IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 9, Issue 3 Ver. V (May – Jun. 2014), PP 01-04
www.iosrjournals.org

Optimal Sizing and Placement of Multi Distributed Generation in Transmission Lines Using Differential Evolution and Firefly Algorithms

P. Sobha Rani[1] , A. Lakshmi Devi [2]
1. Assoc.Professor, Dept.E.E.E., N.B.K.R.I.T., Vidyanagar.
2. Professor. Dept.E.E.E., S.V.University, Tirupathi.

Abstract: *The conventional practice for usage of distributed generation(DG) is in distribution system for loss reduction, voltage profile improvement etc. Recently the distributed generations were used in transmission network as well for overall performance improvement i.e. reduction in losses, reduced cost of electricity, congestion management, improvement in voltage levels. The practice of distribution generation in transmission system is effective if its location and rating of generation is scaled up. In this paper for optimal location of DG, fuzzy inference system is proposed which will decide the DG location. For optimal sizing of DG, differential evolution (DE) technique is proposed. The results were simulated on IEEE-30 bus transmission network. The results are compared with the results obtained by firefly algorithm.*

Keywords: *Differential evolution (DE), Distributed generation (DG), Fuzzy inference system, Firefly algorithm (FF), Power loss, Voltage profile.*

I. Introduction

In a country like India where growth of population is increasing at a much faster rate, the power demand is increasing as well in parallel. The solution to this is to install new generating stations to meet the increasing demand which is a costlier proposal. It takes a long time to erect a generating plant. Thus the economic way is to fully utilize the existing power system. Different concepts are proposed for increasing the utilization of existing power network or decreasing losses associated with it.

In this paper introduction of DG as small scale source to transmission system for loss reduction and voltage profile improvement is presented.

Distributed generation is done with through various small-scale power generation technologies. Distributed energy resources (DE) refers to a variety of small, modular power-generating technologies that can be combined with energy management and storage systems.

Distributed generation is a technology which reduces the amount of energy lost in transmitting electricity because electricity is generated very near where it is used. This also reduces the size and number of power lines that must be constructed. Developing country like India can tap the potential of DG to extend their present generation capacity in an environment friendly manner.

II. Problem Formulation

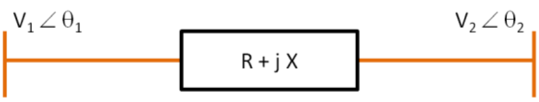

Fig 1: Basic representation of two bus system

The simple two bus system is shown in figure1. V_1 and V_2 are sending end and receiving end voltages respectively. The power flow for the system is given by

$$P = \frac{V_1.V_2.\sin\theta_{12}}{X_{12}} \quad\quad (1)$$

From equation (1), the line reactance x_{12} is more for practical long transmission lines which will reduce 'P' value. Thus to overcome this, DG unit is connected to fictitious line which is shown in fig2.

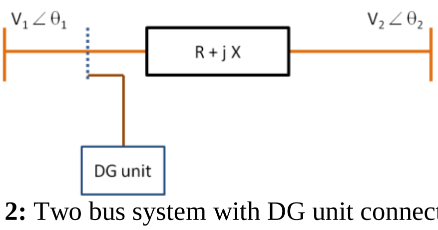

Fig 2: Two bus system with DG unit connected

In this paper the main focus is on voltage improvement and reduction of power loss for a transmission system using DG units. In this paper Newton-Raphson method is used for load flow study. This paper presents a fuzzy logic approach for optimal placement of DG and Differential evolution method and firefly algorithm for optimal sizing of DG.

Fuzzy Logic Implementation

In this paper for optimal location of DG on buses fuzzy approach is used. Fuzzy logic is developed with two objectives: reducing real power losses and maintaining voltage profile within the allowable limits (0.9 p.u. - 1.1 p.u). For writing fuzzy rules two inputs- power loss index (PLI) and nodal voltages (p.u.) are taken.

$$LR_i = P_i^1 - P_i^2 \quad \text{for i= 1 to number of load buses} \qquad (2)$$

Where, LR – loss reduction

P_i^1 - real power for normal load flow

P_i^2 - real power for load flow by total compensation of DG at i^{th} node

The loss reduction input is normalized using equation(2) so that values fall between 0 and 1, where the largest number having a value of 1 and the smallest as 0.

$$PLI = \frac{LR(i) - LR(min)}{LR(max) - LR(min)} \quad \text{for i= 1 to no. of load buses} \qquad (3)$$

The output of fuzzy gives the suitability index for DG placement. Maximum values are the promising locations for DG placement.

Differential Evolution Algorithm For Optimal Sizing

Differential evolution (DE) is a vector based evolutionary algorithm. It can be considered as a further development to genetic algorithm. It is a population based and derivative- free method. One advantage of differential evolution is that DE treats solutions as real number strings, thus no encoding and decoding is needed. Differential evolution consists of three main steps: mutation, crossover, selection.

Algorithm

1.Initialize (x*n) number of particles where x is population and n is number of DG devices.
2. Iteration count is set to one.
3.By placing all ‘n’ DG devices of each candidate node at respective candidate location, load flow analysis is performed. 4 Fitness value corresponding to each particle is evaluated. Fitness= $P_L - P_L^{DG}$ for maximum loss reduction.
5. Set weight function F and crossover probability C_r .
6. For each x, randomly choose 3 distinct vectors x_p, x_q and x_r .
7. Generate a donor vector by the mutation scheme as per eq (4)
$v_i^{t+1} = x_p^t + F(x_q^t - x_r^t)$ ……………. (4)Where F is weight function
8.Carry over crossover and select the minimum objective value.
9. Once the solution is updated, load flow analysis is performed; new fitness is calculated using equation (5)
$V_i^{min} \leq V_i \leq V_i^{max}$ …………………….. (5)
If new fitness is greater than pbest fitness then corresponding then corresponding candidate node is moved to pbest particle.
10. Maximum of pbest fitness gives gbest fitness and corresponding candidate node is stored as gbest.
11. From pbest fitness, maximum fitness and average fitness are calculated. Error is calculated using equation (6)

Error = Maximum fitness – average fitness ………………………….. (6)

If this error is less than a specified tolerance, go to step 9.
12. Increment the iteration count. If iteration count is not reached maximum, go to step 7.
13. Gbest fitness gives maximum loss reduction and gbest candidate node gives optimal DG size.

Firefly Algorithm For Optimal Sizing

Firefly algorithm was developed by Xin-She Yang at Cambridge university in 2007.In the firefly algorithm, two important issues are: the variation of light intensity and formulation of attractiveness. The attractiveness of a firefly is determined by its brightness which is associated with the encoded objective function.

ALGORITHM

1. Read system data.
2. Initialize the parameters and constants of firefly algorithm.
3. Generate n number of fireflies (x_i) randomly.
4. Iteration count is set to one.

5. By placing all 'n' DG devices of each particle at respective candidate location, load flow analysis is performed. 6. Calculate the fitness value corresponding to each particle.
7. Obtain best fitness value Gbest FV by comparing all the fitness values. Obtain the best firefly values Gbest FF corresponding to best fitness value Gbest FV.
8. Determine the randomization parameter α of current iteration using equation (7)
α (iter) = αmax – ((αmax –αmin)(current iteration number / itermax)) …………………. (7)
9.Determine the distance r_{ij} values of each firefly using equation (8)

r_{ij}= GbestFV- FV …………………………. (8)

r_{ij} is obtained by finding the difference between the best fitness value GbestFV and fitness value FV of i^{th} firefly.
10.New x_i values are calculated for all fireflies using equation (9)
$X_{inew} = X_{iold} + \beta_0 * \exp(-\gamma r_{ij}^2 * (x_j - x_i)) + \alpha\,(iter) * (rand-0.5)$ ……………………………… ()
11. Iteration count is incremented and if iteration count is not reached maximum, go to step 6.
12. Gbest fitness gives maximum loss reduction and GbestFF gives optimal DG size.

III. Simulation

The proposed method is tested on IEEE-30 bus system. Three DGs are considered. Three DGs will improve the power loss by 85.63% as compared to 64.17%of single DG. Simulation is done by differential evolution (DE) and firefly (FF) algorithms. Results are shown in table 1.

Table 1: summary of results

No. of DG		Bus No	Power loss(Mw)			DGsize(kw)	Voltage(p.u)		
			Without DG	With DG	% loss reduction		Without DG	With DG	% voltage improvement
1 DG	DE	5	17.528	6.28	64.17	149.8057	1.01	1.01	-
	FF	5	17.528	6.28	64.17	149.8056	1.01	1.01	-
2 DG	DE	5	17.528	4.1633	76.25	93.7598	1.01	1.01	-
		7				90.6847	1.0035	1.019	1.545
	FF	5	17.528	4.162	76.25	93.7597	1.01	1.01	-
		7				90.683	1.0035	1.0194	1.584
3 DG	DE	5	17.528	2.5182	85.63	89.8352	1.01	1.01	-
		7				44.6122	1.0035	1.013	0.947
		8				80.014	1.01	1.012	0.199
	FF	5	17.528	2.518	85.63	89.8096	1.01	1.01	-
		7				44.6097	1.0035	1.0125	0.896
		8				79.9567	1.01	1.012	0.199

Simulation results are shown in following graphs.

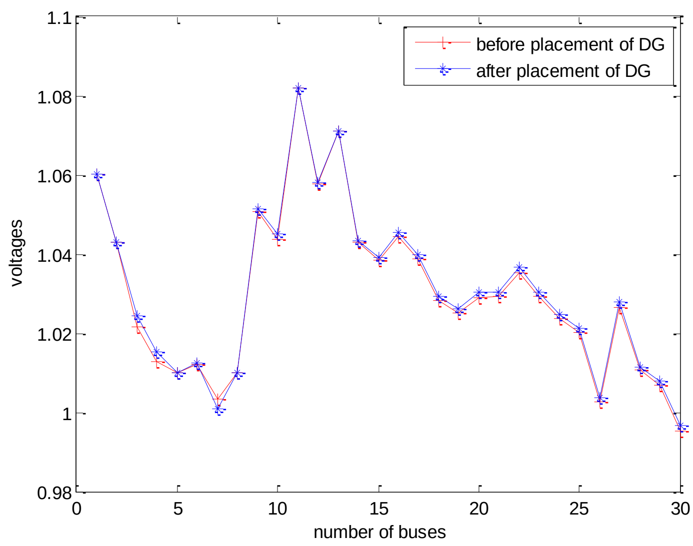

Fig 3: Bus voltages for single DG

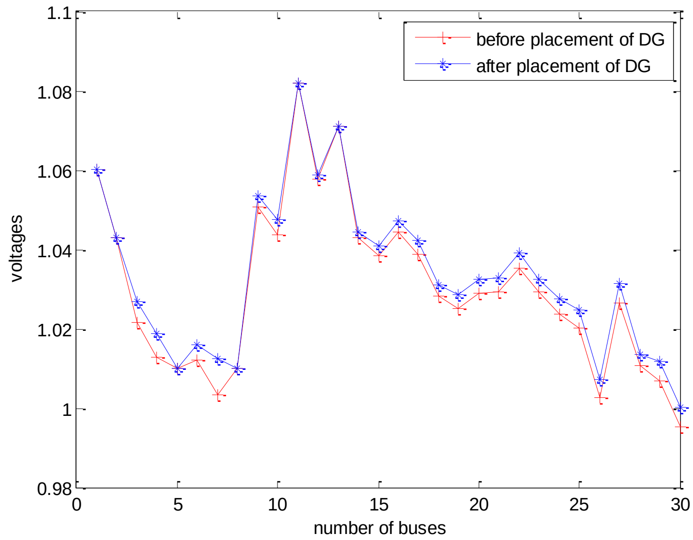

Fig 4: Bus voltages for three DG

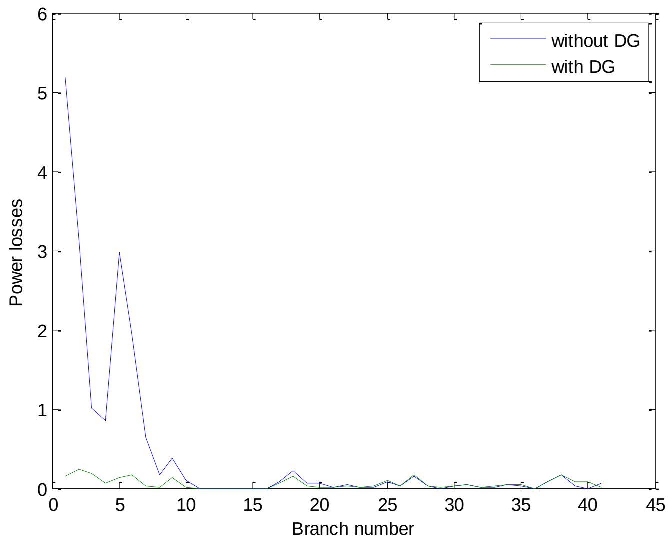

Fig 5: Power loss without and with 3DG

IV. Conclusion

In this paper fuzzy inference method is used for optimal location of multi DG. Differential and firefly algorithms are used for optimal sizing of multi DGs and the results are compared. There is a significant decrease in power loss after placement of DGs. Both algorithms are very efficient. But in firefly algorithm the solutions are still changing as the optima are approaching. It is possible to improve the solution quickly by reducing the randomness gradually.

References

[1]. GriffinT, Tomsivic K, Secrest D and Law A, "Placement of dispersed generation systems for reduced losses", Proceedings of 33rd annual Hawaii international conference on system sciences, No.2, pp 1446-1454, 2000.
[2]. S. Nagendra and A. Lakshmi Devi, "Power loss reduction and voltage improvement in transmission systems using distributed generation units: A case study", The ICFAI university journal of electrical& electronics engineering, vol.2, No.2, 2009.
[3]. RajendraPrasad payasi, Ashish K. Singh and Devendersingh, "Reviews of DG planning, objectives, constraints, algorithms", International journal of engineering science& technology, vol.3, 2011.
[4]. Shilane D, Mardikainen J, Ovaska S.J., "A general framework for statistical performance comparison of evolutionary computation algorithms", Information sciences: An international journal,178,2870-2879(2008).
[5]. Kennedy J, Eberhart R., "Swarm intelligence, Academic press, 2001.
[6]. Price K., Storn R. and Lampinen J., Differential Evolution: A practical approach to global optimization, Springer, 2005.