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A Review on Meta-Heuristic Algorithm for Optimal Placement and Sizing of D.G to Reduce Losses

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Abstract

In order to reduce power losses caused by high current and improve the voltage profile in the network distribution, the introduction of distributed generations also called productions decentralized in distribution network plays a prominent role. The placement and sizing of DGs is essential because wrong choice may jeopardize the system behavior. To solve this combinatorial problem, an meta-heuristic algorithm known as artificial bee colony (ABC) algorithm is proposed in this paper. The paper illustrates the artificial bee colony (ABC) algorithms for optimal location and sizing of distributed generation in a distribution network.

Keywords: *DG placement, Meta heuristic methods, ABC Algorithm, loss reduction*

INTRODUCTION

The increase in demand of energy has brought many challenges on power systems Distributed generation (DG) is an alternative to solve these problems. DG is integration of small generators in a distribution system in order to meet required load demand by improving the voltage profile, increasing life of system, increase of reliability, minimization of power loss and improving in efficiency. DG is much economic than running a power line to remote areas and

DG-unit requires less installation time and the investment risk is not so prominent. It provides power backup during system outages.

The DG-unit capacity is ranges from 15 kW to 50 MW and it gains more importance when it uses of renewable energy sources such as Fuel Cells, Small wind turbines, Solar cells and Small Hydro Turbines as well as some unconventional energy sources.

Significant influence of embedded distributed generators on load demand, voltages profile, power loss, economy and system reliability make a key issues for distribution system planning in the deregulated power system environment. To achieve maximum benefits the optimization of DG unit is necessary. The application of DG unit is a nonlinear optimization problem which is the determination of the size and optimal location for DG-unit to be installed on a network. It includes minimizing power loss and cost and maximizing voltages. DG-unit placement and sizing has been solved by using different approaches. A classical approach second order algorithm method used in to allocate DG-units for minimal power loss. In analytical approaches the location of DGs are determined for the load profiles in radial systems.

As another analytical method in optimal placement is obtained with unity power factor in networked and radial system as well an analytical method is introduced based on the equivalent injection of current techniques without use of jacobian matrix, admittance matrix or inverse of admittance matrix which are proved to be problematic for the networked systems.

A methodology, which is based on exact loss formula and tested in three typical distribution systems. Metaheuristic approaches and analytical ones for DG setting and sizing such as Tabu search, Fuzzy-GA method, Hereford Ranch Algorithm used to reduce power loss. The Craziness based Particle Swarm Optimization (CRPSO) used to consider the optimally allocation for DG which improves the voltage profile system.

The method harmony search algorithm with differential operator is studied for improving voltage profile and minimization of active power loss. The new optimization approach called Artificial Bee Colony algorithm is another meta-heuristic method to solve combinatorial problems.

The Artificial Bee Colony algorithm is Meta heuristic approach inspired by foraging behaviour of honeybee swarm as in the case of genetics and differential evolutions the external parameters such as mutation rate and cross over rate are required but as in case of Artificial Bee colony algorithm external parameter as mentioned above is neglected.

This paper discuss the optimal allocations of DG are identified by Artificial Bee Colony algorithm to determine the optimal size(s) of DG to minimal the real power losses which takes the number and location of DGs as input in distribution systems. The advantages of implementation of Artificial Bee Colony method from determination of locations of DGs are less computational time and improved converged characteristics with thermal and voltage constraints are considered.

Pseudo-code of main body of ABC algorithm:

1) Initiation
2) Evaluate
3) cycle = one
4) repeat
5) Employed Bees (First half Phase)
6) For Onlookers calculate probabilities
7) Onlooker Bees (Second half Phase)
8) Scout Bees (Third Phase)
9) Memorization of best solution achieved so far
10) cycle = previous cycle + 1
11) until cycle =Maximum(specified) Cycle Number

Identification of optimal DG sizes by ABC algorithm

The colony of artificial bees consisting of three groups of bees: scout, onlookers and employed bees. In the dance area a bee is waiting for making decision to choose food source is called an onlooker and the previously visited bee going to food source is named employed bee. A random search is carried out by bee called scout. In the ABC algorithm, first half of the colony comprising of employed artificial bees and the second half comprises the onlookers. For every food source, there is only single employed bee.

By the employed the employed bee whose food source is exhausted and onlooker bees becomes a scout. At starting stage, positions of food source are randomly selected by the bees and their amounts of nectar are determined. These bees will into come hive and shares the nectar information within hive with the bees waiting on the dance area. After sharing the information, each and every employed bee goes to the food source area visited by it at the previous cycle since that food source exists in its memory, and then by means of visual information it chooses a new food source in the neighbour hood of the present one. Then food source areas depending on the nectar information distributed by the employed bees are preferred by onlookers on the dance area. As the amount of nectar of a food source increases, the probability which that food source is chosen by an onlooker increases, too.

After arriving at the particulate area, employed bee chooses the neighbourhood for new food source of the one in the memory depending on visual information. Based on the comparison of food source positions Visual information is performed. When the nectar of a food source is deserted by the bees, by a scout bee a new food source is randomly determined and replaced with the deserted one. In this approach, at every cycle number of employed and onlooker bees were equal and one scout goes outside for searching a new food source. The probability Pi of selecting a food source i is determined by using

$$Pi = \frac{fit\ i}{\sum_{n=1}^{Sn} fit\ n}$$

where fiti is fitness of the solution represented by food source i and SN is total number of food sources.. The best food source among all the neighbouring food sources determined by the onlookers associated with a particular food source i after all onlookers have selected their food sources, each of them determines a food source in the neighbourhood of his chosen food source and computes its fitness will be the new location of the food source i. If a solution represented by a specific food source does not improve for a predetermined number of iterations then that food source is deserted by its associated employed bee and it becomes a scout.

This equivalent to assigning a indefinitely generated food source to this scout and changing its position again from scout to employed. The another iteration of ABC algorithm begins after the new location of each food source is determined. The whole process is repeated till the termination condition is satisfied. The food source in the neighbourhood of a specific food source is determined by changing the value of one indefinitely chosen solution parameter and keeping other parameters unaltered. Suppose solution each consists of'd' parameters and let Xi = (Xi1, Xi2, Xi3…… Xid) be a solution..In order to determine a solution vi in neighbourhood of Xi, a solution parameter j and other solution Xk=(Xk1, Xk2, Xk3…… Xkd) are randomly selected.

Except for values of selected parameter j, all other parameter values of vi are same as Xi ,i.e.,vi=(Xi1, Xi2,Xi3 …… Xi(j-1), Xij, Xi(j+1), … Xid). The value vi of the selected parameter j in vi is determined by,

$$Vij = Xij + U(Xij - Xkj)$$

where u is an variate in [-1, 1]. If the resulting value falls outside the acceptable range of j, it is set to the corresponding extreme value in that range.

ARTIFICIAL BEE COLONY ALGORITHM TO FIND DG SIZES

For minimize the real power losses the proposed ABC algorithm for finding DG sizes as follows,

1) Reading the input data.
2) Initial Bee population Xij construction as each bee is formed by sizes of DG units.
3) Each employed bee is evaluated by fitness formula

$$Fitness = \frac{1}{1 + power\ losses}$$

4) Initialize iteration=1.
5) Generate new population (solution) vijin the neighborhood of Xij for employed bees using below equation (11) and evaluate them.

$$Vij = Xij + U(Xij - Xkj)$$

6) Apply selection process between vi and Xi.
7) The probability values Pi for the solutions Xi by means of their fitness values can be calculated by using the equation,

$$Pi = \frac{fit\ i}{\sum_{n=1}^{Sn} fit\ n}$$

8) Produce the new populations vi for the onlookers from Xi, selected depending on Pi by roulette wheel selection process, and evaluate them.

9) Selection process is applied for the onlookers between Xi and vi.

10) Determine the abandoned solution, if exists, and replace it with a randomly produced new solution Xi for the scout bees using the

$$Xij = \min(j) + rand(0,1) * (\max(j) - \min(j))$$

11) Memorize best solution achieved. If the difference between two consecutive values is less than specified value, stop.

12) Increase another iteration.

13) If iterations are less than valued specified go to step 5, or else stop.

CONCLUSIONS

In this paper, a two-stage methodology of obtaining optimal allocations and sizes of DGs for maximum loss reduction of distribution systems. The DG placement method is proposed to find the optimal DG allocations and Artificial Bee Colony algorithm is proposed to find the optimal sizes of DG. The ABC algorithm is simple in nature than PSO and GA so it takes less computation time. The total power loss of the system has been reduced drastically and the voltage profile of the system is also improved, by installing DGs at all the potential locations. The future scope of this work is insertion of the real time limits such as time varying loads, discrete DG unit sizes and different types of DG units into the proposed algorithm.

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Prof. Dr. T. Ananthapadmanabha, obtained his BE degree in Electrical Engineering with Tenth Rank, M.E. degree in Power System Engineering with First Rank & Gold Medal and PhD in Electrical Engineering with Gold medal from the National Institute of Engineering, University of Mysore. Presently he is Working as Professor of Electrical & Electronics Engineering and Controller of Examination (Also served as HOD of EE dept.) at the National Institute of Engineering, Mysore. He has served as Regional Director (In charge) of Visvesvaraya Technological University, Regional Office, Mysore. Special Officer Bosch Rexroth Training centre of Visvesvaraya Technological University, Regional Office, Mysore. He has also served as member of Board of Studies, Board of Examiners and PhD Registration Committee of Various universities like VTU, University of Mysore, Bangalore University and Kuvempu University. He has also worked as NSS officer at NIE. He has published 170 (One hundred and seventy) papers in National and International Journals /Conferences. He is having 14 (fourteen) Research Students in Electrical Engineering (guided Nine (09) Research students for Ph.D and guiding Five (05) research students leading for their Ph.D). He has also guided more than 120

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