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Electrical Network Power Quality Improvement Through Distributed Generation Optimum Placement Based on Breeder Genetic Algorithm Method

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Abstract— **This paper discussed about electrical network power quality improvement through distributed generation (DG) optimum placement. The objective of DG placement was power losses reduction. The optimization was conducted with Breeder Genetic Algorithm (BGA) method. The simulation result showing that BGA method generated 3.9885 MW or 22.1863 % power losses reduction.**

Keywords— power quality, power losses reduction, distributed generation (DG), breeder genetic algorithm (BGA)

I. INTRODUCTION

Electrical energy demand can be fulfilled by centralized generation system or distributed generation (DG) system. Different with centralized generation, distributed generation system based on small-scale plants, connected to load bus directly and installed at distribution network side [1-5].

In recent years, the regulation provides a great opportunities for rapid development of DG. In other side, the DG installation can give any positive or negative influence on electric power networks.

The negative influence can be occured if the DG installed on wrong location. It has a properly potential to generate a number of problems such as power quality decreasing. Power losses increasing on certain points of the power network and bus voltage rising of buses that pass the specified tolerance value are part of example power quality decreasing.

To prevent that problems, the development of DG must be managed. The DG installation must be installed at proper location and capacity. The optimum DG placement has a correlation to electrical network power quality improvement such as power losses reduction and voltage profile enhacement [6,7,8].

The proper DG placement can be find with optimization techniques. The existing optimization techniques can be based on analytical methods or artificial intelligence methods. The several researches used artificial intelligence methods like Simple Genetic Algorithm (SGA) [9-13].

The SGA method has a number of weaknesses. They are high possibility to be trapped in local convergence, a relatively large number of generations to produce a convergent solution and relatively longer of processing time.

The method to obtain optimum placement of DG was Breeder Genetic Algorithm. The method was developed from SGA method. The shortcomings of SGA can be corrected by BGA. We have expectation to find the better optimization results.

This DG optimum placement research used the IEEE 30 bus test system network as research plant [14]. The initial power loss before connecting to the DG was obtained through load flow program based on Newton Raphson method [15].

II. RESEARCH METHOD

This research discussed the DG units optimum placement on electrical power network load bus. The IEEE 30 bus test system with mesh topology was selected as the research plant. The single line of research plant is shown in Figure 1.

The IEEE 30 Bus Test System consists of 5 generator buses and 24 load buses. One central generator with 260.2 MW and 16.1 MVAr capacity connected to bus 1. Other central generator connects to bus 2 with 40 MW and 50 MVAr capacity. The total load was 283.4 MW and 126.2 MVAr. The network power losses was 17.9773 MW.

The DG using in this research was consisted of three units. Only the active power of each DG was taken into account of the simulation. The DG reactive power was neglected. In this performing simulation, each DG unit could be installed on any possible load buses. This means that all load buses had the same probability to be occupied by the DG unit.

The BGA method is developed base on SGA method. It was proposed and developed by Muhlenbein. The both of methods have almost same of work steps. The significant difference between the two methods lies in the generation replacement scheme.

The SGA uses overall generation replacement scheme. While, BGA method uses partial replacement scheme depend

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on breeding probability value. In the BGA method, if generating random value less than breeding probability, the chromosome will be replaced by the best chromosome at that generation.

The BGA optimization parameter using in this simulation are shown in Table 1. In this optimization, value of of breeding probability was 0.1. The BGA optimization process diagram flow to obtain the optimal placement of DG is shown in Figure 2.

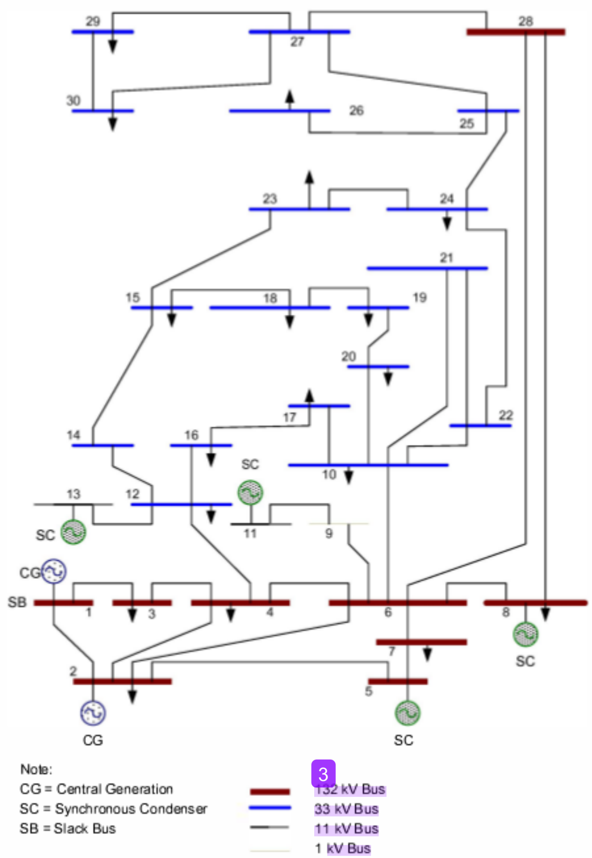

Fig. 1. Single Line Diagram of IEEE 30 Bus Test System

Table 1. Optimization Parameter for BGA Method

No.	Name	Code	Value
1	Number of variable	nvar	3
2	Bit number of capacity	nbit	10
3	Bit number of location	nbit	5
4	Population number	popsize	20
5	Maximum generattion	maxgen	50
6	Crossover probability	p_{co}	0.8
7	Mutation probability	p_{mut}	0.2
8	Number of DG	num_DG	3
9	Breeding probability	p_b	0.1

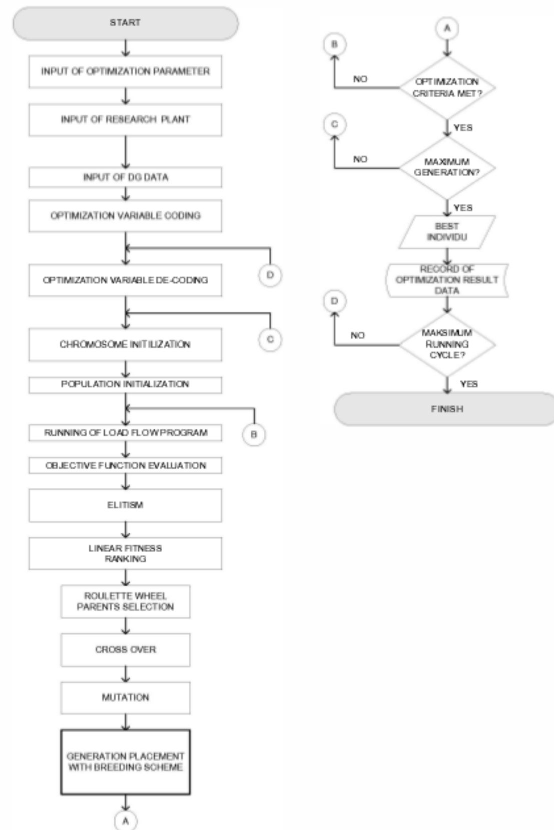

Fig. 2. Flow Chart of BGA Optimization Method

III. RESULT AND DISCUSSION

The optimum placement of three DG units obtaining with BGA method and its comparison with SGA method are shown in Table 2.

The BGA method generated the DG optimum placement at bus 19, 22 and 30, with 8.870, 9.590 and 9.270 MW capacity, respectively. Different with BGA method, SGA method generated the optimum placement at bus 10, 22 and 30. Each unit of DG had 8.900, 9.570 and 9.510 MW capacity, respectively..

Table 2. Optimum Placement of DG

BGA Method		SGA Method	
No. Bus	Cap. (MW)	No. Bus	Cap. (MW)
19	8.870	10	8.900
22	9.590	22	9.570
30	9.270	30	9.510

The DG total capacity generating with BGA method was 27.730 MW, while the SGA method was 27.980 MW. Although the total capacity with SGA method was larger than BGA method but the power losses reduction resulting was

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smaller. The BGA generated 3.9885 MW or 22.1863 % power losses reduction. The SGA only generated 3.8456 MW or 21.3914% power losses reduction . The complete result are shown in Table 3.

Table 3. Total Capacity and Losses Reduction of DG

Method	Cap (MW)	P_{loss} (MW)	P_{loss} Reduction	
			(MW)	(%)
BGA	27.730	13.9888	3.9885	22.1863
SGA	27.980	14.1317	3.8456	21.3914

Besides resulting power losses reduction, optimization for the three units of DG also generated voltage increasing. The voltage comparison before and after DG optimization are shown in Table 4. The BGA method generated a higher voltage increasing 0.0130 pu comparing with SGA method 0.0123 pu.

Table 4. Comparison of Voltage Average

Method	Voltage Average			
	No DG	With DG	Inc. (pu)	Inc. (%)
BGA	1.0117	1.0247	0.0130	1.2850
SGA		1.0240	0.0123	1.2158

The voltage profiles comparison before and after connecting to the DG using BGA and SGA method are shown in Figure 3

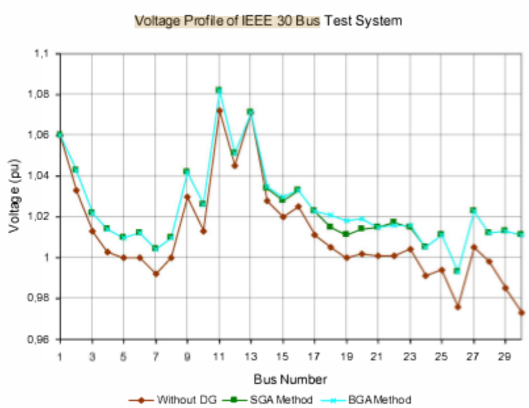

Fig. 3. Voltage Profile of IEEE 30 Bus Test System

IV. CONCLUSION

The BGA method was successfully implemented in this research to find the DG optimum placement on IEEE 30 bus test system. The three DG optimum placement generated of 3.9885 MW or 22.1863% power losses reduction. This value better than SGA method was 3.8456 MW or 21.3914%.

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