Optimal Placement of Capacitor and DG for Minimization of Power Losses using Genetic Algorithm and Artificial Bee Colony Algorithm

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Abstract: *This paper speaks to a viable strategy for ideal situation of DG and capacitor in dispersion framework.   The primary goal is to lessen the power losses in the test system by setting capacitor and DG of ideal size and at ideal area. Conveyance system associate the high voltage transmission system and low voltage side, subsequently it is important to keep the system at least misfortunes for making our system sound. Position of capacitor enhances the voltage profile and lessens the power losses and vitality losses in influence system. Capacitor situation works for reactive power compensation. This paper contains the subsequent graphs for capacitor and generator positions in the test system, the graphs will demonstrate the relative consequences of power losses. Newton-Raphson technique under burden stream study is utilized to figure out the active and reactive losses in the system and relative investigation of Genetic algorithm and ABC is utilized to check the outcomes additionally by utilizing genetic algorithm toolbox as a part of MATLAB programming we get the size and location of capacitor and DG in test system. Genetic algorithm and ABC are the advancement methods utilized here to locate the viable, proficient and best location and size of capacitor and DG by utilizing these advancement systems. IEEE 33 and 69 bus test systems are utilized to confirm the proficiency of these calculations.*

Key words-Capacitor placement, DG placement, ABC algorithm, Genetic algorithm, Distribution System, load flow, power system

1. INTRODUCTION

Distribution generation is the units set close to the heap it serves. These are essentially little scale generators that creates a few KW to several MW of power. They might possibly be joined with the network. DG units are numerous sorts of generation techniques for instance biomass, gas turbine, wind turbine, sun powered voltaic and diesel motors. DG is otherwise called inserted generation, on location generation, decentralized generation. DG gathers vitality from distinctive different sources and consequently Enhances security of supply, additionally the association of DG to network expands the steadiness of power system [1]. Numerous methodologies have been proposed to unravel DG estimating and position in distribution system. Ayse Aybike Seker and Mehmet Hakan Hocaoglu used ABC algorithm on 33, 69, 229 bus radial test systems In solving non linear optimization problems and successfully shows that ABC can successfully determines optimal place and size of DG unit[1]. Dharani Hemanath kumar, P suresh babu, M padma Lalitha perform ABC algorithm on 33 bus test system,in their results they shown that ABC for real power loss minimization is the most effective and efficient technique[2]. Mahdi Mozaffari legha, Marjan Tavakoli, Farzaneh Ostovar and Milad Askari shows a paper having new population based ABC algorithm for solving capacitor placement problem. According to this paper capacitor reduces line losses only and other losses remain unaltered[3]. Mohd Nabil Bin Muhtazaruddin, Nguyen Duc Tuyen and Goro Fujita published a paper in which optimized coordination for DG and the capacitor simultaneously is presented. The proposed method is executing using hybridization of ABC and artificial immune system optimization methods[4]. Israfil hussian and Anjan Kumar roy published a paper in which they proposed a new meta heuristic population based ABC algorithm which achieves the optimal solutions at different cases with advantages of less CPU time consumption and high solution quality[5]. Seyed Abbas Taher and Reza Bagherpour published a paper with a new approach for the discrete optimization problem of fixed and switched shunt capacitor placement and sizing in distorted unbalanced radial distribution system. according to them capacitor placement is necessary to avoid high harmonic distortion levels[6].

In this paper the capacitor and DG are ideally set in IEEE-33 and 69 bus test systems. Genetic algorithm and ABC is utilized to discover the size and location of DG in test system. By setting the DG optimally we can adequately decrease the power

losses in the system. This paper contains a few areas which are as per the following-segment 2 contains distribution generation, segment 3 contains genetic algorithm, segment 4 contains ABC algorithm, segment 5 contains problem formulation and segment 6 contains results and afterward conclusions.

2. DISTRIBUTED GENERATION

In straightforward words we can say that DG is a term that shows an innovation which is set close to an utility's administration range and thus upgrade the nature of administration. At present numerous definations are utilized for distribution generation, some of them are-[7]

1) As indicated by Cardwell, distributed generation is a generation between 500 KW to 1 MW.
2) Gas Research Institute exhibits that distributed generation is in the middle of 25 KW to 25 MW.
3) Rastler and Preston said that the DG size is in the middle of few KW to 100 MW.
4) Additionally the Electric Power Research Institute clarifies that the DG generation ranges from a couple KW to 50 MW.
   The critical explanations behind compelling increment in the utilization of Distribution generation are-[8]
   a) Since DG units are put close to the shopper destinations subsequently the expense identified with transmission and conveyance get lessened.
   b) Presently it is more simpler to locate the monetary and viable spots of little scale generators.

The reason for DG is to satisfy the expanding interest for power specifically territories and perform a few exercises independent in the event of force creation and subsequently picking up vitality reserve funds [9].

3. GENETIC ALGORITHM

Genetic algorithm is utilized as an improvement procedure which is a populace based inquiry method. It takes after the truism of Darwin that is 'survival of fittest' consequently it chips away at the hypothesis that says select the best and evacuate the rest. Genetic algorithm was initially presented by John Holland of Michigan University in 1970's. Genetic algorithm are the methods rely on normal choice and hereditary qualities. It is an iterative procedure which proceeds with a consistent size populace of applicant arrangements. Every emphasis procedure have three hereditary administrators that are 1. Propogation, 2. Hybride, 3. Change. These three administrators perform to deliver another populace likewise the chromosome of new populace are created by the estimation of the wellness which is identified with expense capacity. As indicated by Darwin's hypothesis just the fittest and most suited components of populace can survive and create posterity and henceforth exchange their organic heredity to up and coming new generations. By the utilization of these three hereditary administrators and assessments, enhanced new populaces of applicant arrangement are gotten. In the event that the point of pursuit is not accomplished of course the GA produces new posterity by utilizing these three administrators and this procedure is proceeded till the hunt point is accomplished. They create another arrangement of people, a populace in this manner new posterity are produced from folks. The heredity is put away in the chromosome of people appeared in an improvement issue by a specific numeric code. The adequacy of every part as per the using so as to streamline issue considered is ascertained a wellness quality which is gotten from the target work straightforwardly.

4. ARTIFICIAL BEE COLONY (ABC)

The colony of manufactured honey bees contain three gatherings of honey bees: employed honey bee, onlookers and scouts. A honey bee tending to the move territory for settling on choice to pick nourishment source is called a onlooker bee and a honey bee heading off to the sustenance source went by it beforehand is named employed bee. A honey bee is doing arbitrary inquiry is called scout. In the ABC calculation , first 50% of the province comprises of utilized counterfeit honey bees and second half constitutes the spectators. For each nourishment source, there is one and only employed bee. The employed bee whose nourishment source is depleted by the employed and onlooker bees turned into scout bee. At instatement organize, an arrangement of nourishment source positions are arbitrarily chosen by the honey bees and their nectar sums are resolved. These honey bees come into hive and impart the nectar data of sources to the honey bee attending to the move range inside of the hive. In the wake of sharing the data, each employed honey bee goes to the sustenance source region went by her at the past cycle following that nourishment source exists her memory, and after that picks another nourishment source by method for visual data in the area of the present one. At that point a onlooker inclines towards a nourishment source zone contingent upon the nectar data conveyed by the employed bee on the move territory. As the nectar measure of a sustenance source builds, the likelihood with which that nourishment source is picked by a passerby increments, as well. In the wake of touching base at the choose territory, utilized honey bee picks

another nourishment source in the area of the one in the memory relying upon visual data. Visual data depends on the examination of sustenance source positions. At the point when the nectar of a nourishment source is deserted by the honey bees, another sustenance source is haphazardly controlled by a scout honey bee and supplanted with the surrendered one. In this model, at every cycle one scout goes outside for looking another nourishment source and the quantity of employed and onlooker honey bees were equivalent. The likelihood P_i of using so as to select a nourishment source i is dictated as [10]

$$P_i = \frac{fit_i}{\sum_{n=1}^{S_N} fit_n} \qquad (1)$$

Where fit_i is wellness of the arrangement spoke to by nourishment source i and S_N is aggregate number of sustenance sources. After all spectators have chosen their sustenance sources, each of them decides a nourishment source in the area of his picked sustenance source and figures its wellness. The best nourishment source among all the neighboring sustenance sources dictated by the onlookers connected with a specific sustenance source i will be the new area of the sustenance source i. on the off chance that an answer spoke to by a specific sustenance source does not enhance for a foreordained number of phases then that nourishment source is surrendered by its related utilized honey bee and it runs into a scout. This commensurate to relegating an arbitrarily created nourishment source to this scout and changing its status is again from scout to utilized. After the new area of every nourishment source is resolved, another emphasis of ABC calculation starts. The entire procedure is rehashed over and over till the end condition is fulfilled. The nourishment source in the area of a specific sustenance source is dictated by adjusting the estimation of one haphazardly picked arrangements parameter and keeping different parameters unaltered. Assume each arrangement comprises of d parameters and let $X_i=(X_{i1}, X_{i2}, X_{i3}.....X_{id})$ be a solution. In request to decide an answer V_i in neighborhood of X_i, an answer parameter j and other arrangement $X_k=(X_{k1}, X_{k2}, X_{k3},.....X_{kd})$ are chosen haphazardly. Aside from the estimations of the chose parameter j, all other parameter estimations of V_i are same as X_i, ie $V_i=(X_{i1}, X_{i2},...X_{i(j-1)}, X_{ij}, X_{i(j+1)},...X_{id})$The worth V_i of the chose parameter j in V_i is dictated by equation-

$$V_{ij}=X_{ij}+u(X_{ij}-X_{kj}) \qquad (2)$$

where u is a uniform variate in [-1, 1]. On the off chance that the subsequent worth falls outside the worthy scope of j, it is set to the relating amazing quality.

5. PROBLEM FORMULATION

After electrical power is created, it is exchanged through the transmission line to numerous appropriation circuits that the utility works. In this way, circulation system will take the power and sent it to the buyer to serve their needs. On the other hand, not all the power are conveyed hundred percent effectively because of the losses happens at the transformer and appropriation lines. Electrical cables or circulation lines associate the substation to the heaps. For all intents and purposes, all genuine power that is lost in dissemination system is because of the copper losses. Thus it can be calculated as equation below-[11]

$$P_{loss}=\sum_{k=1}^{n} I_k^2 R_k \qquad (3)$$

Where, I_k=current magnitude and R_k=resistance at branch k. By equation 2 we can say that amount of power loss in the line can be affected by the change of current or line resistance. Hence minimizing the real power loss is considered for the placement and sizing of DG in distribution system as below-

$$Min f(X)=\sum_{k=1}^{line} P_{loss} \qquad (4)$$

Where, P_{loss} is the real power losses

6. RESULTS

At long last the power losses get diminished by arrangement of capacitor and DG successfully and ideally in IEEE-33 bus and 69 bus test systems. After the arrangement of capacitor there is some significant change in the voltage profile. Here in this paper the outcomes are acquired by utilizing 30 population size and 51 iterations in GA toolbox in MATLAB programming and foodnumber=30, iteration=20 and limit=20 in ABC. By the arrangement of capacitor in test system power factor enhances and reactive power get adjusted. In this manner power losses get lessened. The information for this

exploration paper is acquired from load flow program on MATLAB programming are performed on a laptop with processor AMD-A4-3330MX APU with radeon™ HD design 2.20 GHz and RAM of 2.00 GB.By using genetic algorithm and Artificial bee colony algorithm, the optimal location and size for capacitor and DG get obtained. We can easily compare the results of genetic algorithm with the results of ABC. Since ABC is a meta heuristic technique it gives more efficient results than genetic algorithm. Below are the tables showing the respective results of GA and ABC.

Table 1 shows the results of GA and ABC in 33 bus test system. The results clearly shows that ABC reduces more losses than GA also it is beneficial to use capacitor with DG to reduce the system losses more and more. In the table losses are calculated when no capacitor and DG is placed in the system, in this case loss is maximum, next losses are calculated after placing capacitor only. In this case losses get reduced. After this losses are calculated after placing both capacitor and DG, in this case losses are minimum.

Table 2 shows the results of GA and ABC in 69 bus test system. Here the size of DG get calculated first and then the reduction in losses is achieved by placing the generator optimally in the system.

TABLE 1

Shows the losses with location and size of generator and capacitor with GA and ABC for 33 bus test system

Algorithm	Capacitor location	Capacitor size(MVAR)	Generator location	Generator size (MW)	losses
GA 33-bus	No capacitor	-	-	-	0.4653
	30th bus	0.91	-	-	0.3489
	-	-	30th bus	0.93	0.2397
	30th bus	0.91	30th bus	0.93	0.2300
ABC 33-bus	No capacitor	-	-	-	0.4654
	30th bus	0.91	-	-	0.3374
	-	-	30th bus	1.04	0.2337
	30th bus	0.91	30th bus	1.04	0.2285

TABLE 2

Shows losses with generator location and size using GA and ABC for 69 bus test system.

Algorithm	Generator location	Generator size(MW)	Losses
GA-69 bus 2 variables	Without generator	-	0.5002
	61st bus	1.769	0.1544
GA-69 bus 4 variables	Without generator	-	0.5667
	61st bus	1.348	0.0745
	25th bus	0.618	
ABC-69 bus 2 variables	Without generator	-	0.5002
	61st bus	1.297	0.1191
ABC-69 bus 4 variables	Without generator	-	0.5375
	61st bus	1.263	0.0722
	21ST BUS	0.606	

According to tabular results, in both the optimization techniques losses are highest when no capacitor and generator is placed in the system. Also it is noticeable that the losses in ABC are somewhat less than GA. Also these losses get reduced when capacitor is placed and the losses are further reduced by placing generator with capacitor in the system.Table 2 shows the result of GA and ABC on 69 bus system with 2 variables and 4 variable. Here also we can notice that ABC reduces more losses Below are some graphical representation of results coming here. All the four graph shows the variation in voltage magnitude. Fig 1 and Fig 2 shows the results obtained in 33 bus system using Genetic Algorithm and ABC algorithm also Fig 3 and Fig 4 shows the results obtained in 69 bus system using Genetic Algorithm and ABC algorithm. The graphs show the variation comes in voltage magnitude before and after placing the DG in the system.
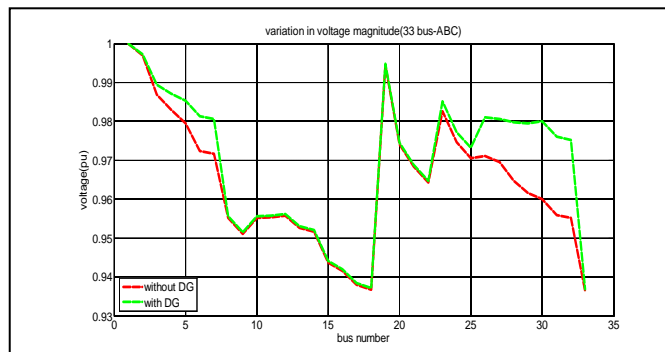
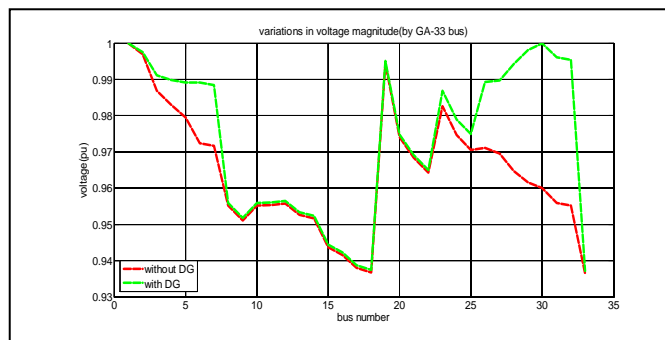Figure 1:Variation in voltage magnitude in 33 bus system by ABC

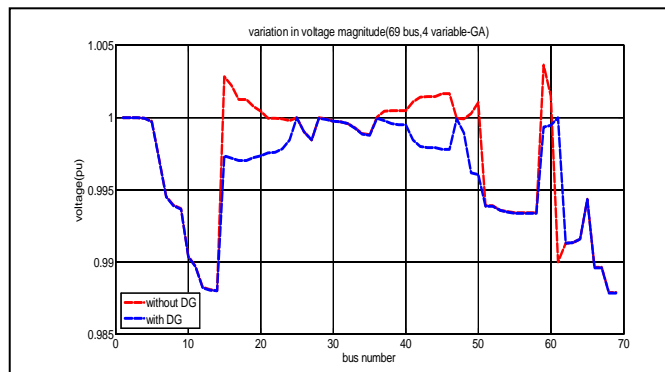Figure 2: Variation in voltage magnitude in 33 bus system by GA

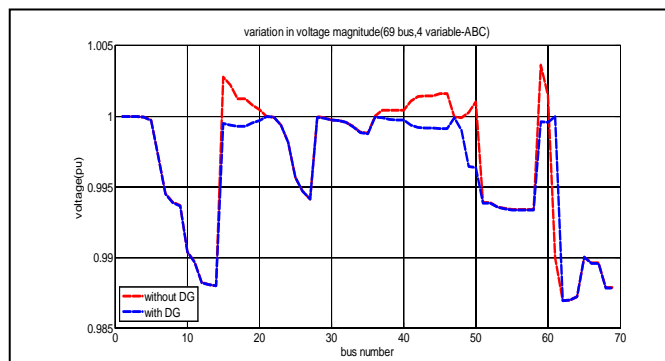Figure 3: Variation in voltage magnitude in 69 bus system by GA

Figure 4:Variation in voltage magnitude in 69 bus system by ABC

CONCLUSION

In this paper two optimization techniques are used to reduce the system losses effectively, these are Genetic Algorithm and Artificial Bee Colony algorithm. These two algorithms are used for both 33 bus test system and 69 bus test system to find out the optimal location and size of DG going to place in these systems for minimizing power losses and improving voltage profile. Here the results of both ABC and GA get compared and it is proved that ABC is more beneficial than GA, since ABC takes less time to operate and also gives more accurate results than GA. In 69 bus test system two generators are placed to minimize the system losses more. It is easy to compare that the losses with two DG placement is less than the losses with single DG placement. Hence it is beneficial to place more number of DGs in large bus systems to reduce the losses more.

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