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Relocation of source of sporadic production using genetic algorithm in distribution network

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Today, due to the development of distribution systems and increase of demand and load, the use of the source of scattered production has developed. The establishment of the installation place and the size of the source of scattered production decrease network loss, lead to best action of network as well as the recovery of the voltage profile. In this article, we use the genetic algorithm for relocating and finding the best sources of scattered production with active power production and reactive power production by arranging and using them. Also in this article, in addition to decreased loss, balanced voltage, stabilization and recovery of profile have purpose function. The results show that the system of 33 bass is the power and effectiveness of the method.

Key words: Scattered production, optimization, genetic logs.

INTRODUCTION

The main shave of loss in one power system is related to the distribution system. The study shows that distribution system loses because of the high relation of R/X and high decrease of voltage in this system.

Today, increased demand and load leads to the development of the distribution system and its aspects; and this agent causes more loss of voltage and increases casualty. As a result, there is decreased voltage stability of knots and load imbalance.

Different methods created for determining the capacity of decomposed granite (DG) are presented in this work. Willis (2000) showed the famous legal 2/3 methods used for determining the optimum place of condenser, which in turn determines the optimum place of DG.

DG of 2/3 length lower than the post was installed. Kashem et al. (2008) offered a number of methods for determining the optimum size of DG based on the sensation of the loss of power. The method based on the minimum casualty power in the presence of DG was established. The methods chosen were tested on the practical network in Tasmania and Australia. Acharya et al. (2007) used the increasing change in casualty power related to the change of the sensation factor of the real power injected; it was developed by Elgerd (1970). The factor this article was used to determine the bass that caused the casualty at the time the DG was installed on it, by arranging the offered method based on factor sensation.

The problem of this method is the length used in determining the place of optimum installation of DG in

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distribution network. It was also the only place to optimize the DG, and the only way to install a DG in the distribution network is proposed. Kean and Omalley (2006) also solve the DG optimum size on one of the line program (LP) on the Ireland network. In the literature, Rosehart and Nowicki (2007) presented a new model to determine location of DGs for economical distribution system and voltage improvement.

The purpose function was solved by using interpolation method (IP). The later output is the other rank of bass for DG installation.

The size of the optimum DG in this installation is not studied in this investigation. Hedayati et al. (2009) presented the method of load distribution for bass that is sensitive to reversal. The sensitive bass in this article is an appropriate place for DG installation.

The repeated method used for determining the place of DG optimum installation was used at first for one of the distinct capacity of DG that connected to the network the program of load distribution and the casualty of real power; voltage profile and the capacity of passing power of line are calculated. In the literature, MIthulananthan et al. (2006) determined the decreased casualty of real power of distribution network by using genetic algorithm (GA) containing the size of DG without considering any condition.

NR was used to calculate the casualty. Only one DG is investigated in this work. In the literature, Nara et al. (2001) hypothesized clearly the place of DG installation and used the method of Taboo to determine the size of DGs for the purpose of designing system network casualty.

Load is the source of fixed current generated by the coefficient of fixed power. Golshan and Arefifar (2007) have propounded the Taboo method for the size recovery of DG, where the source of reactive power like condenser and reactor or both in the distribution system is considered.

The purpose function decreases the cost of the reactive power, line load and the cost of the added reactive source.

In this investigation, the place of DG and source of reactive are not optimal.

PURPOSE FUNCTION

The aim of this study is to recover the technical function of network formulated in the form of recovery of two terms of technical network that include casualty and arrangement of the voltage of network distribution. So the presented purpose function is introduced in the form of one of the two purpose functions. In addition, the problem has equal condition, protection and functional condition which will be introduced later.

Relation 1 is description of the presented purpose function.

$$\text{Min. } f = f_1 + k_1 f_2 \quad (1)$$

The function f_1, f_2 is also introduced by the following arrangement,

$$\text{Min.} f_1 = \min \{ P_{loss}(P_{d1}, P_{d2}, \ldots, P_{dnpq}) \} \quad (2)$$

P_{loss} in above relation is the casualty of real power. P_{di} is the amount of the power of distributed production source in bass i.

f_2 is related to the index of deviation voltage that is introduced in the following form,

$$f_2 = \sqrt{\frac{\sum_{i=1}^{N_n} (V_i - V_{rated})^2}{N_n}} \quad (3)$$

V_{rated} in Relation 3 is related to the bass voltage name, that is, one per unit. V_i the voltage of bass of system and N_n is the number of the bass of the network.

EQUAL CONDITIONS

The presentation of DG in the network should be in one way, in which all of the control and system variables in the equations of load distribution is applied. The active and reactive power based on the famous equation of load distribution in Relations 4 and 5 is shown thus (MIthulananthan et al., 2006),

$$P_{gi} - P_{di} - V_i \sum_{j=1}^{N} V_j Y_{ij} \cos(\delta_i - \delta_j - \theta_{ij}) = 0 \quad (4)$$

$$Q_{gi} - Q_{di} - V_i \sum_{j=1}^{N} V_j Y_{ij} \sin(\delta_i - \delta_j - \theta_{ij}) = 0 \quad (5)$$

In the above relation P_{gi} and Q_{gi} are related to the active and reactive power of load in shin i in arrangement. Also, δ_i, V_i are the angle and the size of the shins voltage in arrangement. θ_{ij} and Y_{ij} are the elements that are extracted from the admittance Matrix.

Operational and protective constraints

Voltage condition

For the purpose of the observation of the quality of delivery to consumer, the voltage of every shin in distribution network should be in the minimum and defined maximum limit.

So in every condition, in the DG installation, the condition of voltage in accordance to the Relation 6 should be checked until the voltage of the bass place is in their allowed field.

$$V_i^{min} < V_i < V_i^{max} \quad \text{I} = 1 \ldots N_n \qquad (6)$$

In the relation above, V_i is the voltage as bass i, V_i^{min} is the minimum allowed voltage at bass i, V_i^{max} is the maximum allowed voltage in bass I and N_n is the amount of bass in the network.

The condition of passing power line in distribution

Systems use the conductor by different segment surfaces, where the limit of the passing power is different. So during the time of installing DG in the network, subsidiary feeder should be investigated, that the power of every angle according to Relation 7 should not be more than the allowed amount (that is based on the kind of connector used).

$$|S_i| \leq |S_i^{max}| \qquad i=1 \ldots N_b \qquad (7)$$

In Relation 7, S_i is the passing power of branch i, S_i^{max} is the maximum passing power of branch i and N_b is the amount of the branch of the tested systems.

MODELING OF THE SPORADIC PRODUCTION

Source of sporadic production generally can be divided into four groups as follows:

1) The source of sporadic production that has the ability of producing real power (fotoveltaik). In recovery program, it is related to the limited power production, which in the form of DG, governs the condition on this kind of formulation.

$$P_{gi}^{min} \leq P_{gi} \leq P_{gi}^{max} \qquad (8)$$

The minimum powerp_{gi}^{min} and maximum power p_{gi}^{max} production of generator, and p_{gi} in Relation 8 are the outputs produced by generator.

2) Sporadic production source that only has the ability to produce of reactive power (synchronous condenser). Governing condition on this equation is written thus,

$$Q_{gi}^{min} \leq Q_{gi} \leq Q_{gi}^{max} \qquad (9)$$

Q_{gi}^{min} and maximum power Q_{gi}^{max} are the reactive power of the generator; Q_{gi} in Relation 9 is the minimum reactive power of the generator.

3) Sporadic production source that produces active power and consumes reactive power (induction generator and winding turbin). DG is the governing condition of this kind,

$$P_{gi}^{min} \leq P_{gi} \leq P_{gi}^{max} \qquad (10)$$

$$Q_{DG_i} = -(.05 + .04P^2{}_{DG_i}) \qquad (11)$$

4) Sporadic production source that is known as the synchronous generator as follows:

a) Has the ability of fixing reactive or any kind of pY
b) Sets voltage or any kind of pV

In this article, we use four kinds of DGs (Yanjun and Yun, 2008; Vinothkumar and Selvan, 2009).

GENETIC ALGORITHM (GA)

We can call the genetic algorithm as an explorer method. This is based on the specification and choosing of the children of sequential generation based on the principles of the best programmed genetic algorithm (from the answer to the problem in one step) This simulates the laws in genetic algorithm and their use leads to the production of children with the best quality.

In every generation, using appropriate choices in reproducing children, better approximated final answers are achieved. This process causes the new generation to be more compatible with the problem condition. This competition between generations, the victory of dominant generations and side tracking of beaten ones are effective methods for solving complex and hard problem (Golberg, 1989).

The methods of solving the problem GA are as follows,

Step 1: (the amount of first overall) we equal the counter to zero (t = 0) and produce the chromosome accidentally [$x_j(.)$, j = 1,…,n] where $x_j(.) = [x_{j1}(0), x_{j2}(0), \ldots, x_{jm}(0)]$. $X_{jk}(0)$, in the form of accidental chromosome in the searching space, is produced.

Step 2: (evaluation) every chromosome in the first population is evaluated by the use of j purpose function, and to choose the best amount, we search for J_{BST} and arrange the chromosome that is proportional to the J_{BEST} for best amount of X_{BEST}.

Step 3 (change of counter) = in this step t=t+1

Step 4: (production of new population) = by repeating the following step, we the complete the new population.

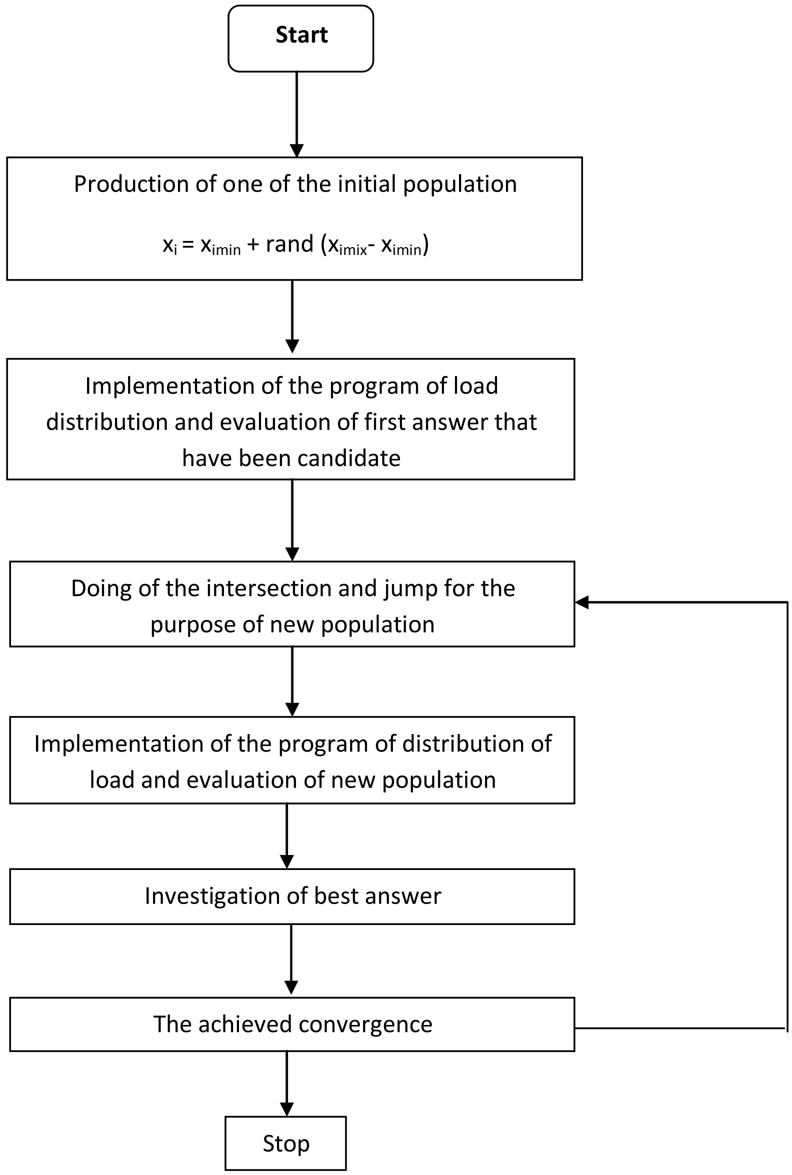

Figure 1. Flowchart of the relocation of decomposed granite (DG) sources production by genetic algorithm (GA).

a) Choice: We took an amount of parent chromosomes based on their suitability (the ones with better suitability have better chance of being chosen).
b) Intersection: By one probability, we apply the intersection operator on the chosen parent to produce the new children. If the intersection is not doing well, every branch of population is precisely copy as a parent.
c) Mutation = by one probability, we change every gene in one chromosome.
d) Acceptance = we put the new chromosome in the population.

Step 5: (replacement) = We used the new population produced to do the algorithm again.

Step 6: (stop) if the amounts of repeats are the distinct amounts needed, the program will stop, but if not, we will go to the next stop as shown in Figure 1.

NUMBER STUDY

The network includes one network of 12.66 radial KW. As shown in Figure 2, the whole active load is 3.2 MVAR and active casualty is about 210 KW before the installation of DG (Chakravorty and Das, 2001; Abu-mouti, 2010).

The appropriate initial population has direct effect on the speed of answer convergence and can directly affect

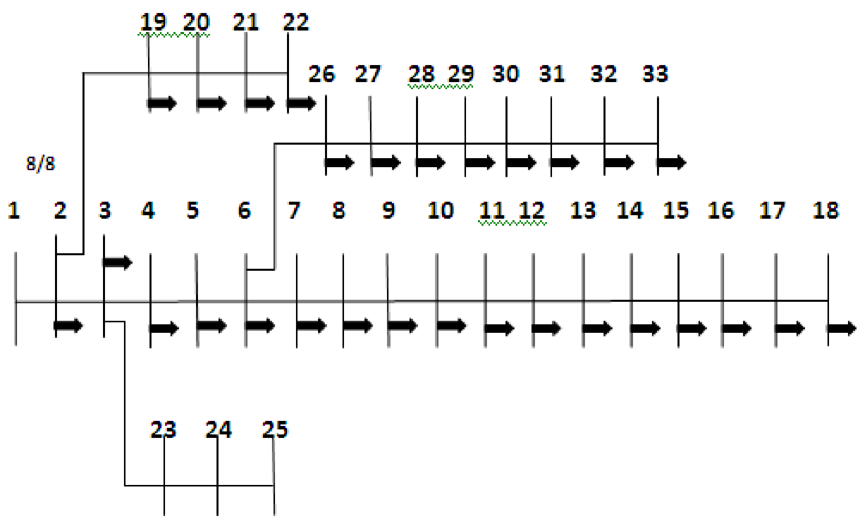

Figure 2. The study of the network by 33 bass.

Table 1. Genetic algorithm parameter.

Population	Method of choice	Intersection	Jump	End condition
300	Accidental	One point	Binary	100 repeated

Table 2. comparison between GA and PSO method for DG installation of type one.

Basic casualty of system				
210. 99 KW			143. 128 KVAR	
Kind of method	**Active casualty (KW)**	**Reactive casualty (KVAR)**	**Place**	**MW**
GA	72. 9601	50. 7721	13 24 30	0. 7571 1. 0429 1. 0429
PSO (Li et al., 2005)	72. 8214	50. 6729	14 30 24	0. 7707 1. 0359 1. 0966
Reload flow (EPRI, Palo Alto, CA, 2003)	116. 26	85. 42	12	2. 4939

the time of convergence.

The initial population DG created by 300 chromosomes and in every field shows the capacity and place of the installation of DG. Another information that is related to the genetic algorithm program is shown in Table 1.

In Table 2, there is a comparative between genetic method and movement algorithm of birds for installation of DG that has the ability to produce one active power.

In Table 2, the first column introduces the kinds of method, the second column introduces the casualty of the active power according to KW, the third column introduces the light reactive casualty according to KVAR, the fourth column shows the installation place of DG and the final column shows the capacity amount of DG installation on candidate bass. The place of DG installation in every three initial method is same; the only difference is in the DG capacity amount using the GA method in relation to the two other methods, which decrease the casualty a little more. Figure 3 shows the purpose function diagram.

Table 3 shows the comparison between the three methods used for DG installation, with the ability to

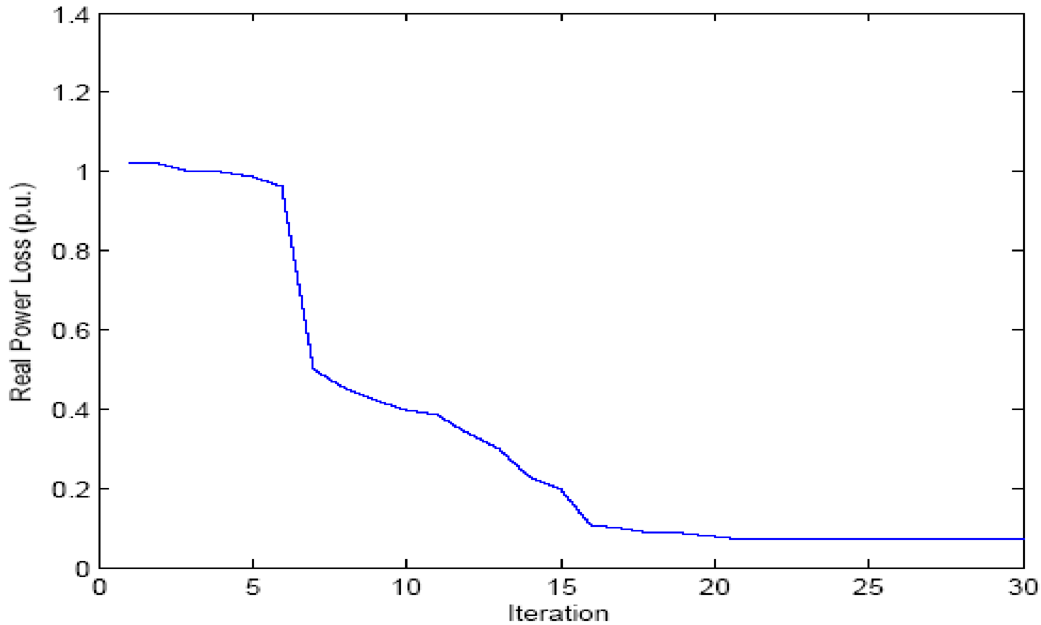

Figure 3. Minimum of the real power casualty by genetic algorithm (GA) method.

Table 3. Comparison between GA and PSO method of DG installation of type second.

Basic casualty of system				
210. 99 KW		143. 128 KVAR		
Kind of method	**Active casualty (KW)**	**Reactive casualty (KVAR)**	**Place**	**MVAR**
GA	140. 6558	95. 7170	10 24 30	0. 3201 0. 2143 1. 0714
PSO (Li et al., 2005)	139. 6957	95.2258	14 30 6	0.3092 0. 8938 0. 5691
Reload flow (EPRI, Palo Alto, CA, 2003)	158. 6782	108. 7812	22	1. 2092

produce reactive power only (type two).

Table 4 shows the comparison between the three methods used for DG installation, with the ability to produce active power and consume reactive power (type three).

Table 5 shows the comparison between every DG 3 method used for the installation of synchronous generator by stabilizing power (type four).

Looking at the charts and graphs of voltage profile presented in the previous section, the following points may be noted:

GA method presented to determine location and installed capacity of the four types of distributed generation sources has similar results with the GA and particle swarm optimization (PSO) methods, whose installation places are the same. The only difference could be found in installed DG capacity that causes less calculated loss in this method than the three other methods. The point is: As the search space and unknown parameters increase, GA method can be more useful. Looking at the calculated active and reactive power losses in the tables, we can conclude that, installed DG of fourth type, that is, synchronous generators have greater role in reducing losses than the other types of DG. After this type of DG, distributed generation sources from the type of photo voltaic systems, induction generator (active power generation and reactive power consumption) and the synchronous condensers decrease losses in distribution companies. Another point about the system voltage profile diagrams (Figures 4 to 7) on the

Table 4. Comparison between method GA, PSO for decomposed granite (DG) installation of type 3.

Basic casualty of system				
210. 99 KW		143. 128 KVAR		
Kind of method	**Active casualty (KW)**	**Reactive casualty (KVAR)**	**Place**	**MVA**
			12	0. 8746
GA	90. 1837	62. 2631	24	1.04701
			30	1. 04701
			13	0. 7899
PSO (Li et al., 2005)	90. 029	95.2258	24	1. 0759
			30	1. 0193
Reload flow (EPRI, Palo Alto, CA, 2003)	148. 18	105. 61	12	2. 4494

Table 5. Comparison between DA and PSO for installation of DG kind 4.

Basic casualty of system					
210. 99 KW		143. 128 KVAR			
Kind of method	**Active casualty (KW)**	**Reactive casualty (KVAR)**	**Place**	**MW**	**MVAR**
			14	0.7371	0.3485
GA	11.914	9.876	24	0.9872	0.4889
			30	1.0714	1.0369
			30	1.0687	0.9956
PSO (Li et al., 2005)	11.8411	9.8065	24	1.01268	0.5273
			13	0.7982	0.3960
Reload flow (EPRI, Palo Alto, CA, 2003)	71.396	57.431	12	2.5013	1.5822

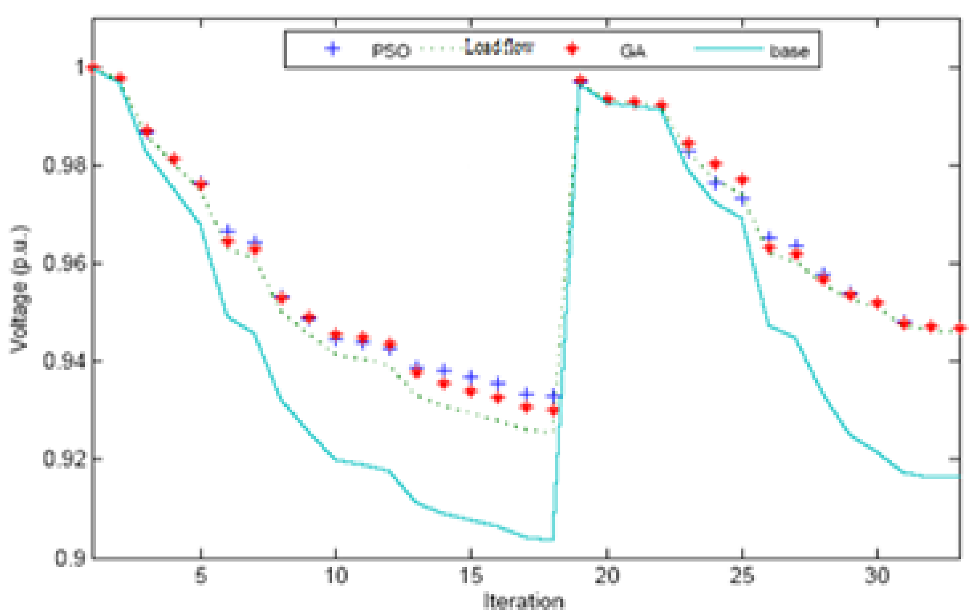

Figure 4. 33-Bus system voltage profile after installation of decomposed granites (DGs) type 2.

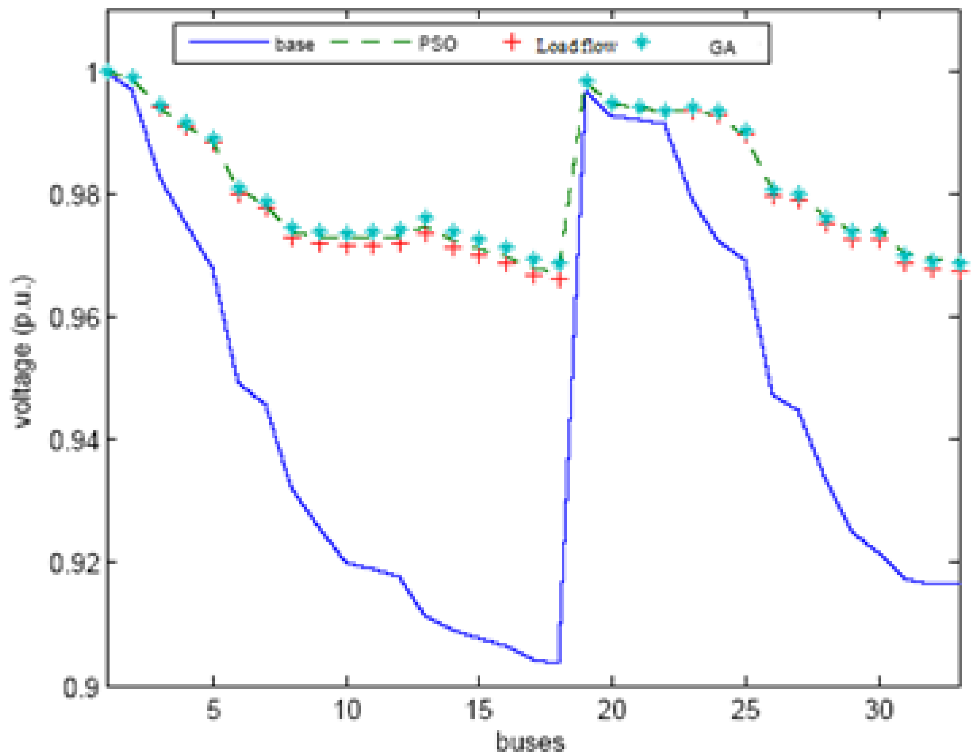

Figure 5. 33-Bus system voltage profile after installation of decomposed granites (DGs) type 2.

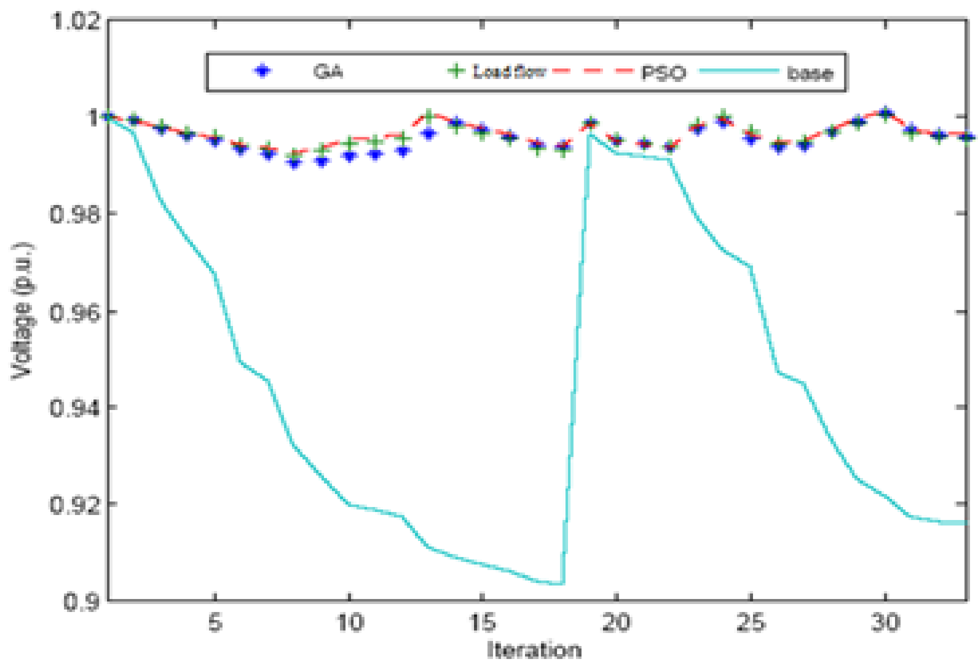

Figure 6. 33-Bus system voltage profile after installation of decomposed granites (DGs) type 4.

bass 33 system after installation of DG is that changes in bus voltage magnitude can be seen at the bass 33 system. As seen, the DG of the synchronous generator (PV), photo voltaic systems (P), induction generator and

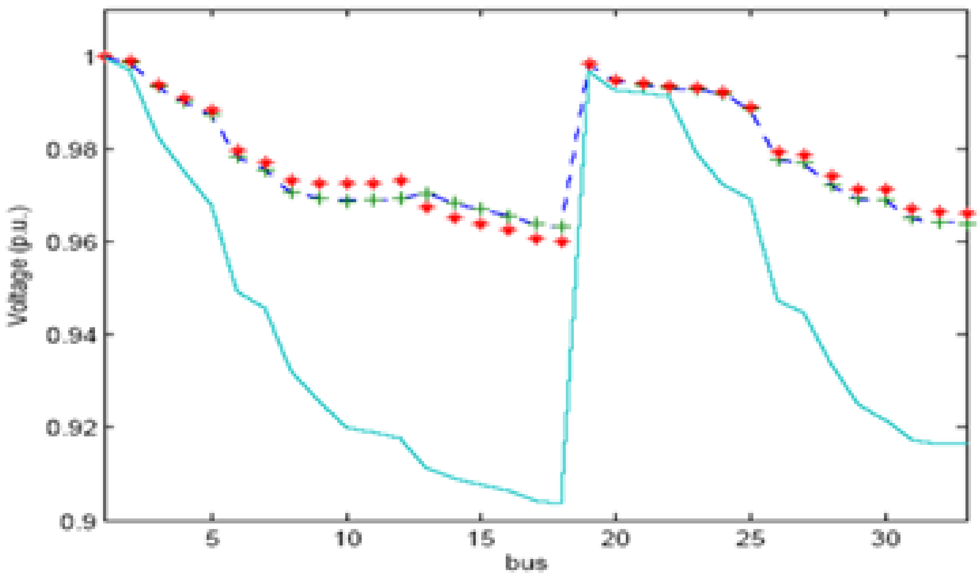

Figure 7. 33-Bus system voltage profile after installation of decomposed granites (DGs) type 3.

synchronous condenser ultimately are effective in improving network profiles.

Conclusion

GA approach was formulated to solve the problem of determining the size and location of DG and in this method, the location and capacity was nominated by GA. in spite of that, object function has two terms that improve Network voltage losses and profile. Also, DG impact of four models in the 33 bus network is evaluated and it could be seen that type of distributed generation sources will have a better impact to generate active and reactive power to reduce losses in the distribution network. Also, after installing the four types of distributed generation sources, loses reduced and the network voltage profile has been improved significantly.

Conflict of Interest

The author(s) have not declared any conflict of interest.

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