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Distributed Generation Allocation and Sizing in Distribution Systems for Loss Reduction via Artificial Bee Colony Algorithm

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***Abstract*-This Distributed generation often offers a valuable alternative to traditional sources of electric power for industrial, residential and commercial applications, particularly where transmission and distribution costs are high. This paper presents a new optimization approach that employs an artificial bee colony (ABC) algorithm to determine the optimal DG-unit's size, power factor, and location in order to minimize the total system real power loss. The outcomes verify that the ABC algorithm is efficient, robust, and capable of handling mixed integer nonlinear optimization problems.**

Keywords—ABC Algorithim, Distrubuted Systems.

I. INTRODUCTION

This is because of the considerable advantages of DG-unit Application (e.g., power loss reduction, environmental Friendliness, voltage improvement, postponement of system Upgrading, and increasing reliability), there has been a significant rise in interest by researchers. Appropriate size and location of DG plays a significant role in minimizing power losses in distribution systems. Many optimization techniques have been used and discussed in literatures. DG has advantages like power loss reduction, environmental friendliness, and voltage improvement, postponement of system upgrading, and increasing reliability. Genetic Algorithm (GA) has been used only for sitting; sizing has been done by Optimal Power Flow (OPF). A new optimization approach that employs an artificial bee colony (ABC) algorithm to determine the optimal DG-unit's size, power factor, and location in order to minimize the total system real power loss. The ABC algorithm is a new meta-heuristic, population-based optimization technique inspired by the intelligent foraging behavior of the honeybee swarm. This algorithm makes the programming simpler.

II.OBJECTIVE FUNCTION

The objective function is to minimize the total system real power loss:

$$\text{Obj.Fun} = \min \sum_{i=0}^{n} \left(\frac{P_i^2 + Q_i^2}{V_i^2} \right) \times r_{i+1}.$$

Where:

n	Number of buses.
P_i	Real power flows from bus i to bus $i+1$.
Q_i	Reactive power flows from bus i to bus $i+1$.
V_i	Bus voltage at bus i.
r_{i+1}	Resistance of line connecting buses i and $i+1$.

The equality and inequality constraints are as:

$$P_i - \frac{r_{i+1}(P_i^2 + Q_i^2)}{V_i^2} - P_{L_{i+1}} + \mu_P A P_{i+1} - P_{i+1} = 0$$

$$Q_i - \frac{x_{i+1}(P_i^2 + Q_i^2)}{V_i^2} - Q_{L_{i+1}} + \mu_Q R P_{i+1} - Q_{i+1} = 0$$

$$V_{i+1}^2 = V_i^2 - 2(r_{i+1}P_i + x_{i+1}Q_i) + \left(\frac{(r_{i+1}^2 + x_{i+1}^2)(P_i^2 + Q_i^2)}{V_i^2} \right)$$

$$V_{\min}^{\text{spec}}| \leq |V_i^{\text{sys}}| \leq V_{\max}^{\text{spec}}$$

$$S_{i,i+1}^{\text{sys}} \leq S_{i,i+1}^{\text{rated}} \geq S_{i+1,i}^{\text{sys}}.$$

Where i= 0,1,2,3,….n

III. LOAD FLOW STUDY

The power system is a large interconnected system, where various buses are connected by transmission lines. At any bus, complex power is injected into the bus by the generators and complex power is drawn by the loads. A Newton-Raphson load flow method has implemented on 69 radial bus system with no transformer connected to the system. The load and generation's active and reactive power values are 3.802 MW, 2.694 Mvar and 3.892 MW , 2.802 Mvar respectively. The line losses obtained are of 0.226 MW and 0.202 Mvar. The power mismatch is of 0.000432188 for 5 iteration of load flow.

The single line diagram of IEEE 69 bus feeder system and load flow graph for 69 bus system is as below in figure(1) & (2) respectively. The bus voltage should be from 0.95 to 1.05 volt per-unit. From the graph it is clear that there is a drop in voltage below 0.95 between the bus 60 to 69 bus. Thus it is clear that the allocation of distributed generation is in between these buses in the distribution generation. The optimal sizing and allocation of DG in distribution system will be using Artificial Bee Colony algorithm.

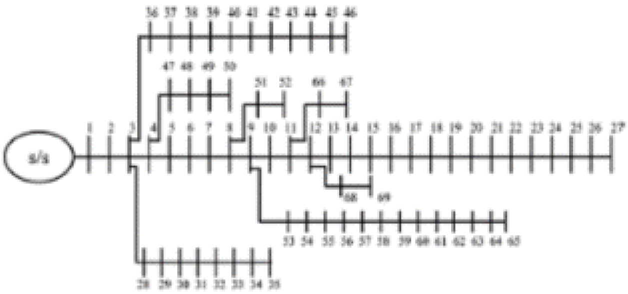

Fig:1.Single Line Diagram of 69 bus feeder system.

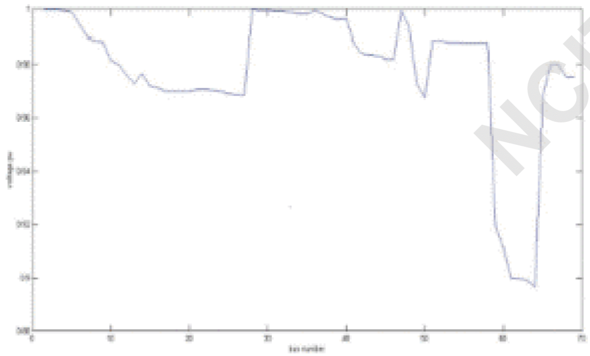

Fig:2.Load Flow Graph of NR-Method for 69-Radial bus system

IV. ABC ALORITHM

A branch of nature inspired algorithms which are known as swarm intelligence is focused on insect behaviour in order to develop some meta-heuristics which can mimic insect's problem solution abilities. Artificial Bee Colony (ABC) is a

VI.RESULT AND DISCUSSION:

relatively new member of swarm intelligence. ABC tries to model natural behaviour of real honey bees in food foraging. The information exchange among individual insects is the most important part of the collective knowledge. Communication among bees about the quality of food sources is being achieved in the dancing area by performing waggle dance.Bee system consists of two essential components: Food Sources and Foragers.

Fig(2): Waggle dance of honey bees

V.ABC ALGORITHM:

The flowchart of the ABC algorithm is illustrated in Fig. 2. The solution steps of the proposed ABC algorithm for DG-unit application are described as follows.

Step 1) Initialize the food-source positions x_i (solutions population), where $i = 1, 2, \ldots, E_b$. The x_i solution form is as follows.

Step 2) Calculate the nectar amount of the population by means of their fitness values using

$$\text{fitness}_i = \frac{1}{1 + \text{Obj. Fun.}_i} \tag{12}$$

where Obj.Fun.$_i$ represents the response of (1) at solution i.

Step 3) Produce neighbor solutions for the employed bees by using (10) and evaluate them as indicated by Step 2).

Step 4) Apply the selection process.

Step 5) If all onlooker bees are distributed, go to Step 9). Otherwise, go to the next step.

Step 6) Calculate the probability values p_i for the solutions x_i using (9).

Step 7) Produce neighbor solutions for the selected onlooker bee, depending on the value, using (10) and evaluate them as Step 2) indicates.

Step 8) Follow Step 4).

Step 9) Determine the abandoned solution for the scout bees, if it exists, and replace it with a completely new solution sing (11) and evaluate them as indicated in Step 2).

Step 10) Memorize the best solution attained so far.

Step 11) If *cycle* = MCN, stop and print result. Otherwise follow Step 3).

A 69-radial distribution feeder system has considered for different test cases. Two load scenario's scenario-I for Normal load and Scenario-II for 50% extra of normal load, all the three test cases conducted. Test case-1 is with one DG and Test case-2 with 2 DG. Test case case-3 with 1 DG and 1 Capacitor. The results obtained are as below in Table(1) and Table(2).

By analysing the results we can understand that the loss reduction of 1 DG 1 capacitor placement is less compared to multiple DG's(2 DG).

Senario-I(For Normal Load)			
Test Cases	**Active power losses**	**DG & Capacitor Placed at Bus no**	**% Reduction of Losses**
1). 1 DG	0.08816	61	39
2). 1 DG	0.06739	61 and 12	29
3). 1 DG and 1 Capacitor	0.08252	61 and 04	36

Table:(1) Results for 69-bus feeder systems Using ABC Algorithm

Senario-II(50% Extra of Normal Load)			
Test Cases	**Active power losses**	**DG & Capacitor Placed at Bus no**	**% Reduction of Losses**
1). 1 DG	0.11695	61	51
2). 1 DG	0.09007	61 and 09	40
3). 1 DG and 1 Capacitor	0.11502	61 and 09	51

Table:(2) Results for 69-bus feeder systems Using ABC Algorithm

VII.REFERENCES

[1] C. L. T. Borges and D. M. Falcao, "Impact of distributed generation allocation and sizing on reliability, losses and voltage profile," in Proc. IEEE Power Tech Conf., Bologna, Italy, 2003, vol. 2, pp. 1–5.

[2] IEEE Standard for Interconnecting Distributed Resources with Electric Power systems, IEEE Std. 1547-2003, 2003, pp. 1–16.

[3] T. A. Short, Electric Power Distribution Handbook, 1st ed. Boca Raton, FL: CRC, 2003.

[4] A. D. T. Le, M. A. Kashem, M. Negnevitsky, and G. Ledwich, "Optimal distributed generation parameters for reducing losses with economic consideration," in Proc. IEEE Power Eng. Soc. Gen. Meeting, Jun. 2007, pp. 1–8.

[5] A. D. T. le, M. A. Kashem, M. Negnevitsky, and G. Ledwich, "Maximising voltage support in distribution systems by distributed generation," in Proc. IEEE TENCON Conf., 2005, pp. 1–6.

[6] M. A. Kashem, A. D. T. Le, M. Negnevitsky, and G. Ledwich, "Distributed generation for minimization of power losses in distribution systems," in Proc. IEEE Power Eng. Soc. Gen. Meeting, 2006, pp. 1–8.

[7] M. Mardaneh and G. B. Gharehpetian, "Siting and sizing of DG units using GA and OPF based technique," in Proc. IEEE Region 10 TENCON Conf., Nov. 21–24, 2004, vol. 3, pp. 331–334.

[8] B. A. de Souza and J. M. C. de Albuquerque, "Optimal placement of distributed generators networks using evolutionary programming," in Proc. Transm. Distrib. Conf. Expo.: Latin Amer., 2006, pp. 1–6.

[9] N. Acharya, P. Mahat, and N. Mithulananthan, "An analytical approach for DG allocation in primary distribution network," Elect. Power Syst. Res., vol. 28, no. 10, pp. 669–678, Dec. 2006.

[10] F. S. Abu-Mouti and M. E. El-Hawary, "A new and fast power flow solution algorithm for radial distribution feeders including distributed generations," in Proc. IEEE Int. Conf. Syst., Man, Cybern., Oct. 2007, pp. 2668–2673.