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Design of Power System by using Grey Wolf Optimization Technique

Sandeep Kaur, Raja Singh Khela

Abstract: ***Power supply determines the adequacy to the consumer devices. Without real power, an electrical device fails to function normally.The purpose of this article is to study and realise the stability of a power system and its modelling .Thus, the purpose of this study is to reduce the problem of sag / swell of the voltage by using the proposed Distribution Static Synchronous Compensator (D-STATCOM). The D-STATCOM is proposed with advanced optimization technique.The stability, modelling and simulation of the electrical system is evaluate by MATLAB.The results thus obtained showed compatibility with the performance of DSTATCOM in reducing the sag of tension and swell.The results are very positive and giving hope for future and have shown that GWO is an effective optimization technique for solving various problems.***

Keywords: ***D-STATCOM, OPTIMIZATION TECHNIQUES, SIMULATIONS, GWO.***

I. INTRODUCTION

Power supply determines the adequacy to the consumer devices [1]. This is used to show the electrical energy that powers an electrical load and the ability of the load to function properly [2]. Without this power, an electrical device may not work properly, fail prematurely, or fail at all. Electrical energy can be of poor quality in many ways and many other causes of such poor quality energy. Modern industrial processes is depend programmable logic controllers, electronic power devices and drive etc because their controls are sensitive to disturbances such as voltage drop, and current swell [4]. The voltage drop is the biggest problem in terms of power quality. It give greater than 82% to the energy quality problems (QPs) encountered in electrical systems, issues that are of greater concern to industries and utilities [1,2]. By definition, the sag of the voltage is reduce the AC voltage to the frequency of the current, for a duration ranging from half a cycle to a few seconds.[1,2] Due to voltage drop a fault occur in the distribution system, a fault in the customer's installations or a large increase in the load current resulting from the starting of an engine[3]. Faults are single-phase or three phase circuit faults, due to these faults very high currents flows in the system.The high current causes a voltage drop on the impedance of the network. Voltage losses are not tolerated by sensitive equipment used in modern industrial installations such as process controllers; programmable logic controllers, speed controller (ASD) and robotics [4,5]. Various authors have suggested / applied various methods for reducing or attenuating voltage drops .D-STATCOM has a device which is used to improve the voltage sag and current swell in the power system .[5,6].

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II. OBJECTIVES

This paper has three main objective as following .

A. Study of major source of power quality problems.
B. Optimization techniques
C. Solving various problems by using GWO

II. LITERATURE REVIEW

1.DSTATCOM Performance for Voltage Sag,Swell Mitigation [1]

From this Paper we refer-

The performance of a DSTATCOM in attenuating sag / swelling of tension is demonstrated using MATLAB. The results of modeling and simulation of a DSTATCOM are presented. D-STATCOM is a device that is used to remove sagging of voltage and swell of current on the distribution side. In this work the DSTATCOM is a device that is used to control the current and voltage from unbalance condition . [1]

2.Simulation and analysis of DVR for mitigating voltage Sags and Swells [2]

From this Paper we refer-

In this paper the modeling and simulation of the Dynamic Voltage Restoration (DVR) is used to reduce the voltage drops and current swell type of major problems of non-linear loads using power theory. Now the utilities have been faced with an increasing number of complaints about the quality of electricity due to downsizing. [2]

3. Design and Simulation Studies of D-STATCOM for Mitigating Voltage Sag Problem by Using Fuzzy Inference System, and Proportional Integral based on controlled application [3]

From this Paper we refer-

In this period, power quality have been reported as a recurring problem in the promotion of delicate and miniature electronic devices in which the problem of voltage drop is the most common problem. the most prejudicial. The present study therefore aimed at solving the problem of sagging of the voltage using the proposed static distribution compensator (D-STATCOM. [3]

4. Mitigation of Voltage SAG and Voltage Swells By Controlling the DSTATCOM [4]

From this Paper we refer-

In this article, describe the Energy difficulty such as voltage drops and their consequences.. This document describes attenuation of voltage hollows and swells. The procedure for designing various components of DSTATCOM is presented. The results of the simulation clearly show the performance of a D-STATCOM to attenuate voltage drops and voltage swells, as well as a fast dynamic response. [4]

5. Design and Simulation of DVR Used For Voltage Sag Mitigation at Distribution Side[5]

From this Paper we refer-

The Dynamic Voltage Conservator is a custom power supply device used to attenuate the voltage across the load. The collapse of power is one of the major problems to be solved here. To resolve the problem of DVR the custom power devices are used. [5]

6. **Modeling and Simulation for Voltage Sags/Swells Mitigation Using Dynamic Voltage Restorer (DVR)[6]**

From this Paper we refer-

This document finds the problem of voltage hollows and current swells and its effects on non-linear loads or sensitive loads. The Dynamic Voltage Conservator (DVR) has become popular as a cost-effective solution for protecting sensitive loads against voltage drops and surges. The results of simulations carried out by Matlab / Simulink make it possible to check the performances of the proposed method. [6]

7. Grey wolf optimization applied to economic load dispatch problems[7]

From this Paper we refer-

This article presents a new evolutionary optimization approach called Gray Wolf Optimization (GWO), based on the behavior of gray wolves, for an optimal operational economic burden sharing (ELD) strategy. The GWO method requires no information on the gradient of the objective of this, while seeking an optimal solution. The GWO optimization technique concept appears to be a vigorous and that is applied to non-linear ELD problems. The result is very supportive and proves that the GWO model is a very useful optimization technique for finding various faults in electrical system. [7].

III. POWER QUALITY

Power quality refers to the ability of electrical equipment to consume the energy being supplied to it. A number of **power quality** issues including electrical harmonics, poor **power** factor, voltage instability and imbalance impact on the efficiency of electrical equipment. In distribution systems and for some sensitive devices, power quality issues generate a wide range of disturbances, such as brownouts, flickering and, transient pulses [6]

1. Voltage sag

Whenever a fault occur on the transmission or distribution network, due to this faults voltage on the single phase and three phase sags .

2. Voltage swells

Due to Start/stop of heavy loads, fault occur on the transmission lines which results the voltage swell. **DISTRIBUTION STATIC COMPENSATOR (D-STATCOM)**

A Static Distribution Compactor (D-STATCOM) is achieving maximum productivity with minimum wasted effort [2]. D-STATCOM has less costs, small size, and dynamic response to disturbance.D-STATCOM has a DC power storage device (ESD), a coupling transformer connected to the shunt delivery system through a coupling transformer. VSC transforms the DC voltage on a storage device into a set of three-phase output voltage [3]. These voltage are in phase phase and coupled through the reluctance of the coupling transformer to the AC system. [4][5]

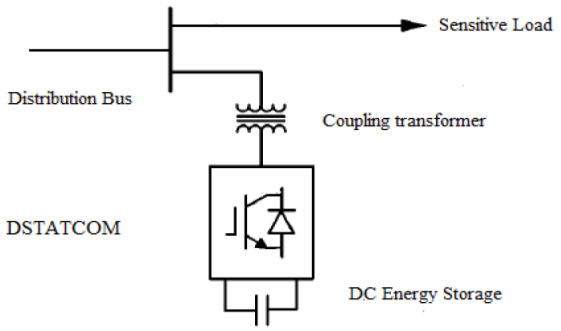

Figure 1.Basic configuration of D-STATCOM

IV. SIMULATION MODEL FOR THE SYSTEM

To better performance of the distribution system, D-STATCOM is connected to the distribution system. DSTATCOM is designed with MATLAB simulink[4]. 230 kV, 50 Hz transmission system supplying the primary side of a 230/11 / 11kv connected 3-winding transformer. A variable load is connected to the 11kV secondary side of the transformer. The capacitor on the DC side provides the DSTATCOM energy storage capabilities. The circuit breaker is used to control the operating period of the DSTATCOM[4,5].

a.Model for single phase fault.

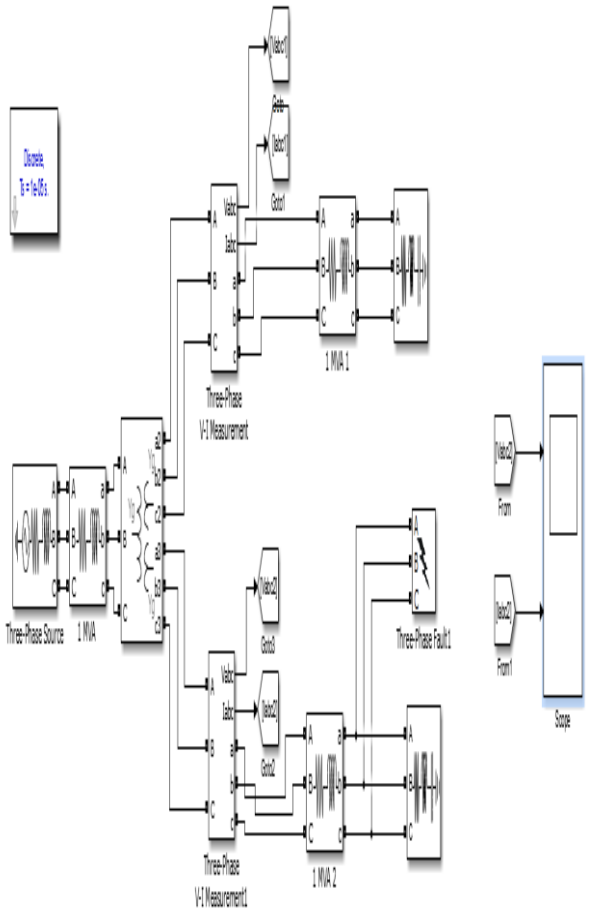

Figure 2.Simulation model for single phase fault

b. Model for three phase fault

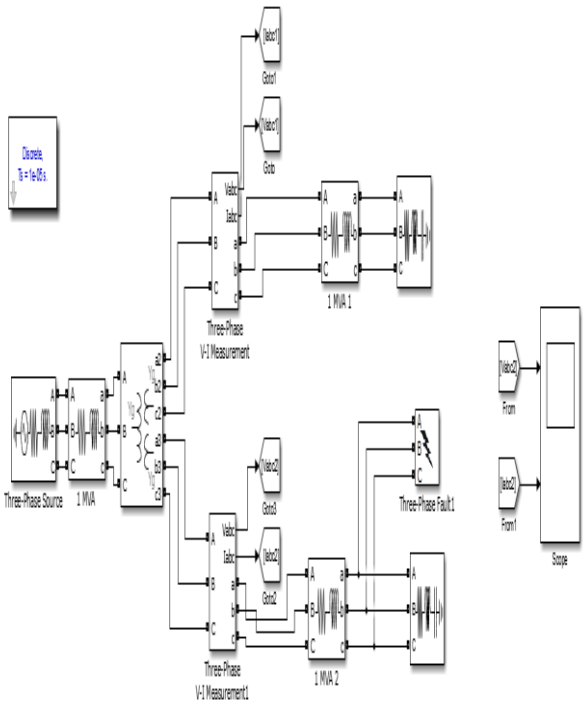

Figure 3. Simulation model for three phase fault.

V. SIMULATION RESULT FOR THE SYSTEM

a. Simulation result for load (1 phase balanced load) In this system balanced voltage sag and current swell are occur for a duration 400ms to 700ms [6]

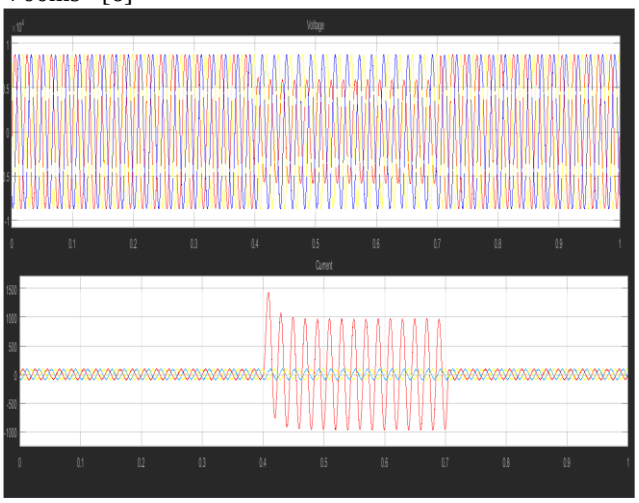

Figure 4. Simulation result for single phase fault

b. Simulation result for load (3 phase balanced load) In this system balanced voltage sag and current swell are occur for a duration 400ms to 700ms [6]

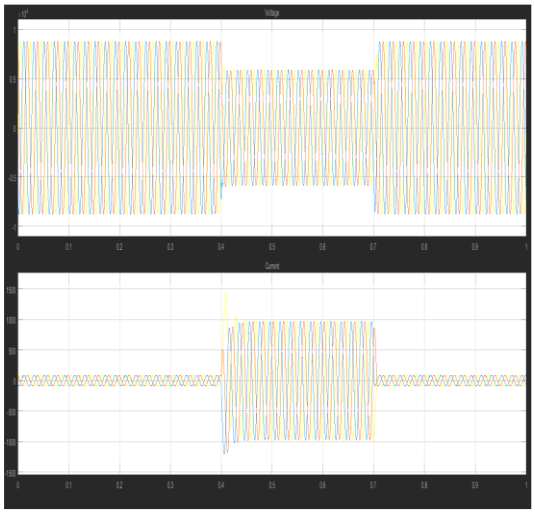

Figure 5. Simulation result for three phase fault

VI. GREY WOLF OPTIMIZATION TECHNIQUE APPLIED TO SINGLE PHASE AND THREE PHASE PROBLEMS

The advantage of the GWO is that it imposes no limit of convexity on the characteristics of the production unit [7]. The results show that the GWO method has high quality characteristics, the ability to withstand or overcome adverse conditions or rigorous testing, simple applicability and a location where airflows or ocean currents meet, characteristically marked by upwelling (of air) or down welling (of water). [8]. It seems unique in its character that GWO is used to solve many optimization problems in electrical systems [7].

The different steps of GWO algorithm for solving electrical system problems are given below.

Step 1: The amount of energy production of the unit is calculated and checks to satisfies the inequality constraint. Unfeasible solutions are reset. Many sets of initial solutions are generated based on the size of the population.[9] The position of the different search agents (gray wolves) is represented by a reasonable set of solutions (control variables)[11]. According to the position matrix of the initial search agents (gray wolves):

$$P = \begin{bmatrix} P^1_{g_1}, & P^1_{g2} & , \ldots , & P^1_{gi} & \ldots , & P^1_{gn} \\ P^2_{g_1}, & P^2_{g2} & , \ldots , & P^2_{gi} & \ldots , & P^2_{gn} \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ P^i_{g_1}, & P^i_{g2} & , \ldots , & P^i_{gi} & \ldots , & P^i_{gn} \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ P^{n_p}_{g1}, & P^{n_p}_{g2} & , \ldots , & P^{n_p}_{gi} & \ldots , & P^{n_p}_{gn} \end{bmatrix}$$

SStep 2: Solve the suitability of all problems by current population [10]. Each result gives the distance between the wolf and the prey

Step 3: find out the population from good to bad The good, second and third good solutions gives the wolf categories a, b and d respectively.

Step 4: Make partial changes to the position of each search agent using the desired prey, the encircled prey, the hunting and attacking concepts[7]. The position of each search agent gives a potential solution including the active generation of the ELD problem.

Step 5Then, the last unit of the energy production is evaluated and one checks if it satisfies all the constraints of inequality or not. Unfeasible solutions are exchanged by the best feasible solutions.[9]

Step 6: Go to Step 2 till the final criteria are reached. The execution of GWO is stopped when the highest number of iterations is reached or in the absence of significant improvement of the solution.

VII. FINAL MODEL AFTER GREY iiWOLF OPTIMIZATION

Final Model after GWO

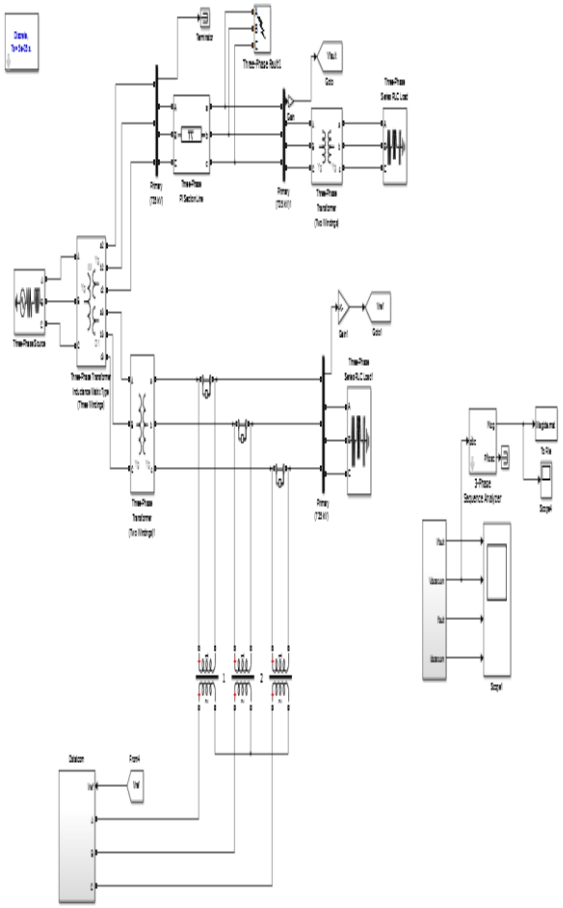

Figure 6. Model for GWO

VIII. SIMULATION RESULT OF FINAL MODEL

Simulation result of final model after grey wolf optimization. It is clear that by GWO Optimization Technique the voltage sag and current swell are removed.

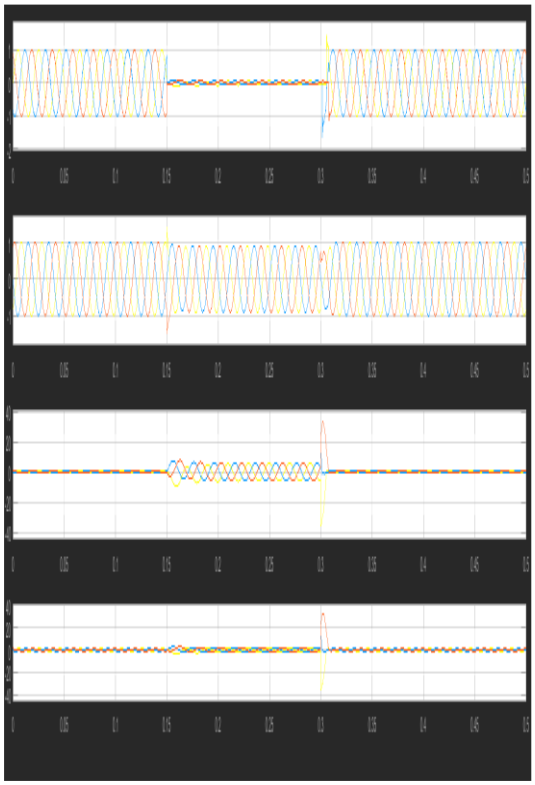

Figure 7. Simulation result for GWO

IX. CONCLUSIONS

The action of a DSTATCOM for voltage sag and current swelling is understand by using MATLAB. The results of modeling and simulation of a DSTATCOM are presented [1,2,3]. D-STATCOM is used to reduce the voltage sag and current swelling on the distribution side. In this work, an algorithm and relatively new, called GWO, is proposed to solve the problem taken into account the effects of load at valve points, multiple fuel, prohibited area of operation, ramp rate limits into consideration.

The advantage of the proposed GWO is that it imposes no limit of convexity on the characteristics of the production unit[9,10,11]. Results of the simulation Confirmation is that the GWO method has advantages as compare to others in terms of unlikely to break or fail less computational effort, avoids premature convergence, simple applicability and a stable convergence characteristic. Although the proposed algorithm is applied to solve the problems of this study, it seems unique in its character that GWO has the potential to solve many other optimization problems in the field of planning and operations[12,13].

REFERENCES

1. Rupali D. Burungale, C. R. Lakade"DSTATCOM Performance for Voltage Sag,Swell Mitigation" International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering ,Vol. 6, Issue 2,pp-697-709, February 2017.
2. Shakti Prasad Mishra,Bishnupriya Biswal,J Preetha Roselyn,D.Devaraj, "Simulation and Analysis of DVR for Mitigating voltage Sags and Swells"International conferences on Design and Manufacturing,Science direct,pp341-350,2013.
3. Hamza jabber Mohamed,Mohamed Ali Abdulsalam,Fathi A Mansur,Miftahul Anwar, "Design and Simulation Studies of D-STATCOM for Mitigating Voltage Sag Problem by Using Fuzzy Inference System, and Proportional Integral based on controlled application" international journal of advanced research in electrical electronics and instrumentation engineering ,vol.3 ,issue8, pp-11413-11421,August 2014.
4. Zarana Bhindi, Rakesh Akbari "Mitigation of Voltage swell by DSTATCOM" IJEDR 2018 | Volume 6, Issue 2,pp-364-368.
5. Jaykant Vishwakarma , Dr. Arvind Kumar Sharma "Design and Simulation of DVR Used For Voltage Sag Mitigation at Distribution Side" International Journal of Novel Research in Electrical and Mechanical Engineering Vol. 2, Issue 2, pp: (51-58),May - August 2015.
6. Rosli Omar And Nasrudin Abd Rahim " Modeling and Simulation for Voltage Sags/Swells Mitigation Using Dynamic Voltage Restorer (DVR)" Australasian Universities Power Engineering Conference AUPEC'08,pp-027.
7. Moumita Pradhan , Provas Kumar Roy and Tandra Pal "Grey wolf optimization applied to economic load dispatch problems" Elsevier Electrical Power and Energy Systems ,pp-325–334,2016.
8. Hamza Jaber Mohamed, Mohamed Ali Abdulsalam , Fathi A Mansur, Miftahul Anwar "Design and Simulation Studies of D-STATCOM for MitigatingVoltage Sag Problem by Using Fuzzy Inference System, and Proportional Integral based on controlled application" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering,Vol. 3, Issue 8, August 2014.
9. Amin Nazarloo, Student Member, IEEE, SeyedHosseinHosseini, Member, IEEE, EbrahimBabaei, Member,IEEE, "Flexible DSTATCOM Performance as a Flexible Distributed Generation in Mitigating Faults" 2011 2nd Power Electronics, Drive Systems and Technologies Conference
10. El-Keib AA, Ma H, Hart JL. Environmentally constrained economic dispatch using the Lagrangian relaxation method. IEEE Trans Power Syst 1994;9 (4):1723–9.
11. Fan JY, Zhang L. Real-time economic dispatch with line flow and emission constraints using quadratic programming. IEEE Trans Power Syst 1998;13 (2):320–5.
12. Chen CL, Wang SC. Branch- and bound scheduling for thermal generating units. IEEE Trans Energy Convers 1993;8(2):184–9.
13. Aravindhababu P, Nayar KR. Economic dispatch based on optimal lambda using radial basis function network. Int J Electr Power Energy Syst 2002;24 (7):551–6.
14. Dodu JC, Martin P, Merlin A, Pouget J. An optimal formulation and solution of short-range operating problems for a power system with flow constraints. IEEE Proc 1972;60(1):54–63.
15. Parikh J, Chattopadhyay D. A multi-area linear programming approach for analysis of economic operation of the Indian power system. IEEE Trans Power Syst 1996;11(1):52–8.
16. Nanda J, Hari L, Kothari ML. Economic emission dispatch with line flow constraints using a classical technique. IEE Proc Gener Trans Distrib 1994;141 (1):1–10.

17. Liang ZX, Glover JD. A zoom feature for a dynamic programming solution to economic dispatch including transmission losses. IEEE Trans Power Syst 1992;7(2):544–50.
18. Yang L, Fraga ES, Papageorgiou LG. Mathematical programming formulations for non-smooth and non-convex electricity dispatch problems. Electr Power Syst Res 2013;95:302–8. Fig. 4. Convergence characteristic of generation cost using GWO for 140-unit system. M. Pradhan et al. / Electrical Power and Energy Systems 83 (2016) 325–334 333
19. Park JH, Kim YS, Eom IK, Lee KY. Economic load dispatch for piece wise quadratic cost function using Hopfield neural networks. IEEE Trans Power Syst Ap Syst 1993;8(3):1030–8.
20. Lee KY, Park JH. Adaptive Hopfield neural networks for economic load dispatch. IEEE Trans Power Syst 1998;13(2):519–26.
21. Su CT, Lin CT. New approach with a Hopfield modeling framework to economic dispatch. IEEE Trans Power Syst 2000;15(2):1325–32.
22. Sood YR. Evolutionary programming based optimal power flow and its validation for deregulated power system analysis. Int J Electr Power Energy Syst 2007;29(1):65–75.
23. Swain AK, Morris AS. A novel hybrid evolutionary programming method for function optimization. In: Proc 2000 congr evolut comput, vol. 1; 2000. p. 699– 705.
24. Varadarajan M, Swarup KS. Solving multi-objective optimal power flow using differential evolution. IET Gener Transm Distrib 2008;2(5):720–30.
25. Devaraj D, Yegnanarayana B. Genetic-algorithm-based optimal power flow for security enhancement. IEE Proc Gener Transm Distrib 2005;152(6):899–905.
26. Amjady N, Nasiri-Rad H. Solution of non-convex and non-smooth economic dispatch by a new adaptive real coded genetic algorithm. Expert Syst Appl 2010;37:5239–45..
27. S.Krishna and K. R. Padiyar ”Transient stability assessment using artificial neural networks”proc.IEEE International conference on Industrial Technology 2000 ,Goa ,India ,vol.2 ,p. 627 -632.
28. Pravin Balasaheb Shendge, Prof. S. H. Pawar “Simulink model for Mitigation of Sag/ Swell by Dynamic Voltage Restorer using SPWM Technique” Proceedings of the International Conference on Intelligent Sustainable Systems (ICISS 2017) IEEE Xplore Compliant,pp 747-750.
29. El-Keib AA, Ma H, Hart JL. Environmentally constrained economic dispatch using the Lagrangian relaxation method. IEEE Trans Power Syst 1994;9 (4):1723–9.
30. Fan JY, Zhang L. Real-time economic dispatch with line flow and emission constraints using quadratic programming. IEEE Trans Power Syst 1998;13(2):320–5.
31. Chen CL, Wang SC. Branch- and bound scheduling for thermal generating units IEEE Trans Energy Convers 1993;8(2):184–9.
32. Dodu JC, Martin P, Merlin A, Pouget J. An optimal formulation and solution of short-range operating problems for a power system with flow constraints. IEEE Proc 1972;60(1):54–63.
33. Parikh J, Chattopadhyay D. A multi-area linear programming approach for analysis of economic operation of the Indian power system. IEEE Trans Power Syst 1996;11(1):52–8.
34. Nanda J, Hari L, Kothari ML. Economic emission dispatch with line flow constraints using a classical technique. IEEE Proc Gener Trans Distrib 1994;141 (1):1–10.
35. Liang ZX, Glover JD. A zoom feature for a dynamic programming solution to economic dispatch including transmission losses. IEEE Trans Power Syst 1992;7(2):544–50.
36. Yang L, Fraga ES, Papageorgiou LG. Mathematical programming formulations for non-smooth and non-convex electricity dispatch problems. Electr Power Syst Res 2013;95:302–8.

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