National Journal of Research in Technology & Engineering

“Significant of Distributed Generation System in Power System for improving Power Quality’’

Prof.Hemendra Khedekar[1], Prof.Manisha Gaur[2]

Assistant professor, Dept. of EE, Swami Vivekand College of Engineering, Indore, India[1]

Assistant professor (HOD), Dept. of EE, Swami Vivekand College of Engineering, Indore, India[2]

***Abstract*—-** The distributed generation (DG) generates electrical power in the distribution networks or on the network user side. In distribution networks, DGs have significant role to perform for reduction of real power and enhancing the stability in voltage of power system. Distribution companies find that it is an effective way of minimizing losses, handling the great cost of energy that is not supplied or preventing or delaying the expansion of the network. But, precise positioning and sizing of DGs in network is the crucial problem because in case the position of DGs is not appropriate, then the increased size can cause a big risk and loss for system. The installations of DG require special attention and studies to enhance the reliability and performance of the system. When the DGs are placed optimally, it can minimize the cost of operation and network losses and enhances the power quality.

Keywords— PSO, MATLAB, Voltage Stability, Load Flow, Distribution Generation, Artificial Neural Networks

I. Introduction

Power system is an interconnection of networks working together to fulfill the load demand. Power system consists of generation, transmission and distribution sectors. Generators generate the power and this power is transmitted through transmission lines to the distributor end. This centralized generation system was built centuries ago to fulfill the demand which was only required to supply small loads (e.g. lighting loads, radio, television etc. De centralized generation is one in which generator is not connected as a central entity rather it is connected locally wherever the demand is required to be fulfilled. Distributed generation has developed an effective solution in order to fulfill the demands in the restructured and derestricted power system with the limitations on the young generation's communication lines and plants. Conventional distributed systems are developed to work with the single directional power flow i.e. from the main source to load. Combination of distributed generation in distributed system change the flow of power and execute a unique set of functioning conditions on the network. From many reports is noticed that due to improper size the installation of distributed generation at non-optimal places may lead to heavy loss in the system and thus, the overall cost should be nullifying the reason for the linked to the system. The significance of the optimal distributed generation allocation. The collection of suitable places for the installations and in the large distributed system the size of the distributed generation units is a complicated combinatorial optimization issue and can be understood as a combined integer non-linear optimization issue.

II. SYSTEM MODEL AND ASSUMPTIONS

Voltage stability index was introduced in the last chapter this index is used in order to find the stability of a bus.

Calculation of this index is performed by proper utilization of load flow techniques. Load flow technique used in distribution sector is backward forward sweep simply, because of its faster convergence in the distribution system.

Load flow method is generally used to determine various parameters of system (e.g. line current, bus voltage, load current etc.). There are many load flow methods available which are used for different applications. Methods like Newton Raphson, Gauss seidel load flow can also be used in distribution systems but due to high resistance to reactance (R/X) ratio of distribution system the convergence of these methods will be very poor. Therefore, we will look at a method with good convergence in distribution systems. One such method is Backward Forward load flow method. This method has very good convergence in distribution systems and hence, it is widely used. Backward Forward sweep methods are very simple to implement. These have a higher convergence speed than any other load flow technique. Due to its simplicity, this method requires low memory and is very reliable. Hence, this makes backward forward method one of the best methods to perform load flow operation in the distribution system.

III. PROBLEM DEFINITION & METHODOLOGY

In distribution networks, Distribution Generation (DG) is regarded as a significant issue. DG is a generating plant that transfers the power on the user on-site or supports a grid-connected distribution system at the distribution-level voltages. In electric power system, role of DGs is very significant because of raised availability of the small capacity generating techniques.

In order to enhance the reliability and performance of system, DGs must be installed with special attention. When the DGs are placed optimally, then it can minimize the cost of operation and network losses and enhances the power supply quality.

However, if they are not placed optimally, then it can lead to increase in the system losses and thus makes the voltage profile greater or minimum than the acceptable limits. The direction of basic power flow can get changed by DG installation, which will greatly affect the static voltage stability of DN. Thus, optimal allocation (positioning and sizing) of DG units is very significant to enhance voltage stability and minimize the network losses.

Fitness function is one, which determines the fitness of the particle. This is the quantity which has to be maximized or minimized depending upon the necessity. The initial population which is generated is put through the fitness function and fitness of the particle is calculated. This can be done by forming a function F1 such that value of F1 is near to zero and hence, we can easily minimize the function. So, F1 can be formed as

$$F_1 = \sqrt{\sum_{i=1}^{k}(VSI_i - 0.9)^2}$$

Where, i is the bus number,

In the literature, various approaches were proposed for determining the DGs optimum size and location. For this, Evolutionary and meta-heuristic optimization algorithms, such as artificial neural networks (ANN), GA were implemented to the optimal operation of systems. However, these approaches converge slowly.

IV. PROPOSED WORK

As defined in problem formulation section, for optimal placement and sizing of DGs, various approaches were developed in the existing works; however, they are not efficient enough to provide the optimal results and enhance the voltage stability and minimize the power losses to great extent. Thus, a requirement of new efficient approach arises. Therefore, in the proposed work, in order to place and size the DGs optimally, three approaches are proposed i.e. GA (Genetic Algorithm), PSO (Particle Swarm Optimization), and PSO-Sim. In GA and PSO approach, the DGs placement is done consecutively, however, in PSO-Sim approach, the DG placement is done simultaneously. These proposed algorithms consist of various advantages as compared to other existing approaches and thus can help in voltage stability enhancement as well as power loss reduction.

V. RESULT AND DISCUSSION

In the proposed work, three approaches i.e. GA, PSO and PSO-Sim are presented that are used for optimal placement and sizing of DG units so that voltage stability can be enhanced and power losses can be minimized. Now, in order to demonstrate the efficiency of these approaches, simulation is performed and these approaches are implemented on IEEE-33 bust test system.

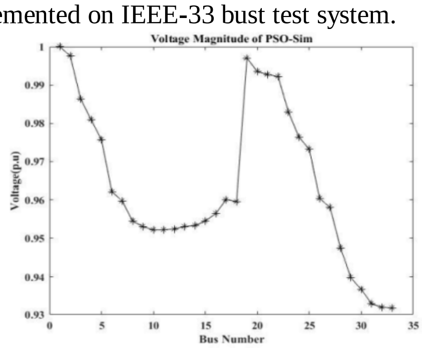

Figure 1: Voltage magnitude of PSO-Sim

Now, after implementing the proposed approaches on this bus test system, their performances are analyzed in terms of different parameters i.e. voltage magnitude (voltage profile), voltage stability index (VSI) and power losses.

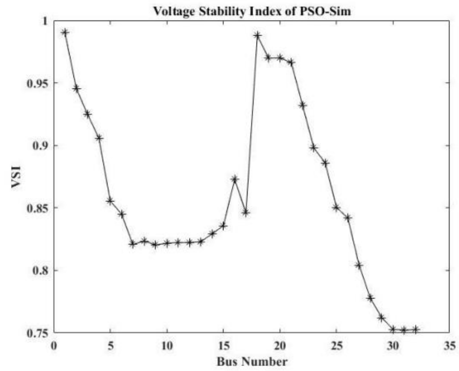

Figure 2: VSI of PSO-Sim

The analysis of PSO-Sim approach is also performed in terms of VSI, and the obtained result is represented graphically in figure 2. In the represented graph, values of VSI and bus number are shown along y-axis and x-axis, respectively. In the graph, the value of VSI varies between 0.75 and 1.

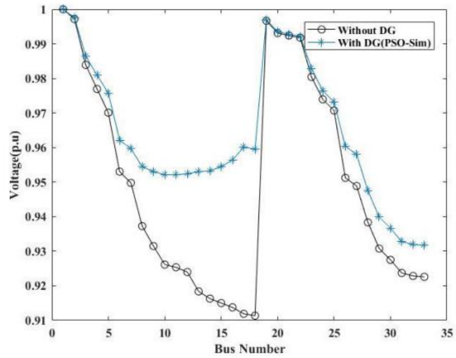

Figure 3: Voltage profile of PSO-Sim with DG and without DG

The voltage profile of PSO-Sim approach is analyzed for two cases i.e. with DG and without DG, the result of which is illustrated in figure 3. In the graph, the y-axis and x-axis calibrates the value of voltage and bus number, respectively.

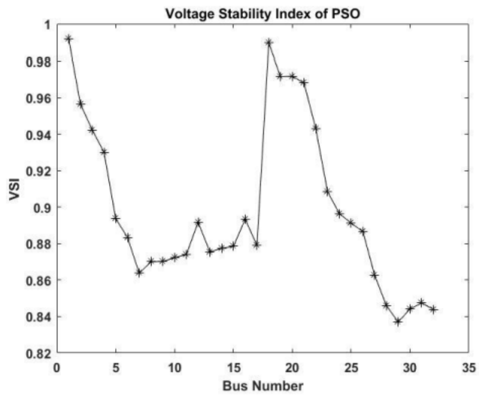

Figure 4: VSI of PSO

Now, the results are analyzed for another proposed approach i.e. PSO.

The analysis of voltage stability index of this approach at different bus numbers is performed and the result is represented graphically in above figure 4.

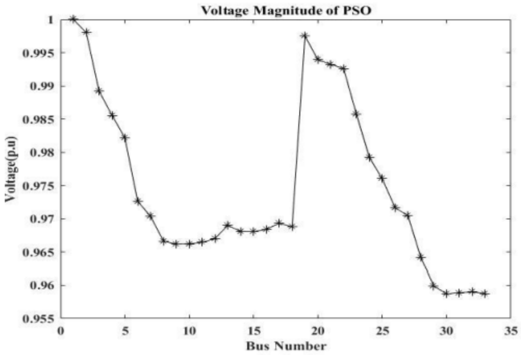

Figure 5: Voltage magnitude of PSO

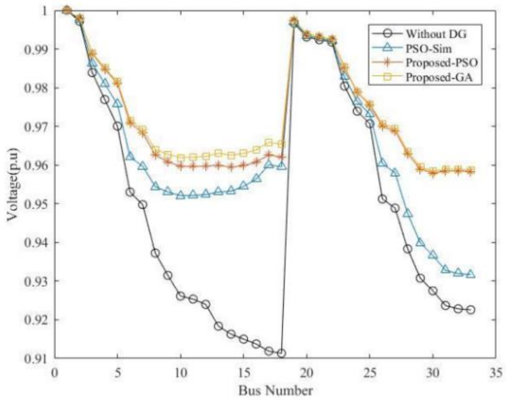

Figure 6: Comparative analysis in terms of voltage profile

The different approaches are compared in terms of voltage profile and the results of this comparison are depicted in graph of figure 6. By analyzing the graph, it is revealed that the lowest voltage profile is obtained for without DG.

VI. CONCLUSION AND FUTURE SCOPE

1.1 Conclusion

DGs optimal placement and sizing has a great significant in the distribution system for the voltage stability enhancement and active power loss minimization. The non-optimal placement of the DGs can result in huge loss of system as well as cause instability in the system voltage. Therefore, placement and sizing of DGs is the most significant aspect which needs special attention. Number of approaches has been proposed in the literature for DGs optimum placement with the objective to reduce power losses, cost and enhance the voltage stability of the system.

1.2 Future Scope

As the GA approach leads to achieve an efficient system, however, as a future scope, in order to make the system more efficient, hybrid optimization techniques can be used. And also, multiple fitness' can be considered for system analysis.

This work can be expanded by studying the characteristics of compensating devices with DGs, as compensating devices can supply reactive power and can improve system parameters.

Another interesting work can be done by considering the cost of the DG installation and the emissions from the DG as the fitness function. This function can be minimized by the use of any of the optimization technique.

REFERENCES

[1] Anderson, Roger & Ghafurian, Reza & Gharavi, Hamid. ―Smart Grid The Future of the Electric Energy System J. Clerk Maxwell, A Treatise on Electricity and Magnetism‖, 3rd ed., vol. 2. Oxford: Clarendon, pp.68–73,2018.

[2] Bayod Rújula, A. A., Mur Amada, J., Bernal-Agustín, J. L., Yusta Loyo, J. M., & Domínguez Navarro, J. A. ―Definitions for distributed generation: A revision‖,Renewable Energy and Power Quality Journal, 1(3),340–343,2005.

[3] B. Yu, J. Guo, C. Zhou, Z. Gan, J. Yu and F. Lu "A Review on Microgrid Technology with Distributed Energy," International Conference on Smart Grid and Electrical Automation (ICSGEA), Changsha, pp. 143-146,2017 ―Ministry of New and Renewable Energy Resources‖

[4] Mahmoud, G. A. ―Voltage stability analysis of radial distribution networks using catastrophe theory‖. IET Generation, Transmission and Distribution, 6(7), 612–618,2018

[5] Esmaili, M. ―Placement of minimum distributed generation units observing power losses and voltage stability with network constraints‖,IET Generation, Transmission and Distribution, 7(8), 813–821,2018

[6] H. Chen, J. Chen, and X. Duan, ―Reactive power optimization in distribution system with wind power generators,‖ Proceedings of the CSEE, vol. 28, no. 7, pp. 40-45, Mar. 2018.

[7] L. Mariam, M. Basu, F. Michael, ―A Review of Existing Distributed network,‖ Architectures Journal of Engineering‖, pp. 1-8,2019.

[8] Siemens Power Distribution & Control, Technical: Types of Power Distribution Systems, ED-1, vol. 18, (2007-2008), pp. 3-5.

[9] R. Sonderegger, D. Henderson, S. Bubb and J. Steury, "Distributed asset insight", IEEE Power and Energy Magazine, vol. 2, no. 3, pp. 32-39, 2004.

[10] T. S. Ustun, C. Ozansoy, A. Zayegh, ―Recent developments in distributed networks and example cases around the world—Areview,‖ Renewable and Sustainable Energy Reviews, vol. 15, no. 8, pp. 4030–4041, Oct. 2011.

[11] Ghosh S. and Sherpa K., ―An Efficient Method for Load−Flow Solution of Radial Distribution Networks,'' Proceedings International Journal of Electrical Power and Energy Systems Engineering, 2008