of 0.4 to 0.9. The (PSO) was able to search for larger space and discover the G-best. The constants were set to 2. Then, the number of iterations was set as 1000 iterations to avoid the analysis completely. Before it was really done, the iteration, the Error was set as e-6, so if the error was less than this value, the iteration process would terminate after 5000 iterations. During the analysis, the B-coefficient was considered to calculate the losses in the transmission line for a more accurate result. Besides, the generator's power limit constraint was also involved in the analysis. The computational time was obtained by using MATLAB.

Table III: ELD using PSO

PD (MW)	P1(MW)	P2(MW)	P3(MW)	P4(MW)	P5(MW)	P6(MW)
500	216.3295	50	85.662	50	50	50
700	312.223	73.383	159.456	50	59.100	50
1000	391.002	131.731	220.399	93.3474	121.6150	50
1300	454.7530	178.860	269.893	145.337	171.56	92.713
1450	496.7303	200	300	150	200	120

Table IV: Computational Time and cost using PSO

PL (MW)	Cost $/h	Comp Time/s
1.9916	6106.07	2.91
4.1622	8286.89	2.995
8.094	11929.2	3.04
13.11	15885.8	3.04
16.730	17974.8	3.05

Table (V) describes the comparison between lambda iteration results and particle swarm optimization results, including various load demands, costs, power losses, and computation time columns. It was found that the (PSO) method is more accurate in fuel cost and power losses compared to the (LI) method. Besides, the (LI) method losses are also higher than the (PSO) method, which will cause a cost increase.

Table V: Comparison of Methods

Load Demands (MW)	Costs($/h)		Power losses (MW)		Comp-time/s	
Methods	PSO	LI	PSO	LI	PSO	LI
500	6106.07	6107.1	1.9916	1.9924	2.91	0.0688
700	8286.89	8288.8	4.1622	4.1642	2.995	0.15759
1000	11929.2	11957	8.094	8.127	3.0189	0.16085
1300	15885.8	15862	13.11	13.0854	3.038	0.15755
1450	17974.8	17980	16.730	16.7391	3.0579	0.16379

V. CONCLUSION

Economic dispatch played an important role in the economy and environment. Thus, to achieve a more effective dispatch, two methods were used to solve, IEEE 30 busses generators power system. The methods were Particle Swarm Optimization (PSO) and Lambda Iteration (LI). These two methods were analyzed using MATLAB software by running the codes for each of the methods. From the analysis of IEEE 30 busses generators system with transmission losses, it was found that the PSO method was able to produce a better accuracy in fuel cost and power losses compared to the LI method.

REFERENCES

[1] J.H.Park, Y.S. Kin, I.K.Eong and K.Y.Lee, “Economic Load Dispatch for Piecewise Quadratic Cost Function using Hopfield Neural Network,” IEEE Transaction on Power System, Vol. 8, No.-3, pp. 1030-1038, August 1993.
[2] Po-Hung and Hong-Chan Chang, “Large Scale Economic Dispatch by Genetic Algorithm,” IEEE Transaction on Power System, Vol.10, No.-4, pp. 1919-1926, Nov. 1995.
[3] Zee-Lee Gaing, “Particle swarm optimization to solving the economic dispatch considering the generator limits, ” IEEE Trans. Power Syst., vol. 18, pp. 1187-1195, Aug. 2003.
[4] T. Aruldoss Albert Victoire, A. Ebenezer Jeyakumar, “Hybrid PSO-SQP for Economic Dispatch with Valve-Point Effect,” Elsevier, Vol. 71, pp. 51-59, December 2003.
[5] G.Kalidas Babul et al, “Network and Generator Constrained ED Using Real and Binary Coded Gas”, Int. Journal of Engineering Research and Applications ISSN: 2248-9622, Vol. 3, Issue 5, Oct 2013, pp.1185-1192.
[6] D. Rahall, G. Nikita and S. Harsha “Economic Load Dispatch Problem and MATLAB Programming of Different Methods” International Conference of Advance Research and Innovation (ICARI-2014).
[7] A. Zonal, D. Devendra “Power Economic Dispatch of Thermal Power Plant Using Classical Traditional Method” International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol. 4 Issue II, pp2321-9653.
[8] K.D. Susheel, J. Achala, and A.P.Huddar “Journal of Electrical and Electronics Engineering” (IOSR-JEEE), Vol. 10, Issue 2 Ver. III, PP 27-32.
[9] Z. Lee Gaing- “Particle Swarm Optimization to Solving the Economic Dispatch Considering the Generator Constraints” IEEE Transactions on power systems, VOL. 18, NO. 3, Apr 2003 pp (1187-1195).
[10] Sivanagaraju “power system operation and control” JNTU Kakinada” copyripht2010, typeset by mukesh technologies pvt.ltd Pondicherry. Associate professor, department of electrical &electronics engineering university college of engineering.
[11] A. Kauri, A.P. Singh and A. Hardwar. “Analysis of Economic Load Dispatch Using Genetic Algorithm,” International Journal of Application or Innovation in Engineering & Management (IJAIEM), vol. 3, no. 3,pp. 240-246.
[12] Y. M. Swarup, K. S. Izui, “Optimal economic power dispatch using genetic algorithms” Proceedings of the Second International Forum. 1993 Neural Networks to Power Systems.ANNPS157- 162.
[13] Zaineb Nisar, “Economic Load Dispatch using Lambda Iteration, Particle Swarm Optimization & Genetic Algorithm,” Volume 9 Issue VIII Aug 2021, IJRASET