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Diminution of Losses and Reliability improvement of distribution systems Using Genetic Optimization

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Abstract-In the current epoch of power system efficiency of power distribution system enhanced by number of method like genetic algorithm, simulated annealing, swarm optimization method etc. A genetic algorithm (GA) is a exploration or maximization algorithm based on the technicalities of natural selection and natural genetics. Since GA is suitable to solve combinatorial optimization tribulations, it can be effectively applied to problems of loss minimization in distribution systems. This paper proposes a general approach and a set of indices to assess some of the technological benefits in a quantitative manner. The index proposed is: 1) voltage profile improvement index; 2) line-loss reduction index. Simulation results obtained using a simple IEEE-14 bus test system is presented and discussed to illustrate the value and usefulness of the proposed approach.

Key words-Genetic Optimization, power distribution system

I.INTRODUCTION

As we are familiar with deliverance of electricity to the consumers is a final stage of Electricity distribution. Consumers carry electricity from the transmission line. It is the most visible part of the supply chain, About 30 to 40 % of total investments in the electrical zone go to distribution systems, but nevertheless, they have not received the hi-tech impact in the same manner as the generation and transmission systems. The greater significance in power system epoch is the loss minimization in distribution system since the inclination towards allocation computerization is to improve their stability, effectiveness and service quality will require the most efficient operating state for economic viability aviations. Simply capacitors are widely used for compensation of reactive power, better voltage regulation, to improve power factor feeder voltage profile, etc. Capacitors are second-hand increases available capacity of feeders in distribution system. Static capacitors are the reliable and the simplest means for reactive power compensation. Because of this reason it is momentous to find the optimal location of capacitor and sizes of in the system to achieve the above mentioned objectives. There are many ways for capacitor situation and fortitude size of capacitors in power systems. Many techniques have been developed for solving the capacitor placement problem, namely, analytical, numerical programming, heuristic and artificial based techniques [1]. Duran et al. [2] consider the capacitor sizes as discrete variable and employed dynamic programming, whereas, Grainger and Lee were expressed the location and capacity of capacitor as continues variable based on non linear programming. Maxwell [4] suggests there are several benefits of capacitor placement which include:

I. Reduced copper losses and energy losses.
II. Reduced regulation cost.
III. Reduced KVA input to feeder
IV. Reduced reactance losses.
V. Increased returns as result increased voltage levels.

Salama M.M.A. et al [5] in their work assume a fixed load condition and a uniform feeder. A concentrated load at the end of the feeder is dealt with singly. In optimizing optimal capacitor situation problem heuristic based techniques have been extensively used [6] in their paper uses heuristic technique for reactive loss reduction in distribution network. The capacitor rating is determined by differentiating the system losses with respect to the load connected to that node [7]

Fuzzy logic has been applied to solve the capacitor placement problem in which the constraints are fuzzified and the alpha cuts are used to direct the search process to ensure that the intention task is enhanced at each iteration process. In 2012 [8] developed an efficient Genetic Algorithm with a new coding as two rows of genetic material used for optimization in real-time allocation of predetermined and switchable capacitors. Genetic Algorithm (GA) is an valuable contrivance in solving the optimization pickle especially in case of capacitor location in radial distribution system [9] and paper uses concept of ant colony search with limits and improvement technique is use along with GA to search the proper mutation operator to gather speed pointed out the global solution. To improve quality of power and its stability and voltage regulation shunt compensation are basically used in transmission system. By reactive power compensation shunt capacitor maintains the voltage level in power line, Series compensation is used to control the impedance of power line. whereas reactive power utilization by shunt reactors reduce the overvoltage. The placement and sizing of capacitors should be modeled simultaneously in the form of an optimization problem. Otherwise, the power system will not be most advantageous. This paper is organized as follows: section II discussed the proposed Genetic Algorithm, section III gives the problem formulation, section IV presents result of the proposed problem and section V outlines conclusion

Capacitors are provided to minimize power and energy losses, maintain best voltage regulations for load buses and improve system security. They have been commonly used to provide reactive power compensation in distribution systems. A large variety of research work has been done on capacitor placement problem in the past [1], [2].The amount of compensation provided is very much linked to the placement of capacitors in the distribution system which is essentially determination of the location, size, number and type of capacitors to be placed in the system [2]. All the approaches differ from each other by the way of their problem formulation and the problem solution method employed. Some of the early works have not considered capacitor cost in the formulation. In some approaches the objective function considered is to control the voltage. In some techniques, only fixed capacitors are considered and load changes which are very important in capacitor placement have not been considered. Other techniques have considered load changes only in three different levels. A few proposals were schemes for determining the optimal design and control of switched capacitors with non-simultaneous switching [4]. It is also very important to consider the real cost of the capacitors found in the market. Different problem solution methods have been employed to solve
the capacitor placement problem, such as, gradient search optimization, local variation method, optimization of equal area criteria method for fixed capacitors and dynamic programs [4], [5], [6].
Genetic Algorithms (GA) have been applied in various power system problems [7], [8]. GA is a very well known and capable method for optimization problems. It is capable of determining near global solution with lesser computational burden. In this respect, it is very suitable to solve the capacitor placement problem. In the present work GA is applied to determine the optimal capacitors location for IEEE- 33 bus distribution network.

II.TOTAL REAL POWER LOSS IN A DISTRIBUTION SYSTEM

The total I^2R loss (P_L) in a distribution system having *n* number of branches is given by

$$P_{Lt} = \sum_{i=1}^{n} I_i^2 \; R_i \; \ldots\ldots\ldots\ldots (1)$$

Here I_i and R_i are the current magnitude and resistance, respectively, of the i^{th} branch. The branch current can be obtained from the load flow solution. The branch current has two components; active (I_a) and reactive (I_r). The loss associated with the active and reactive components of branch currents can be written as

$$P_{La} = \sum_{i=1}^{n} I_{ai}^2 \; R_i \; \ldots\ldots\ldots\ldots (2)$$

$$P_{Lr} = \sum_{i=1}^{n} I_{ri}^2 \; R_i \; \ldots\ldots\ldots (3)$$

Reducing the inductive reactive portion of the line loading, would reduce the reactive losses. With a highly inductive load we want to reduce the level of inductive load current. This is done by the addition of shunt capacitors. Note that for a given configuration of a single-source radial network, the active current component I_a depends only on the circuit load. The loss P_{La}, associated with the active component of branch currents cannot be minimized because all active power must be supplied by the source at the root bus. However, the loss P_{Lr} associated with the reactive component of branch currents can be minimized by supplying part of the reactive power demands locally. The purpose is to locate these capacitors in the points where they can improve best the technical circuit performance.

III.GENETIC ALGORITHM

The process involved in GA optimization problems is based on that of natural evolution and broadly works as follows,
1. Randomly generate an initial population of potential solutions.
2. Evaluate the suitability or 'fitness' of each solution.
3. Select two solutions biased in favour of fitness.
4. Crossover the solutions at a random point on the string to produce two new solutions. 75
5. Mutate the new solutions based on a mutation probability.
6. Go to 2.

Selection, crossover and mutation are the basic operators involved in GAs. How these and other factors can affect the operation of GAs will be demonstrated by means of several examples and experimental observations. Consider the popular board game 'Mastermind' where a player has to determine a hidden sequence of colours starting from an initial random guess. This initial guess is scored with a black marker for each color in the correct position and a white marker for a correct color but in the wrong position. Further guesses are made and scored until the correct sequence is determined or a given number of attempts have been made. In this game the correct solution evolves from the more suitable of all previous attempts, with clues from unsuitable candidate solutions also being part of the deduction process. This is a type of 'blind' optimization problem where no information is available on what makes a good solution, only information on how good solutions are given a few initial guesses the player will select high scoring attempts and perform crossover to see if this results in an improvement. New colours will almost certainly have to be mutated into the 'educated guesses' in the attempt to find the correct sequence.Fig 4-1 demonstrates how these three operators work considering a scoring scheme where a point is scored only for a number in the correct position. The GA search procedure is very easy to understand and implement, with nature providing ready examples of exactly how things could be done.required solution

1 2 4 3

attempt score

1 1 4 2 1 1

2 2 1 4 4 1 >selection

3 2 1 2 3 2 >selection

4 3 1 2 4 1 crossover

5 4 1 2 4 3 mutation

IV. ENCODING

first described by John Holland and then presented tutorial by David Goldber. Genetic algorithms are search algorithms based on the process of biological evolution. GA uses a "Chromosomal" representation which requires the solution to be coded as a finite length string. The basic structure of GA used in this paper is as Follows: First, a randomly constructed initial population of solutions is generated. Within this population new solutions are obtained during the genetic cycle using crossover and mutation operators. Crossover produces a new solution from a randomly selected pair of parent solutions providing the inheritance of some basic properties of the parents in the new solution. Mutation results in slight changes in the new solution structure and maintains diversity of solutions. Each new solution is decoded and its objective function "fitness" values are estimated. These values are a measure of the quality which is used to compare different solutions. The comparison is done by a selection procedure that decides which solution is better: the newly obtained one or the worst solution in the population. The better solution joins the population and the worse one is discarded. If the population contains equivalent solutions following selection, redundancies are eliminated and the population size decreases. After several repetitions of the crossover-selection sequence, new randomly constructed solutions are generated to refill the shrunken population, and a new genetic cycle is started. The iterative loop is executed until the termination condition is satisfied. The termination condition is met when either the process has converged or the specified maximum number of generations has been reached. The degree of change in the quality of the individuals within the population over successive generations can serve as a measure for convergence.

V. CAPACITOR ALLOCATION ALGORITHM USING GA

First the initial population of randomly constructed solutions (strings) is generated i.e. capacitors of given value are placed at random nodes in the distribution system. Within this population new solutions (capacitor values for all the buses of the distribution system under study) are obtained during genetic cycle using crossover and mutation operator. Since the sizes of the capacitors are taken as discrete values, zero magnitude capacitor value is taken as one possibility of erecting capacitor at the bus, indicating zero reactive volt-amperes injected.

Each new solution is decoded and its objective function values (power loss) are estimated. Selection procedure describes which solution is better.

The better solution (i.e. a solution amongst the present population that reduces the system losses) joins the new population and worst is discarded.

Individuals in the initial population ranked higher in terms of fitness value are selected to replenish the shrunken population.

A new genetic cycle is started till the terminating criterion is met which is the maximum number of generations.

Figure 4 presents the flow chart of a typical capacitor allocation problem using genetic algorithm.

VI. RESULTS OF IEEE- 33 BUS SYSTEMS

As power losses are reduced so there is a net profit in installing the capacitors. After the compensation of system there is a considerable improvement in voltage profile. It satisfies the voltage constraint. Result obtained in paper is by using iterations and population size in GA toolbox in MATLAB software. As a result of capacitor placement reactive power is compensated, power factor of the system improves. So both energy loss & power loss reduces. Data is obtained from load flow programme on MATLAB are carried on a computer with Intel core i-3, 2.50 GHz, and 2.0 GB RAM.

WITHOUT INSTALLED CAPACITOR

RESULT OF LINE FLOW AND LOSSES OF IEEE 14 BUS DISTRIBUTION SYSTEMS(NR Method)

Loss(Without capacitor)	Line Loss	
	Kw	Kvar
Total loss	13.533	27.386

USING 3 CAPACITOR -WHICH ARE PLACEMENT ON THE IEEE 14 BUS DISTRIBUTION SYSTEM

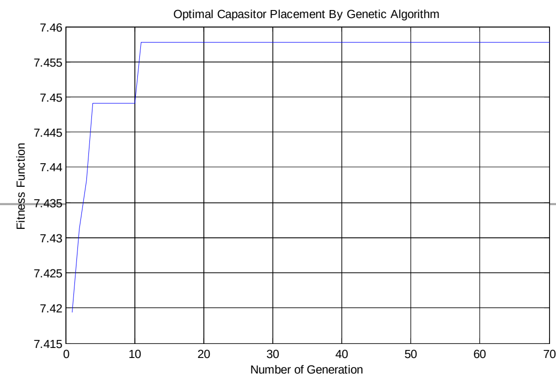

Fig 5 Best Fitness Function

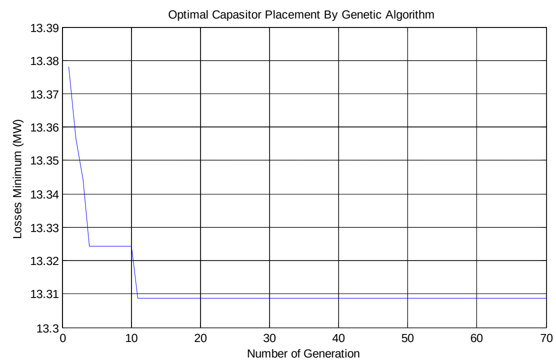

Fig 6 Minimum losses

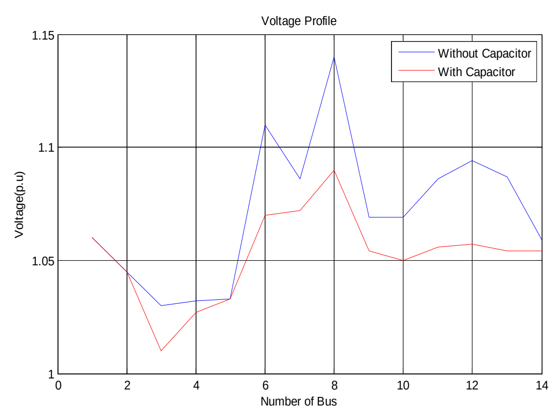

Fig 7. Voltage Profile

Table-1 Results of size of capacitor and its location using 3 capacitor using GA

Bus No	Capacitor size (Mvar)
5	29.247

7	18.146
14	11.750

Table-2 SUMMARY OF REAULTS FOR IEEE-33 BUS SYSTEM

Total Loss (MW) of IEEE 33 BUS	Without Capacitor	With 3 Capacitor
	13.533	13.309

VII. CONCLUSION

The comparison results in Table 1 and 2 indicate that the Genetic Algorithm works better to locate optimum size, location of capacitor, to reduce the power loss and to improve the system voltage profile.

An approach incorporating the use of Genetic Algorithm has been presented in this paper to determine the optimal locations and size of capacitors to place in a distribution system at dynamic load level. To reduce the power losses solution is been obtain in IEEE 14 bus distribution system

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