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Literature Survey on Voltage Profile Management Methods of Distributed Generation

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ABSTRACT
Distributed Generation (DG) has been utilized in some electrical networks in order to manage the low level demand. Environmental and economical issues have driven significant increase in the development of distributed generation. DG connected to the distribution systems, however, may impose negative influences with respect to power quality and efficiency. This negative influence is based on the location of the DG in the distributed system. In order to optimally positioning the DG in the system to improve the power quality and efficiency many algorithms are used. In this paper we made a literature survey on different algorithms used for positioning and sizing of DG in order to reduce losses, maintaining voltage profile. Also we have explained the methodology of each algorithms used.
Keywords - Artificial Bee Colony, Ant Colony Optimization, Distributed Generation, Genetic Algorithm, Optimization Algorithms.

I. INTRODUCTION

Distributed generation for a moment is loosely defined as small scale electricity generation, is a fairly new concept in the economics literature about electricity markets, but the idea behind it is not new at all. Interconnecting DG to an existing distribution system provides various benefits for example an enhanced power quality, higher reliability. DG is a method of generating electricity on a small scale from renewable and non-renewable energy sources. DG systems are located close to where the electricity is being used and hence the position of DG places an important role in achieving better efficiency. And so many optimizing algorithms are used for optimally positioning and sizing the DG systems. Each algorithm gives different results since their methodology is entirely different from each other. In this paper we have discussed about various algorithms used for positioning and sizing of DG. The introduction about algorithms and their methodology have been described. This paper gives the clear idea about the concepts of different optimization algorithms.

II. OVERVIEW OF DISTRIBUTED GENERATION

Before launching into an overview of distributed generation, it is appropriate to put forward a definition or at least an operational confine related to distributed generation. It is generally agreed upon that any electric power production technology that is such that it is integrated within distribution systems fits under the distributed generation umbrella. The designations “distributed” and “dispersed” are used interchangeably. The single line diagram of DG is shown in fig.1

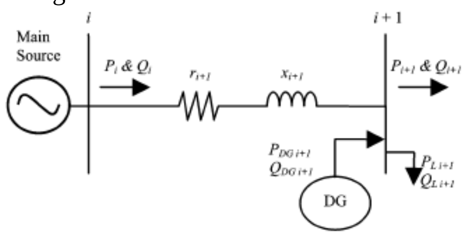

Fig.1: Single Line Diagram of Two Bus System

Distributed generation (or DG) generally refers to small-scale (typically 1 kW – 50 MW) electric power generators that produce electricity at a site close to customers or that are tied to an electric distribution system. Distributed generation, also called on-site generation, dispersed generation, embedded generation, decentralized generation, decentralized energy, distributed energy or district energy generates electricity from many small energy sources.

Distributed generation is an approach that employs small-scale technologies to produce electricity close to the end users of power.

DG technologies often consist of modular (and sometimes renewable-energy) generators, and they offer a number of potential benefits. In many cases, distributed generators can provide lower-cost electricity and higher power reliability and security with fewer environmental consequences than can traditional power generators.

One can further categorize distributed generation technologies as renewable and nonrenewable.

Renewable technologies include:

- Solar, photovoltaic or thermal
- Wind
- Geothermal
- Ocean.

Nonrenewable technologies include:

- Internal combustion engine, ice
- Combined cycle
- Combustion turbine
- Micro turbines
- Fuel cell.

Distributed generation should not to be confused with renewable generation. Distributed generation technologies may be renewable or not; in fact, some distributed generation technologies could, if fully deployed, significantly contribute to present air pollution problems.

III. OPTIMIZATION ALGORITHMS

3.1 ANT COLONY OPTIMIZATION (ACO):

Since it was proposed as an optimization method in 1991 by Dorigo et al., ACO techniques have been attracting the attention of more researchers [1]. The ACO algorithm is originally inspired by the biological behavior of the ants and, specifically, their way of communication [1]. In this algorithm the ant's movement is taken into account for placing of distributed generators in the distributed side. Such that each ants are placed at the home colony and are allocated the next node. Also pheromone (link) is given to each ant. The ant does not communicate with each other directly and each follows a different path to reach the node. Thus an n number of paths for reaching the nodes are obtained and from that the shortest and low cost path is chosen for optimizing. This process is iterated until a stopping criterion is reached where the Table.1 shows the process of genetic algorithm.

TABLE 1: A Genetic ACO Algorithm.

STEP 1	**INITIALIZATION**	initialize pheromone trail
STEP 2	**SOLUTION CONSTRUCTION**	For each and repeat solution construction using pheromone trail.
STEP 3	**UPDATE THE PHEROMONE TRAIL**	until stopping criteria

In the optimal placement of DG in the distribution network, ACO minimizes the DG investment cost and total operating cost. It improves quality and reliability. But the theoretical value calculation is difficult. It is not independent and time to convergence is uncertain.

3.2 VECTOR SWARM ALGORITHM (VSA):

VSO same as most of the evolutionary techniques is started with an initial population randomly and the steps of algorithm are iteratively repeated until a termination criterion is met such as a maximum number of generations or when there has been no change in the solution found of the problem for a given number of generations.

VSO algorithm can be simplified as below:

1) Initialize population of random vectors (the parents population of the first iteration)
2) Calculate the fitness of each vector
3) Generate a new population of vectors based on fitness children of population is obtained by changing in the value of each dimension of each parental population based on four operators: Participation, Mutation, Conformation and Selection.
4) Repeat steps 2 and 3 until a termination criterion is met.

This operator is introduced by suitable combines of multiple vectors for problem search space, which is consist of two sections:

a) Vector Direct Cooperation,
b) Vector Difference Cooperation.

3.3 HARMONY SEARCH ALGORITHM (HSA):

The HSA is a new meta-heuristic population search algorithm proposed by Geem et al, Daset al [4]., proposed an explorative HS (EHS) algorithm to many benchmarks problems successfully. HSA was derived from the natural phenomena of musicians' behavior when they collectively play their musical instruments (population members) to come up with a pleasing harmony (global optimal solution) [4].

The main steps of HS are as follows:

Step1-Initialize the problem and algorithm parameters:

In this step the problem statement is formulated and the required variables and parameters are defined.

Step2-Initialize the harmony memory:

The initialization of the harmony memory is made. Such that the memory space and the memory for the defined variables and parameters are also allocated.

Step3-Improvise a new harmony:

After the first two steps are over, the harmony search is started and many harmonies are generated for the defined problem. The selection of the best harmony and rejection of the worst harmony are also made in this step.

Step 4-Update the harmony memory:

After selecting the new harmony (best one), the space for the new one is allocated and that of old harmony is erased.

Step 5-Check the termination criterion:

This step is for redirecting as well as terminating the process. A check is made to ensure whether a best result is obtained for the stated problem. If the result achieved satisfies the condition then the process gets terminated or else the steps 3 & 4 are executed until the condition gets satisfied.

3.4 GENETIC ALGORITHM (GA):

Genetic algorithm is based on techniques on principles from the genetic and evolution mechanism observed from the natural system and living beings [2]. In general it consists of three types of searches

1. Initial population creation
2. Evaluation of the fitness function
3. New population production

A genetic first starts with then initial population searches, where each individual is evaluated by its fitness function. Subsequent values are eliminated by its fitness values. This GA leads generation of high performing individuals. The GA has three different types of operators. In first operator, an individual makes performs a high fitness value. In second operator, it selects two individuals within generation and carries a swapping operation. 3. Third operator used to explore some of invested point in search space, called mutation operator.

Using GA in distributed generation minimizes the total real power losses. Also it works on both discrete and continuous parameters. But the main drawback is the lack of accuracy when a high quality solution is required.

3.5 ARTIFICIAL BEE COLONY ALGORITHM (ABC):

The artificial bee colony algorithm is a new meta-heuristic optimization approach, introduced in 2005 by Karabog [3]. Used for both constrained and unconstrained optimization problems and also the results obtained in this method is better than the other methods of optimization. The colony of artificial bees consists of three types of bees-employed, onlookers and scout bees [3]. The employed bees are those who search for food sources (solutions) and share them to the onlookers that are waiting in the dance area of the hive. As the information are shared by means of dancing only. The duration of the dance is proportional to the nectar content (fitness value) of the food source currently being exploited by the employed bees. The dances performed by the employed bees are watched by onlookers and scout bees and they choose the best food source and avoids the bad ones. Once the onlookers choose the food source (solution) they change their status and become employed bees. Meanwhile if the food source is fully visited means the corresponding employed bee becomes scout bees or onlookers. The total size of the algorithm is divided into two halves- one half is assigned to employed bees, in which each individual represents the separate food source. And the other half represents the onlookers. The entire algorithm process comprises of three steps.

1. Finding the possible food source by sending the employed bees and also calculating the fitness value.
2. Selecting the best food source and rejecting the bad ones by using the onlookers, i.e., sharing the information between employed and onlookers.
3. Determining the scout bees and then sending them into entirely new food source positions [3].

On using the ABC algorithm, we can minimize the total system real power loss subject to equality and inequality constraints. Unless other metaheuristic algorithms, ABC has only 2 parameters to be tuned which avoids complexity. The only drawback is that the efficiency of the process is confirmed only by tuning the parameters.

3.6 DIFFERENTIAL EVOLUTION ALGORITHM (DEA):

Differential evolution (DE) is a method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality. A basic variant of the DE algorithm works by having a population of candidate solutions (called agents). These agents are moved around in the search-space by using simple mathematical formulae to combine the positions of existing agents from the population. If the new position of an agent is an improvement it is accepted and forms part of the population, otherwise the new position is simply discarded. The process is repeated and by doing so it is hoped, but not guaranteed, that a satisfactory solution will eventually be discovered.

IV. COMPARISON

The Table.2 shows the different algorithms such as Ant Colony, Artificial Bee Colony, Genetic Algorithm, Vector Swarm Algorithm, Harmony Search Algorithm and Differential Evolution Algorithm.

Table 2: Difference Between Various Algorithms:

SL.NO.	ALGORITHM	METHODOLOGY	OBJECTIVE	BENEFITS	DRAWBACKS
1.	**ACO**	Based on the movement of ants. The result generated depends on the path developed by the ants.	Minimizing the DG investment cost and total operating cost	It improves quality and reliability.	Theoretical value is difficult. It is not independent. Time to convergence is uncertain.
2.	**GA**	It is a population search technique. Based on the fitness value generated the results are obtained.	Minimization of total real power losses.	It works on both discrete and continuous parameters.	Lack of accuracy when a high quality solution is required.
3.	**VSA**	It is an evolutionary technique based on population search. But this population search is different from the GA search.	Reduces the size of step velocity.	The convergence rate is improved. It controls the movement of particle.	More sophisticated finite element formulation.
4.	**HSA**	It is the concept from natural musical performance process. The solution depends on the harmony generated by the musical instruments.	Minimization of power loss.	Diversification is controlled.	It requires more number of parameters.
5.	**ABC**	It is a new concept based on the path of honey bees. The path used by honey bees to collect honey gives the solution.	To minimize the total system real power loss subject to equality and inequality constraints.	Unless other metaheuristic algorithms, ABC has only 2 parameters to be tuned**.**	The efficiency is confirmed by tuning of parameters.
6	**DEA**	It is a method to optimize a problem by maintaining a population of candidate solutions and creating new candidate solutions by combining existing ones.	By using Differential Evolution (DE) for the placement of DG units in electrical distribution systems to reduce the power losses and to improve the voltage profile.	It improves the overall efficiency of power system and the performance of distribution system must be improved.	DE is used for multidimensional real-valued functions but does not use the gradient of the problem being optimized

V. CONCLUSION

In this paper the different algorithms used for the optimization of distributed generation in the distribution networks are presented. The methodology of each algorithm is described and finally a comparison is made on the methodology and their effect in the distributed generation. The comparison shows us that one algorithm is superior to one another.

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