INVESTIGATION ON OPTIMAL PLACEMENT AND SIZING OF DISTRIBUTED GENERATION UNITS USING OPTIMIZATION TECHNIQUE

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Abstract: Distributed Generation (DG) has gained more importance to meet the increased load demand. Its integration in a distribution system in comparison to conventional system stacks numerous potential benefits related to losses reduction, improvement in voltage profile, etc. Few important issues involved with distributed generation are placement, sizing, its rating, mode of operation and technology etc. This paper focuses on one of the issue that is optimal placement of DG unit as the allocation of DG units at inappropriate places results in increase in system loss and also reduction in bus voltage profile. Alternative sources of energy based distributed generation has one of the considerable benefit as environmental friendliness. Hence, allocation of distributed generation units in proper place is an important aspect for maximizing the benefits stated above.

1.INTRODUCTION

Performance analysis of distributed generation plays a important role in network using power flow analysis in power system. The optimal location of wind based DG unit is determined using Newton raphson method for obtaining the voltage profile with the analytical approach [1]. The analytical expressions used are based on exact loss formula. The proposed technique has been tried and validated on IEEE 9 bus and IEEE 33 bus distribution systems. Results are obtained for normal load and with the increased load. The outcomes show that by proper placement of solar/wind based DG units at appropriate bus locations; power losses are minimized and corresponding bus voltage contour is improved [2-3].

2.DISTRIBUTION SYSTEM OPTIMIZATION

Finding of minima or maxima of functions with applied problem constraints through mathematical formulation is called optimization. Some choice making analysis is done that involves determination of the best action that could achieve the desired objective. This finding tells about the action/s that optimizes the values of various constraints under observation in an objective function [5-7]. Optimization is applied in the deregulated power system network to find best placement of DG units. Numerous optimization techniques are proposed by authors for the distribution system planning environment to be used for the placement of DG.

3. OPTIMIZATION TECHNIQUE

A hybrid optimization technique Hybrid Genetic Algorithm and State Transition (HGAST) has been applied to solve the said problem. HGAST is made up of two pure optimization methods GA and ST. The individual methods are discussed and then the hybrid formed is presented.

3.1 GENETIC ALGORITHM

The GA operates by creating random solutions to the optimization problem (OP) to form a population of individuals. These individuals are then sorted based on the value they return on evaluation using the objective function. The genetic algorithm(GA) has been proposed as a method for resolving both controlled and uncontrolled optimization issues that are based on natural range. GA is a robust optimization technique aims to optimize the given fitness functions. It is an artificial intelligence technique which has been applied in various optimization problems such optimal DG placement [8-10]. Following steps are involved in handling the desired optimization problem:

i) A set of chromosomes are created randomly.

ii) The fitness of individual chromosome is assessed based on the defined objective function.

iii) Based on the values of individual chromosomes, diverse genetic machinists including crossover, reproduction and mutation are applied on the entire population so as to produce the second generation of chromosomes.

iv) Steps 2 and 3 are repeated till the criterion is satisfied.

The chromosome with the best fitness value is the ultimate solution to the said target problem.

3.2 STATE TRANSITION (ST) METHOD

The perception of state means to a condition that a material system upholds, and it is categorized by a collection of physical qualities. When the system turns from one state to another; this process is known as state transition. The process of state transition was described by an Russian mathematician called Markov; when he anticipated to characterize a specific stochastic procedure (known as Markov process) [4-6]. Markov introduced a new technique for optimization of continuous nonlinear functions, that belongs to meta-heuristic random search. For its basis on state and state transition, the technique is known as state transition algorithm [5-7]. For continuous function optimization problems, four special conversion operators known as translation, rotation, axesion and expansion are planned.

In ST algorithm, a result of an optimization problem is measured as a state, and an apprise of a solution can be viewed as a state transition. The ST algorithm is an individual-based optimization method, differently from other population-based stochastic optimization techniques, such as, particle swarm optimization, differential evolution and genetic algorithm etc. A neighborhood with distinct property will be molded automatically when using firm state transformation operator, founded on an obligatory best solution [7-8]. A sampling technique is used to generate a candidate set on the basis of the neighborhood, and the subsequent best solution is rationalized by using a selection technique based on prior best solution and the candidate set. This process is recurrent until some incurable conditions are contented.

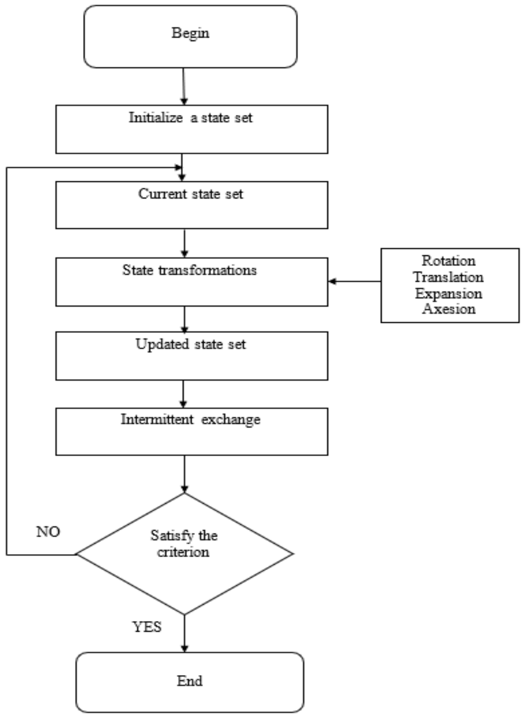

Figure 1: Flowchart of State Transition Method

4 RESULTS OF 9 BUS SYSTEMS WITH DG (SOLAR)

The proposed technique for finding the optimal placement and sizing of DG units has been investigated using MATLAB and established intended for several scenarios. The optimization was performed using HGAST technique that is proposed for the simulation of optimal placement and sizing of DG in any radial distribution systems. Table 1 gives detailed results of voltages (p.u) with and without DG for different solar radiations on 9 bus radial distribution system. Table 2 gives results of losses. It is observed that in the absence of DG, the total active loss without DG 794.345KW and final loss is 434.5806 KW. The voltage without DG is 8.8031p.u.and final voltage with installation of DG is 8.918p.u.

Table 1: Voltages with and without DG at weak buses

Bus No.	Without DG(KW)	With DG(W)				
		$200m/s^2$	210	220	230	240
4	0.95773	0.96371	0.96945	0.96878	0.96572	0.96836
5	0.94333	0.9557	0.95396	0.9506	0.94569	0.95016
6	0.91173	0.92406	0.9227	0.92208	0.92569	0.93428
7	0.90173	0.91714	0.91835	0.9137	0.92715	0.90721
8	0.88353	0.88904	0.89205	0.88954	0.88884	0.88754

Table 2: Losses with and without DG

Bus No.	Without DG(KW)	With DG(W)				
		200	210	220	230	240
4	114.4	57.442	57.277	57.256	57.469	57.547

5	190.22	95.352	95.187	95.166	95.379	95.457
6	47.77	24.127	24..962	24.941	24.154	24..232
7	75.74	38.112	37.947	37.926	38.139	38.217
8	88.46	44.472	44.307	44.286	44.499	44.577

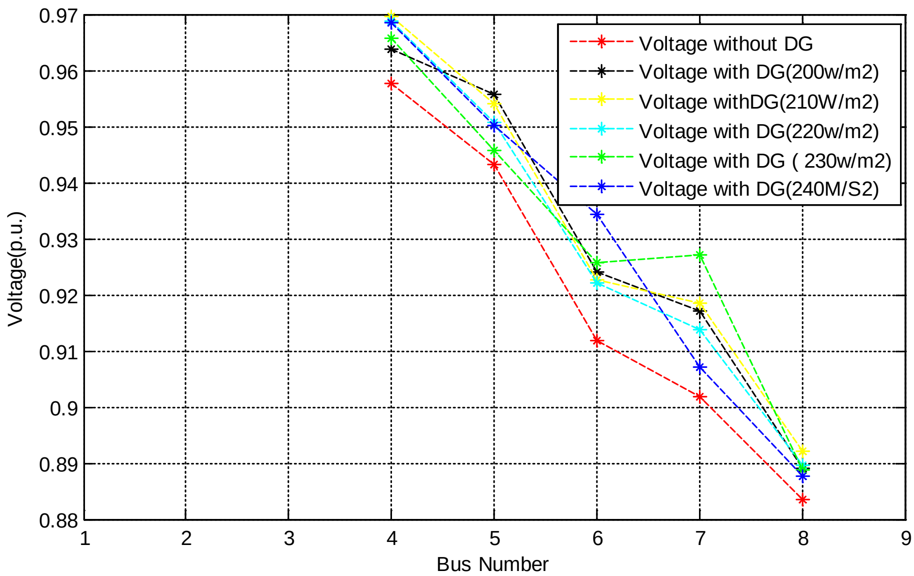

Figure 2: Voltages (p.u.) with and without installation of DG (SOLAR)

Figure. 2 portrays voltage profile in 33 bus distribution system. The outcomes show different voltage levels of DG (Solar) before and after installation of DG. Before installation of DG, voltage level of bus 8 was low. After installation; the voltage was improved at this Bus. As observed the percentage improvement in voltage is 1.065%

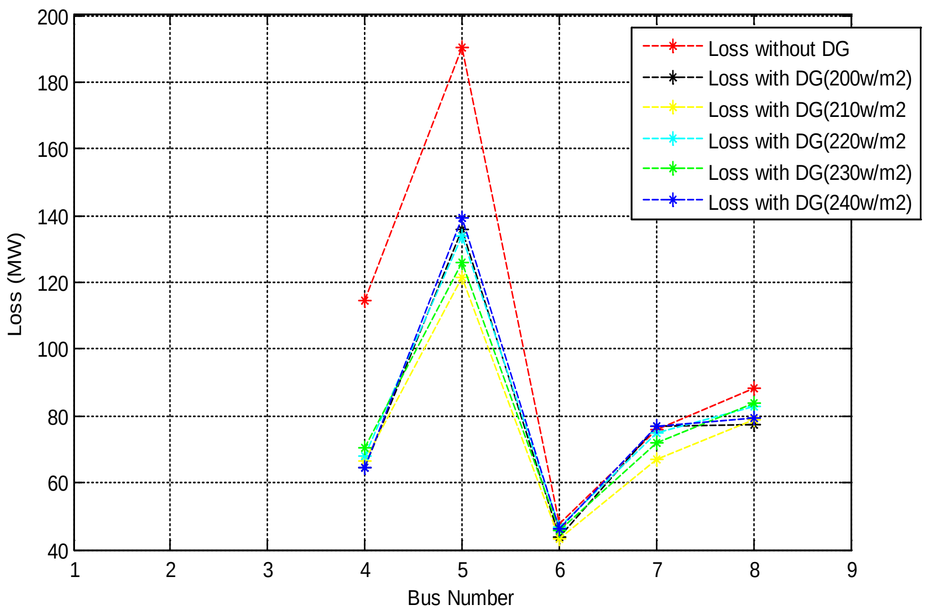

Figure 3: Losses with and without installation of DG (SOLAR)

Figure. 3 represents system losses in 33 bus distribution system. The outcomes show different loss levels of DG (Solar) before and after installation of DG at weak busses.

5 CONCLUSION

Optimal placement and optimal sizing of DG for radial distribution network is carried out. Results are obtained for the increased load. The outcomes show that by proper allocation of wind based DG units at pertinent bus location corresponding bus voltages are improved. Performances like real power loss and voltage profile for two test systems are analyzed with before and after installation of DG. As seen from analysis, system performances are improved with placement of DG is the system for both solar and wind DG for increased load conditions. A new optimization technique HGAST which is one of the recently developed optimization technique is implemented and successfully applied on radial distribution network. The simulation results have shown good performances and effectiveness of the proposed method compared to GA method for the same test system. Further work can be explored considering different types of DG. Along with DGs, fixed capacitors can be used for obtaining more effective results. The wind and solar energy impact on power system particularly on voltage of buses and losses of the system were discussed. It is observed that placement of wind/solar DG unit at improper places leads to increase in power loss and poor voltage.

The magnitude of voltage and system losses are taken as a main concern and the change in system performance is observed in a system. Loads were increased to obtain the system performance at weakest buses, that is, the buses are more sensitive to a change in load. Voltage profile improvement in the buses when wind /solar power were connected with increased loading condition and voltages were found to be within the limits.

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