Journal of Scientific & Industrial Research
Vol. 78, October 2019, pp. 678-680

Comparative Analysis of HGAST Technique with GA and ST for Loss minimization and Voltage Improvement Constraint in Distributed Generation (DG) System

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Received 19 July 2018; revised 5 May 2019; accepted 4 August 2019

Distributed generation is the process of generating electricity from many small energy sources and connecting it directly to the distribution network. Sizing and placement of these DG units is an important issue of concern. In this paper, the performance and comparison of various optimization techniques for optimal sizing and placement of DG units in distribution networks is donefor IEEE 9 BUS System.

Keyword: DG units, Optimization Technique

Introduction

The DG units are placed near to the load as opposed to the concept of increasing the capacity of the main generator which is centrally located. But, the concept brings with it several challenges which need to be addressed in order to exploit its benefits[1]. The major among them is finding the optimal location and size of the DG units. The aim is to minimize the losses by adding additional units of distributed generation. A hybrid technique (HGAST) of GA (Genetic algorithm) and ST (State transition algorithm) techniques is developed[5]. GA is a widely used tool for optimization and fast search applications. On being inspired from biological evolution, it optimizes a problem as genetic processes such as mutation, crossover and selection.On the other hand, ST is a new heuristic random search algorithm. State transition algorithm (ST) has been emerging as a novel stochastic method for global optimization in recent few years[7]. IEEE-9 bus systems have been considered in order to test the proposed algorithm and the results shows an improved performance[8]. The comparative analysis of proposed hybrid technique is done with existing optimization techniques.

Distributed system optimization

Optimization is a mathematical formulation that is concerned with finding of minima or maxima of functions subject to the so called constraints. Some decision making analysis involves determining the action that best achieves a desired goal or objective. This finding means the actions that optimizes (i.e. minimizes or maximizes) the value of an objective function. Optimization is applied in the deregulated power industry to find best allocation of DG and other devices. There are many optimization techniques available for the distribution system planning in the presence of DG as discussed in the literature. In this paper, the placement and sizing problem is solved using a hybrid of GA and ST (HGAST) for DG

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.

HGAST Algorithm

A fast systematic approach to allocate DG units and then determination of their sizes need step-by-step computational procedure. The procedure for proposed methodology is as follows:

Step 1 Initialize the population set
Step 2 Calculate fitness according to its population
Step 3 Start GA Process. Apply crossover
Step 4 Update population
Step5 Calculate the fitness again. If the present fitness is better than its initial fitness then maintains it as global solution otherwise update population using ST Process

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Table1 — Comparison of Voltage with HGAST, GA, ST for 9 BUS System

S. No.	BUS No.	Voltage (p.u) With HGAST	Voltages With GA (p.u.)	Voltages With ST (p.u.)
1	1	1	1	1
2	2	0.9880	0.9852	0.9869
3	3	0.9819	0.9811	0.9814
4	4	0.9691	0.9592	0.9585
5	5	0.9518	0.9444	0.9450
6	6	0.9182	0.9123	0.9136
7	7	0.9083	0.9026	0.9025
8	8	0.8848	0.8842	0.8846
9	9	0.8532	0.8529	0.8530

Table 2 — Comparison of Loss with HGAST, GA, ST for 9 BUS System

BUS NO.	Loss(KW) HGAST	Loss (KW)GA	Loss(KW) ST
1	23.571	29.699	34.150
2	2.221	3.012	3.650
3	89.096	111.606	127.757
4	57.436	72.0311	82.529
5	95.346	119.418	136.686
6	24.121	30.387	34.936
7	38.106	47.868	54.914
8	44.466	55.818	64.000
9	19.886	25.093	28.886

Step 6 Rearrange population gradually

Step 7 Perform flipping, swapping

Step 8 Calculate the fitness again

Step 9 Compare the local fitness. If the best fitness is achieved, close the process if not update the population set

Step 10 Obtain DG Size, new voltage and new losses from optimization.

Results and Discussions

The voltages and losses are calculated for 9 Bus System with GA, ST and HGAST techniques. The Comparisonof voltages and losses are shown in table 1 and table 2.

It is observed from figure 1 that the voltage profile of 9 Bus System is improved with HGAST as compared with GA and ST Methods.

It has also been observed from figure 2 that the losses are reduced to a lower level when HGAST Technique is applied as compared with GA and ST Techniques.

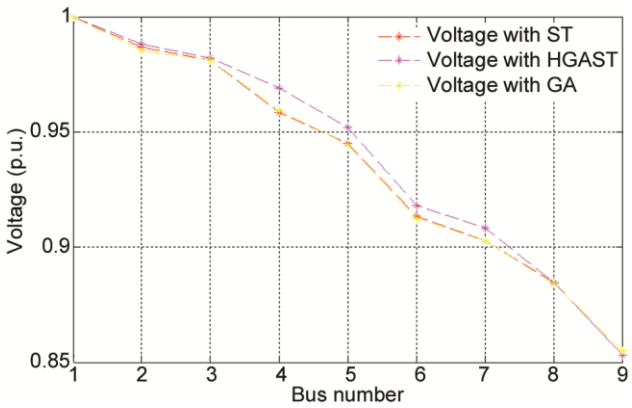

Figure 1 — Voltage Profiles of 9 Bus System with GA, ST and HGAST

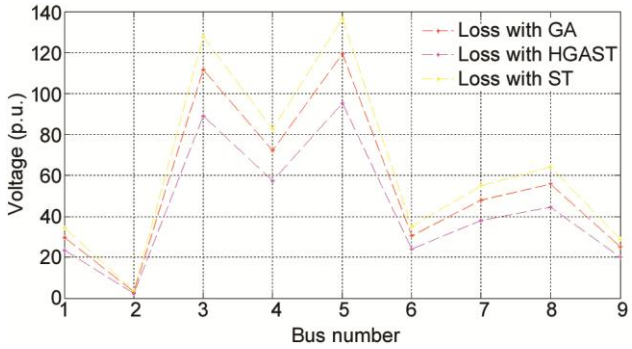

Figure 2 — Comparison of Loss for 9 Bus System with GA, ST and HGAST

Conclusion

Comparative analysis of 9 was done for GA, ST and HGAST techniques. It was observed that the losses were reduced significantly and the voltage profile of the buses were improved within permissible limits.The proposed HGAST technique is fast and efficient as compared to GA and ST. The best part of the proposed technique is that it utilizes the key features of both techniques to collectively and effectively search for better optimization results.

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