Genetic Algorithm Optimization Technique For minimization of Losses Using DER'S

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Abstract- This article, describes about the optimization technique named as GA to figure out optimal deployment of RES base distribution for minimization of total energy loss and enhancement of voltage stability using newton rapson method. GA is used for optimization of difficult problems very fast, stable and precise. Newton rapson method is used in this optimization because the convergence is very fast as compared to other. This is done on 33 bus test distribution system on MATLAB 2015a software. Solar and wind renewable energy generation sources are considered in the analysis. The main aim is minimization of active power losses; reduction of cost, better voltage profile, higher power reliability and enhancement of voltage stability .The results shows that presented heuristic approach is strong in obtaining the optimal results than the algorithms presented so far. Further this optimization technique has been checked and compared with existing method.
Keywords – GA (genetic algorithm), DER'S (distributed energy resources), RES (renewable energy sources) and DG (distributed generators)

I. INTRODUCTION

This paper presents a genetic algorithm optimization methodology in order to find optimal location of DG to simultaneously optimize annual energy losses and voltage stability index. The basis advantage of this is that it provides a near optimal solution rather than an optimal one in a limited iteration cycle. Additionally it gives a higher energy loss reduction. We discuss the technology for enhancing renewable energy deployment and energy use efficiency.

Distributed generation is known as a collection of technologies that generate power at or near where it will be used like solar panels and combined heat and power .it may serve a single structure or it may be a part of micro grid or a large university campus

During power outages distributed generation system, mainly combined heat and power and emergency generators are used to provide electricity, it also includes those that occurs after severe storms and high electricity demand days.

Solar and wind RES are used in this optimization process. Solar energy is the conversion of energy from sunlight into electricity directly with the help of photovoltaics or indirectly with the help of concentrated solar power or a mixture. For focusing a big area of sunlight into a small beam concentrated solar power system uses lenses or mirrors and tracking systems. Using the photovoltaic effect photovoltaic cells convert light into electric energy.

Wind is on 5th no, in India for the generation of wind energy after china, USA, Germany and Spain in grid connected wind power generation. Wind energy has made its most important contributes in china, US and Germany where the cumulative installed capacitors are 62, 47and 29 GW respectively.

For solving the DER integration and operation problems, some meta-heuristic optimization methods have been introduced. One of these can include GA aiming to minimize annual energy loss. A DER integration problem is formulated with the help of wind turbines (WTs) and photovoltaics (PVs) and then GA is applied to solve it. The performance of GA is found to be promising when compared with some of the other optimization technique.

II. PROPOSED ALGORITHM

2.1 Genetic algorithm

An american scientist john holland in 1960 introduced GA after his student David E.Goldberg extended GA in 1989. Genetic algorithm is a technique/method which forms its basis from the biological evolution. It Consist of three major steps selection, crossover and mutation. Genetic algorithm is used to solve problems with an optimal solution and generate a high quality solution. This algorithm shows the process of selection of natural where the fittest individual are selected for reproduction in order to produce offspring of the next generation.

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2.2 Basic function of genetic algorithm:

1. Selection: in the first step in selection process, the selection of fittest individual and then they pass their gene to the next generation. The parents (pair of two individuals) are selected on basis of their fittest scores. Individuals with bettter fittest have more chances to be selected for reproduction.
2. Crossover: crossover is the most important step in the genetic algorithm. For mating of each parent, a crossover point is chosen at random from within the genes.
   Offspring are produce by interchanging the genes of two Individuals (parents) among themselves until the crossover point is reached. Then the new offspring are added to the population.
3. Mutation: now after selection and crossover process we have new population full of individuals, some of them are directly taken and others are produced by crossover.
   To ensure that all individual are not same exactly, you allow for a small chance of mapping .you loop, through all the allelomorph of all the individuals, and if that allelomorph is chosen for mapping, you can either replace it with a new value or change it by a small amount. The probability of mapping is between 1 and 2 tenths of percent.
   Mutation is somewhat easy. We just have to change the chosen allelomorph based on what you feel are needed and move on. Mutation is necessary to ensuring genetic distinction within the population

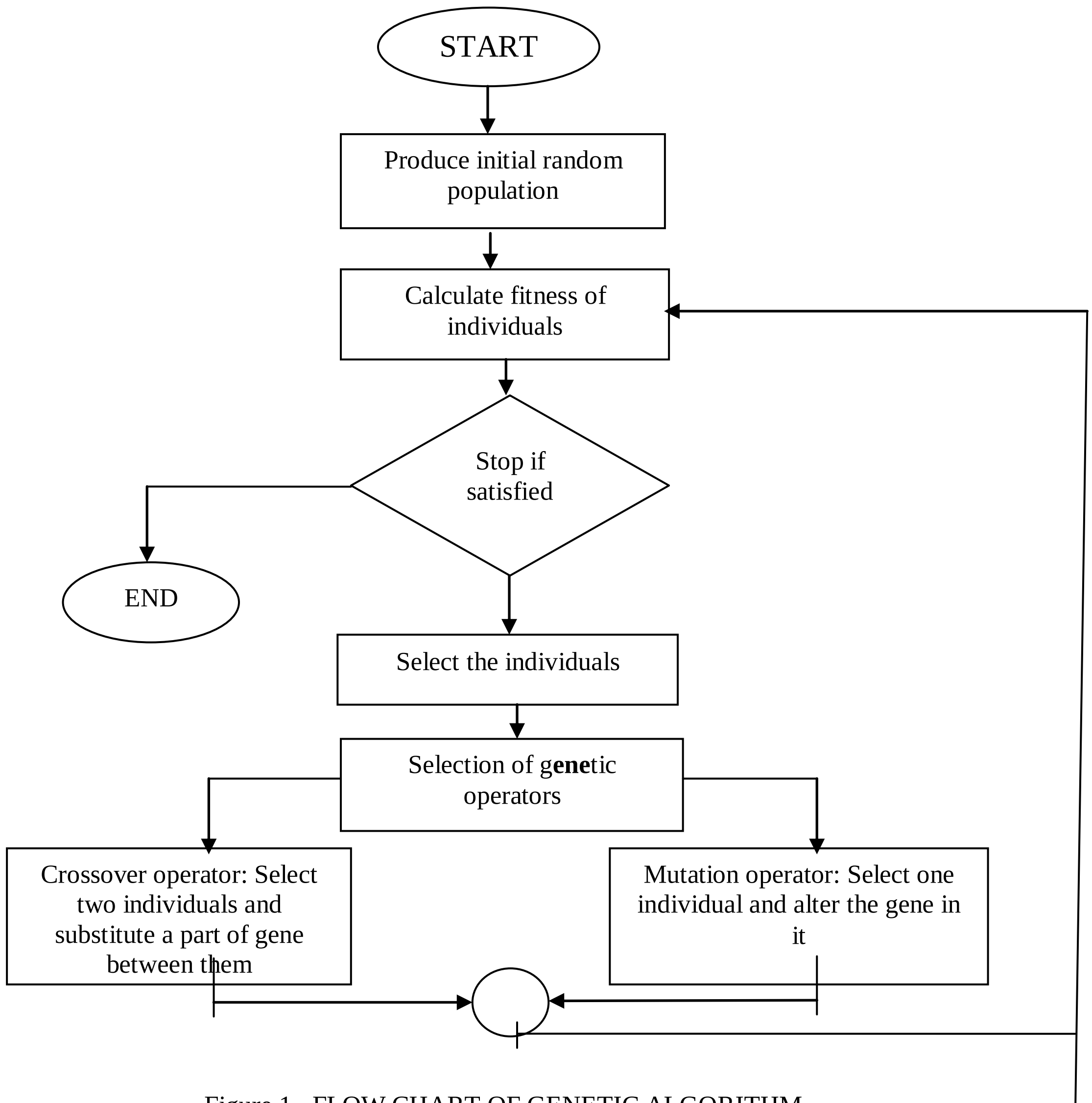

Figure 1. FLOW CHART OF GENETIC ALGORITHM

In this section, for optimal integration, an optimization problem is formulated to minimize annual energy energy loss and node voltage deviation of distribution system simultaneous with the multiple wind turbines and photovoltaics.

Objective function:
A panelty function based approach is adopted to combine objective function expressed as

$$minimum\ f = \varphi \sum_{t=1}^{24} (F_1 [1 + F2]) \qquad \{1\}$$

Here φ=daily to annual transformation factor
$P_i, Q_i =$ Real and reactive power injections
R_{ij}=resistance of branch connecting nodes i and j

N=no. of buses

$$F_1 = \sum_{i=1}^{n} \sum_{j=1}^{n} R_{ij} \cos(\delta_i - \delta_j)/V_i V_j \left(Q_i Q_j + P_i P_j\right) + R_{ij} \sin(\delta_i - \delta_j)/V_i V_j \left(Q_i P_j - P_i Q_j\right) \qquad \{2\}$$

$$F_2 = maximum < \Delta V_{i,t} > \quad \forall\, i, t \qquad \{3\}$$

Here= $V_{minimums}, V_{minimum}, V_{maximum}$ =minimum and maximum specified voltage limit

$\Delta V_{i,t=}$

$$\begin{cases} |1 - V_{i,t}|, V_{minimums} \le V_{i,t} \le V_{minimum} \\ 0, \ if\ V_{minimum} \le V_{i,t} \le V_{maximum} \\ large\ penalty, \quad else \end{cases} \qquad \{4\}$$

Values for the above constraints:
Here $V_i \delta_i$ =real load demand, voltage magnitude and angle at node I respectively

$$P_i = V_i \sum_{j=1}^{n} V_j . Y_{ij} . \cos(\theta_{ij} + \delta_i - \delta_j) \quad \forall i \qquad \{5\}$$

$$Q_i = -V_i \sum_{j=1}^{n} V_j . Y_{ij} . \sin(\theta_{ij} + \delta_i - \delta_j) \quad \forall i \qquad \{6\}$$

$$V_{minimum} \le V_i \le V_{maximum} \quad \forall i \qquad \{7\}$$

Here P_i^{DER} =DER capacity assumed to be deployed
$P_{maximum}^{DER}$=maximum allowed DER size at a node

$$0 \le P_i^{DER} \le P_{maximum}^{DER} \quad \forall i \qquad \{8\}$$

n_{der}=no. of DERs to be installed in distribution system respectively

$$\sum_{i=1}^{n_{der}} P_i^{DER} \le 1.6 \sum_{i=1}^{n} P_i^d \qquad \{9\}$$

Here $I_{ij}, I_{ij}^{maximum}$ =current and maximum current limit

$$I_{ij} \le I_{ij}^{maximum} \quad \forall i \qquad \{10\}$$

III. EXPERIMENT AND RESULT

For the validation of the ability of GA approach,for solving dispatchable DG integration problems,a active power loss minimization problem is solved for a benchmark 33 bus test distribution system,with base voltage 12.66 KV radial test distribution networkwith total real power demand of 3.715MW and reactive power demand of 2.300 MVAr respectively.
Following cases are solved by GA:
Case 1: In case1(base case)there is no DG
Case 2: In case2 only WTs are optimally integrated,at unity power factor(OPF)
Case 3: In case3 WTs and PV are optimally integrated
The simulation results of these three cases are presented in table 1. The sites and sizes of different DG with annual energy loss are presented in the table 1. From these cases it observed that the integration of WTs and PV minimize the annual energy loss of the system.

In case 3 the mixed integration of DERs provides higher loss minimization as compared to case 2 where optimal integration of WTs.it is because wind power generation is high at light load hours at night whereas in the day time peak demand occurs.

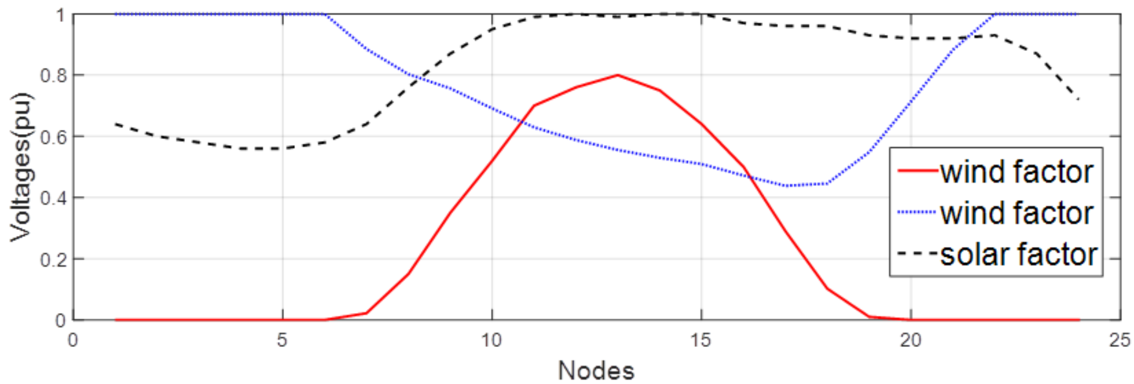

Figure2. Wind and solar factors

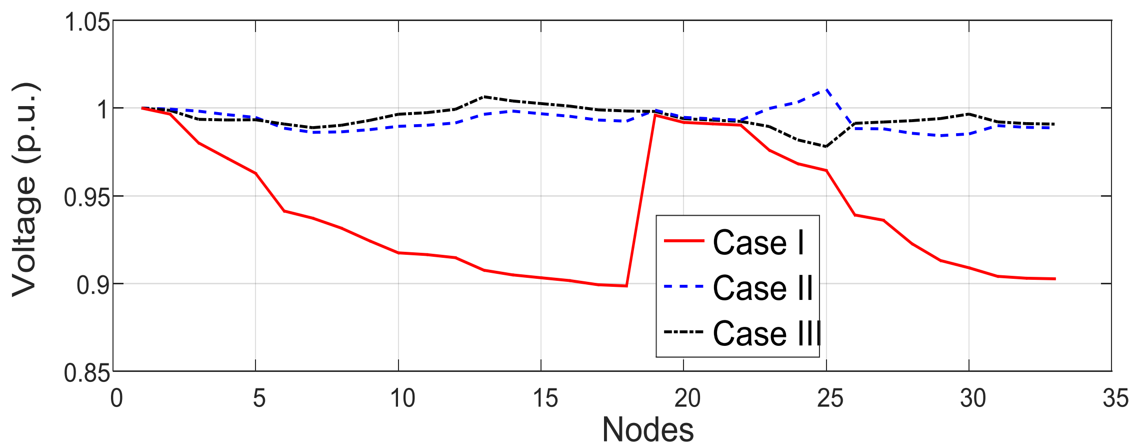

Figure3.Mean node voltages of the system for all cases

Case	DG types, site (sizes in kW)	Annual Energy Loss(MWh)
Case-1(Base case)	-	3493.27
Case-2	@28(2000)WT @11(2000)WT @24(1250)WT	1.7046
Case-3	@30(2250)WT @13(1500)WT @ 08(2613.7)PV	1.6461

Table 1.Simulation results for optimal allocations of different DGS, DG penetration and annual energy loss

IV.CONCLUSION

In this paper a technique is proposed to solve optimal DER integration problem of distribution system. The technique solves the optimal deployment of dispatchable DGs for power loss reduction, node voltage deviation and RES based DGs for annual energy loss reduction. It has been assessed using test system, a 33 bus test system. The result shows that the integration of DERs gives better results than the optimal integration of single DER. This shows that the GA has ability to provide promising results.

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