Congestion Management in Deregulated Power System by Firefly Algorithm

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Abstract— In power system congestion is one of the critical issue. As the cascading outage initialize that can cause the system may collapse due to congestion. In this paper, Firefly Algorithm is used for congestion management. The natural behavior of fireflies is used in firefly algorithm. In this, firefly works individually and tries to find the best position for itself in consideration with its current position as well as the position of the fireflies.it moves from the local minima to the global minima in minimums number of iteration. This proposed technology helps n removing the congestion as well as minimize the rescheduling cost. This firefly algorithm applied on IEEE-30 bus system.

Key words: Firefly Algorithm, Congestion Management

I. INTRODUCTION

One of the ISO (Independent System Operator) key functions is congestion management .In deregulated electricity market the generating, transmitting and distributing companies are working independently and to operate system in synchronism, it's a main challenge of ISO. The main aim of this system is to decrease the price of electric energy and the increment of in new ideas and bring a reliability and quality in electrical energy. Congestion Management is an important issue in reducing the generation cost and improving the transfer capacity of the system within the available network condition. The main issue is congestion in lines, which limits transfer capability of a system with available generation capacity. In deregulated market, all independent entities are free to interact with each other. The main aim is that to maximize the profit, in buying and selling of electricity is by participant, causing the system operates beyond their operational limit. When a transmission system is fail to attend the demand of consumer, then in that case one or more constrains violate and for contingencies created in the system. The open access transmission system results in the more intensive use of the transmission system, which in turn, leads to more frequent congestion situations. To ensure system security and reliability the constraints are defined as either physical limit or thermal or voltage limit. The causes of congestion are such as suddenly increase in demand of a consumers, generation system goes suddenly out of service, restriction on the construction of new transmission lines, unexpected power flow in lines, failures of the equipment in transmission lines. The congestion is main challenge to ISO, who is responsible to manage congestion in the transmission line and make sure about system security. The congestion causes a market efficiency decreases and electricity price increases.

II. LITERATURE SURVEY

The literature survey shows that, the various technique has been used for to point out serious issues related to congestion management. In open access electricity market congestion management is discussed in reference [1]. Hans Glavitsch & Fernando Alvarado has discussed how the multiple congested conditions manage in unblundled operation of a power system [2]. For a reactive power and voltage control consider voltage security assessment by particle swarm optimization proposed in reference [3]. Shu Tao and George Gross has proposed In a Multiple Transaction Networks Congestion–Management is used [4]. Ashwani Kumar, S.C. Srivastava, S S.N. Singh, proposed Congestion management in competitive power market: A brief survey[5]. Antonio J. Conejo. Federico Milano proposed Congestion Management used to meet the Voltage Stability [6]. Firefly Algorithm,for CM and Design Optimisation proposed by Xin-She Yang in reference [7]. In Open Access how the congestion is managed, A Review by Abhishek Saxena & Dr. Seema N. Pandey [8]. Optimal utilization of renewable energy sources for congestion management.by J. Jeslin Drusila Nesamalar & P. Venktesh.[9]. Daya Ram & Laxmi Srivastava studied RBF neural network used for the corrective action planning [10]. A firefly algorithm Optimizing real power loss and stability limit of voltage in a transmission system addressed by P. Balachennaiah & M. Suryakalavathi. Discussed in reference [11]. Controller design for integrating and unstable delay processes by using Modified Firefly Algorithm by A. Gupta, P.K. Padhy[12]. Modified social spider algorithm for solving the economic dispatch problem W.T. Elsayed & Y.G. Hegazy [13] An efficient particle swarm optimizer for congestion management in deregulated environment proposed by Md Sarwar & Anwar Shahzad Siddiqui [14]. Xin-She Yang discussed the Cuckoo Search and Firefly Algorithm Theory and Applications also.

III. FIREFLY-INSPIRED ALGORITHM

A. Firefly Algorithm

So as to develop firefly-inspired algorithms we use the main flashing characteristics of fireflies. Xin-She Yang developed the new Firefly Algorithm (FA) in 2007, for that use some idealized rules are as follows:

- One firefly shall be attracted to second one fireflies due to their sex.
- Attractiveness is proportional to the brightness, thus for any two flashing fireflies, the less bright one will move towards the brighter one. The attractiveness is directly proportional to the brightness and the attractiveness and brightness decrease then distance increases. If there is no brighter one than a particular firefly, it will move randomly.
- The brightness of a firefly is find out by the objective function value.

For optimisation problem, the brightness can simply directly proportional to the objective function. These three rules are the basic steps of the firefly algorithm (FA) can be used in this work.

B. Light Intensity and Attractiveness

In the firefly algorithm, the variation of light intensity and formulation of the attractiveness are two important issues. For that we simply assume that the attractiveness of a firefly is determined by its brightness which in turn is related with the encoded objective function.

In the for maximum optimization problems, At a particular location x the brightness of a firefly can be chosen as I(x) oc f(x). However, the attractiveness ß is relative, it should be judged by the other fireflies. Thus, the distance r between firefly i and firefly j vary with attractiveness. In this, the light intensity decreases with the distance from its start point, and light is also absorbed in the media, so we say that the attractiveness to vary with the degree of absorption.

The light intensity I(r) simply varies according to the inverse square law, That is given by eq. (1).

$$I(r) = \frac{Is}{r \times r} \quad (1)$$

where Is is the intensity at the source point. For a given form, fixed light absorption coefficient is γ, As the light intensity I varies with the distance r. That is given by eq. (2)

$$I = I0\exp(-\gamma\, r) \quad (2)$$

Where, I0 is the original light intensity. In order to avoid the singularity at r = 0 in the expression Is/r2, By Gaussian form the combined effect of both the inverse square law and absorption can be given as the follow.

$$I(r) = I0\exp(-\gamma\, r^2) \quad (3)$$

As a firefly's attractiveness is directly proportional to the light intensity is seen by adjacent fireflies, So now we can define the attractiveness ß of a firefly by

$$\beta = \beta 0\exp(-\gamma r^2) \quad (4)$$

where, ßo is the attractiveness at r = 0.

The distance between any two fireflies i and j at x, and Xj, respectively, is given by Cartesian distance are as follows,

$$r_{ij} = ||X_i - X_j|| = \sqrt{\sum_{K=1}^{d} (Xi,k - Xj,k)2} \quad (5)$$

where, Xi,k is the Kth component of the spatial coordinate Xi of ith firefly.

In 2-D case,its given by,

$$r_{ij} = \sqrt{(Xi - Xj)2 + (Yi - Yj)2} \quad (6)$$

The movement of a firefly i is attracted to another more attractive (brighter) firefly j is find out by

$$X_i = X_i + \beta 0\exp(-\gamma r_{ij}^2) \times X_j - X_i) + \alpha \times \epsilon i \quad (7)$$

Where, the second term is due to the attraction. The third term is randomization with a being the parameter of randomization, and ϵi is vector of a randomization numbers drawn from a uniform distribution. For example, the simplest form is ϵ and can be replaced by rand -0.5 where rand is a random number generator uniformly distributed in [0,1].

The flowchart of the FFA is given in fig.1.

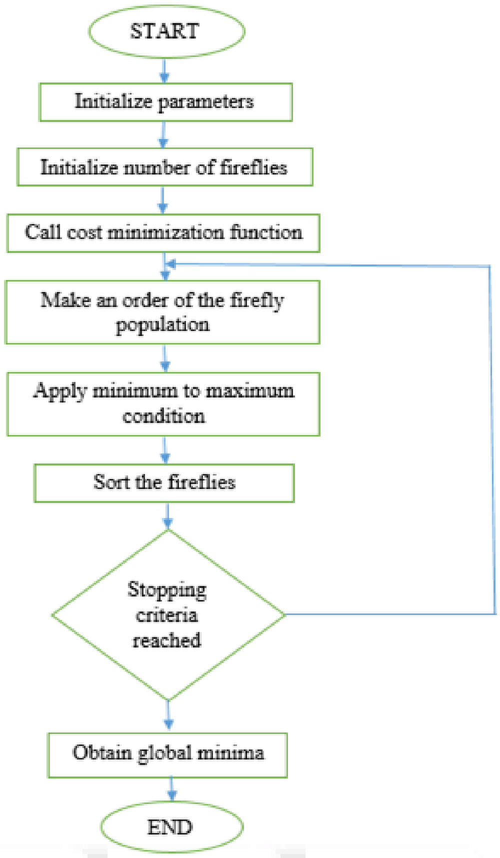

Fig. 1: flowchart for the FFA

IV. RESULT AND PERFORMANCE ANALYSIS

In the paper, CM problem is solved by FFA is implemented using MATLAB software. To verify the effectiveness of the proposed FFA, simulations are carried out on modified IEEE 30-bus test systems. The bus data and line data are given in the software.

Congestion is created in lines for the simulation purpose by overloading the lines. In this paper, line overloads are created either by reducing the capacity of lines as to the compared standard limits or by considering generator or line outage. The proposed FFA has been executed for 100 independent trial runs, out of which the best solution set is presented here. The values of α and γ are taken in the range of 0 to 1, while the value of β0 is kept constant at 10. It has been found that population of 40 fireflies is sufficient in solving the CM problem of the present work. The maximum number of iteration is set to 150 for all the test cases. The major observations of the present work are documented as results.

The modified IEEE 30-bus test system is taken for consideration. It has forty-one transmission lines, twenty-four load buses and six generator buses. Contingencies like unexpected line outage and increase in system load are considered for the simulation purpose.

It is worth indicating out that the distance defined above is not restricted to the Euclidean distance. In fact, any measure that can effectively characterize the quantities of interest in the optimization problem can be used as the distance. For a given optimization problem typical scale, for a very large number of fireflies n >>m where m is the number of local optima, then the initial locations of these n fireflies should distribute comparatively homogeneously over the entire search space. As the iterations proceed, the fireflies would converge into all the local optima (including the global ones). By comparing the best solutions among all these optima, the global optima can easily be achieved. In Our research suggests that it is possible to prove that the firefly algorithm will approach global optima when n —► 00 and ί > 1. An additional improvement of FFA is that dissimilar fireflies can work almost autonomously, it is thus predominantly suitable for parallel implementation.

It is even better than genetic algorithms and PSO because fireflies aggregate more closely around each optimum. It can be expected that the interactions between different sub regions are minimal in parallel implementation. In order to demonstrate how the firefly algorithm works, we have implemented it in MATLAB, where we have used a simple function

$(x,y)=(|x|+|y|)\exp[-0.06250(x2+y2)$ (8)

which has four equal peaks at (- 2 , - 2) , (-2,2), (2,-2) and (2,2). This function can easily extended to any higher dimensions. In order to show that both the global optima and local optima can be found simultaneously, now we use the following four-peak function. This function has four peaks. Two local peaks and two global peaks as shown in figure 2. We can see that all these four optima can be found using 25 fireflies in about 20 generations (see figure 3). So, the total number of function evaluations is about 150.

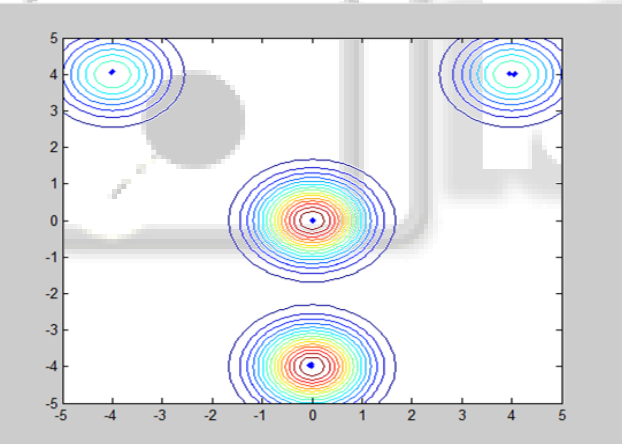

Fig. 2: Final location of a fireflies that obtain an optimum point

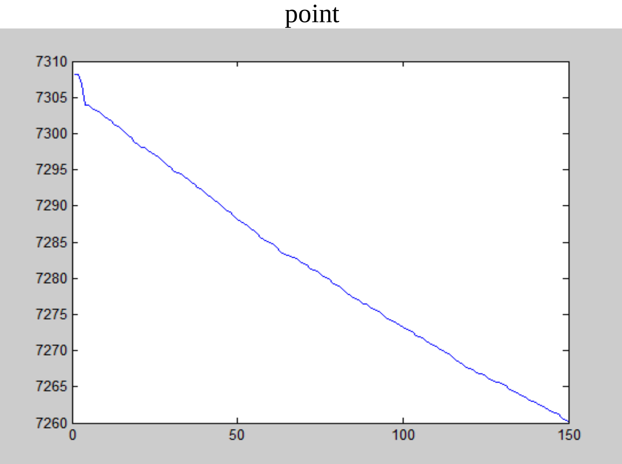

Fig. 3: fitness function value for modified IEEE-30 bus system by FFA.

V. CONCLUSION

This paper illustrate solution of CM problem in open access market is solved by optimization technique. FFA is minimize the rescheduling cost for removing congestion completely. Contingencies like outage of a line and unexpected load variation are considered in this system. It is observed that the proposed FFA efficiently removes congestion, and rescheduling cost obtained is much lower than the costs given by the other techniques. Moreover, total amount of rescheduling and losses are also found to be lower. From all conclude that, it may be observed that FFA is a main tool to solve a non-linear problems.

REFERENCES

[1] M. Shahidehpour, H. Yamin, Z. Li, Market Operations in Electric Power Systems, forecasting, scheduling, and risk Management John Wiley & Sons, Chichester, 2002.

[2] Hans Glavitsch & Fernando Alvarado,/ The Management of multiple congested conditions in unblundled operation of a power system. IEEE Transactions on Power Systems, Vol. 13, No. 3, August 1998.

[3] Hirotaka Yoshida, Kenichi Kawata, A particle swarm optimization for reactive power and voltage control considering voltage security assessment. IEEE Trans. on Power Systems, Vol.15, No.4, pp.1232-1239, November 2001, presented at IEEE PES Winter Meeting, Columbus, Jan.28-Feb.1, 2001.

[4] Shu Tao and George Gross,A Congestion–Management Allocation Mechanism for Multiple Transaction Networks. IEEE Transactions on Power Systems, Vol. 17, No. 3, August 2002.

[5] Ashwani Kumar, S.C. Srivastava, S S.N. Singh, Congestion management in competitive power market: A bibliographical survey. Electric Power Systems Research 76 (2005) 153–164.

[6] Antonio J. Conejo,, Federico Milano, and Raquel García-Bertrand ,Congestion Management Ensuring Voltage Stability.

[7] Xin-She Yang, Firefly Algorithm, Stochastic Test Functions and Design Optimisation. Department of Engineering, University of Cambridge,Trumpington Street, Cambridge CB2 1PZ, UK March 9, 2010.

[8] Abhishek Saxena Dr. Seema N. Pandey Dr. Laxmi Srivastava Congestion management in Open Access: A Review. International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, Issue 4, April 2013.

[9] J. Jeslin Drusila Nesamalar P. Venktesh S.Chasrles raja. Optimal utilization of renewable energy sources for congestion management, 2405-8963 © 2015, IFAC (International Federation of Automatic Control) Hosting by Elsevier Ltd.

[10] daya ram, laxmi Srivastava ,corrective action planning using RBF neural network.

[11] P. Balachennaiah, M. Suryakalavathi, Palukuru Nagendra, Optimizing real power loss and voltage stability limit of a large transmission network using firefly algorithm. Engineering Science and Technology, an International Journal 19 (2016) 800–810.

[12] A. Gupta, P.K. Padhy, Modified Firefly Algorithm based controller design for integrating and unstable delay processes. Engineering Science and Technology, an International Journal 19 (2016) 548–558.
[13] W.T. Elsayed, Y.G. Hegazy, F.M. Bendary, M.S. El-bages Modified social spider algorithm for solving the economic dispatch problem. Engineering Science and Technology, an International Journal 19 (2016) 1672–1681.
[14] Xin-She Yang, the Cuckoo Search and Firefly Algorithm, Theory and Application.
[15] Hadi. Saadat, Power System Analysis, Tata McGraw Hill Ltd, New Delhi, 2002.