Optimal Location and Sizing of Distributed Generation for Improving Voltage

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***Abstract*- Nowadays, a distributed generation (DG) in distribution systems has increased to high penetration levels. The impact of DG units on the voltage stability margins has become significant. Optimization techniques are used to locate and size the DG units in the system, so as to utilize these units optimally within certain limits and constraints. The bio inspired fruit fly algorithm is proposed to be used for optimizing the location and size of the DG units. The main objective of this work is to propose a method for locating and sizing DG units so as to improve the voltage stability margin. The 33 node test system is considered for validating this work.**

***Index term*- Distributed Generation, Voltage stability, Distribution system, Minimization of losses, Voltage profile.**

NOMENCLATURE

Init X axis = Randomly generate a fruit fly swarm's initial position

Init Y axis = Randomly generate a fruit fly swarm's initial position.

Xi ,Yi = Randomly assign each and every fruit fly a direction and distance for their movement to look for food with their olfactory organ.

$Dist_i$ = Distance of the origin is estimated first.

S_i = Judged value of smell concentration.

Smell_i = To get the smell concentrations of at positions of each and every fruit flies.

$\max(\mathrm{Smell})$ = Identify the fruit fly whose position has the best smell concentration (maximum value).

I. INTRODUCTION

The distributed generation (DG) in power system networks has rapidly increased. This increase can be justified by factors such as environmental concerns, the restructuring of electricity market, and the development in technologies for small-scale power generation. DG units are typically connected so that they work in parallel with the utility grid, and they are placed depending on availability of the resources. Integrating DG units can have an impact on the practices used in distribution systems, such as the voltage profile, power flow, power quality, stability, reliability, and protection [1]-[5],[17]-[21].

Since DG units have a small capacity compared to central power plants, the impacts are minor if the penetration level is low less than 5%. However, if the penetration level of DG units increases to the anticipated level of 20-30%, the impact of DG units will be profound[1]-[3].Voltage instability in distribution systems has been under stood for decades and was referred to as load instability[1]-[2]. With the development of economy, load demands in distribution networks are sharply increasing. Hence, the distribution networks are operating more close to the voltage instability boundaries. The decline of voltage stability margin is one of the important factors which restricts the increase of load served by distribution companies[8]-[16].Therefore, it is necessary to consider voltage stability with the integration of DG units in distribution systems[3]-[7].

II. PROBLEM FORMULATION

$$f = min(P_L) \quad (1)$$

Where:

P_L: Active Power Loss

The active power loss is obtained from load flow program[1].

II A.CONSTRAINTS

The main constraints in the optimization process in the proposed methodology are:

1. Active and reactive power losses constraints
2. Voltage Constraints
3. DG size constraint

A) 1. Active and reactive power losses:

The losses after installing DG in power grid should be less than or equal losses before installing DGs.

PL with DG ≤ PL without DG

QL with DG ≤ QL without DG

A) 2. Voltage constraint:

$$V_i^{min} \leq V_i \leq V_i^{max}; i \in N_B \quad (2)$$

A) 3. DG Size constraint:

To obtain a reasonable and economic solution, the size of generators should not be so small or so high with respect to load value. The DG size is considered not less than one quarter of the load and not more than three quarters of the load as following:

$$25\%L \leq D_{Gi} \leq 75\%L \quad (3)$$

L : Load value

DG_i: DG size

II B. IEEE RADIAL NETWORK DG NETWORK

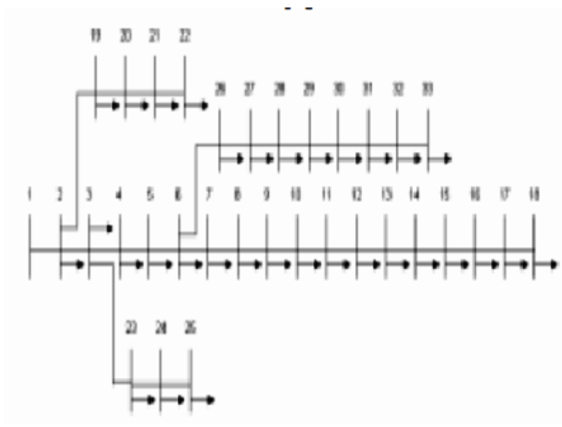

Fig-1 shows that IEEE-33 Radial Network diagram

From fig-1 it indicate IEEE-33 radial network diagram considered for this paper to perform the optimizations.

III. PLACEMENT OF PROBLEM FORMULATION

After formulating problem formulation allocating DG units with the system requires investigation in DG resources.

Fruit Fly Optimization Algorithm was put forward by Taiwanese scholar Pan. It is a new optimization method based on fruit fly's foraging behaviors and most researchers used this algorithm for many optimization problem. Fruit flies are superior to other species in terms of visual senses. They can successfully pick up various odors floating in the air with their olfactory organ, some can even smell food sources 40 kilometers away. Then, they would fly to the food. They may also spot with their sharp vision food or a place where their companions gather.

Fruit fly's foraging characteristics have been summarized and programmed into the following steps, which are:

1:Randomly generate a fruit fly swarm's initial position

$$Init\ X\ axis;\ Init\ Y\ axis \quad (4)$$

2: Randomly assign each and every fruit fly a direction and distance for their movement to look for food with their olfactory organ.

$$X_i = X_{axis} + RandomValue \quad (5)$$

$$Y_i = X_{axis} + RandomValue \qquad (6)$$

Since food's position is unknown, the distance (Dist$i$) to the origin is estimated first, and the judged value of smell concentration (Si), which is the inverse of distance, is then calculated.

$$Dist_i = \sqrt{(X_i^2 + Y_i^2)}; \quad S_i = 1/Dist_i \qquad (7)$$

3: Substitute the judged values of smell concentration (Si) into the smell concentration judge function (also called fitness function) to get the smell concentrations (Smell$i$) of at positions of each and every fruit flies

$$Smell_i = Function(S_i) \qquad (8)$$

4: Identify the fruit fly whose position has the best smell concentration (maximum value)

$$[bestSmell bestIndex] = max(Smell) \qquad (9)$$

5: Keep the best smell concentration value and x, y coordinate; the fruit fly swarm will see the place and fly towards the position.

$$Smellbest = bestSmell \qquad (10)$$

$$X\ axis = X(bestIndex) \qquad (11)$$

$$Y\ axis = Y(bestIndex) \qquad (12)$$

6: Enter iterative optimization, repeat steps 2-5 and judge whether the smell concentration is higher than that in the previous iteration; if so, carry out step 6.

III A. BIO INSPIRED ALGORITHM

A) 1. Fruit Fly Behavior

In Current trends in research development are focusing more on the Drosophila Melanogaster (scientific name for fruit fly) species. The initial ground work in this study has also singled and out focused on this particular species. Individual flies vary in body length from 1to over 20mm. the work involving studies on fruit fly was confined to the field of genetics, the main idea of behind this algorithm is based upon the fruit fly's behavior.

1. The fly hunts for food
2. Its moves randomly with levy motion.
3. It smells the potential location.
4. It would then taste.
5. While foraging our mating the fly also sends and receives message with its friends about its food and mates.

A) 2. Levy Flights

On the other hand, various studies have shown that flight behavior of many animals and insects has demonstrated the typical characteristics of Levy flights. A recent study by Reynolds and Frye shows that fruit flies or Drosophila Melanogaster, explore their landscape using a series of straight flight paths punctuated by a sudden 90^o turn, leading to a Levy-flight-style intermittent scale free search pattern. Studies on human behaviour such as the Ju/'hoansi hunter-gatherer foraging patterns also show the typical feature of Levy flights. Even light can be related to Levy flights.

A) 3. Fruit Fly Algorithm

The main idea behind the algorithm is based upon the fly decides to go for hunting, it will randomly to find the location guided by a particular odor. While searching ,the fly also sends and receives information from its neighbors and makes comparison about the best current location no longer exists or the taste is 'bitter', the fly will go off searching again. The fly will stay around the most profitable area, sending , receiving and comparing information at the same time. The total number of flies depends upon the number of sources,. However, since the most of the flies are near to the food source location, the next generation of flies is considered to be already close by to the potential food location.

III B. Objective function

The objective work of this project is to improve the voltage stability of distribution network by minimizing the losses, and also to determine the best location and size for new DG resources by minimizing real power losses.

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III C. FLOWCHART

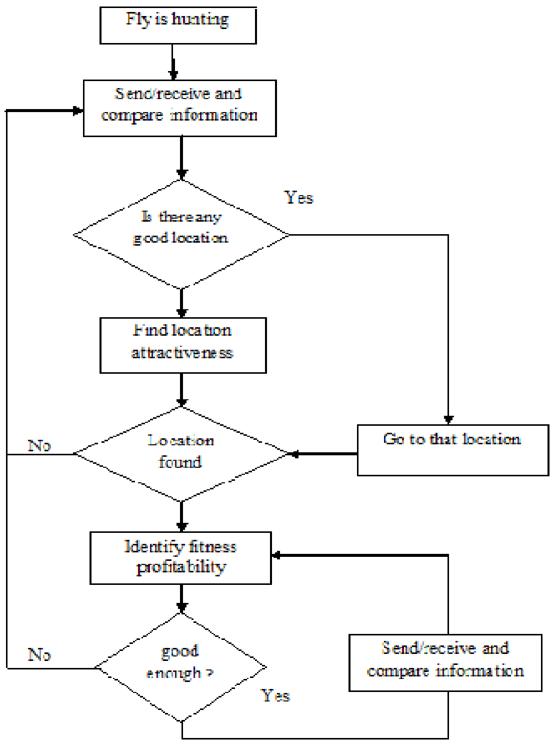

Fig-2 Shows that the optimization performance flow chart.

From Fig-2 we know that the optimization performance for optimal placement and location of the DG units and also to identify the performance.

IV. SIMULATION RESULT

BEFORE OPTIMIZATION

vbp =

1.0000
0.9960
0.9770
0.9668
0.9568
0.9318
0.9271
0.9205
0.9119
0.9040
0.9028
0.9008
0.8924
0.8894
0.8874
0.8856
0.9320
0.9273
0.9207
0.9122
0.9042
0.9031
0.9010
0.9270
0.8896
0.8877
0.8858
0.8831
0.8823
0.9953
0.9907
0.9898
0.9890
0.9722
0.9633
0.9589
0.9294
0.9259
0.9103
0.8992
0.8944

ans =

281.5877

AFTER OPTIMIZATION

MASS OBJ = 277.5231

MASS SIZE = 10 10

MASS LOC = 16 17

vbp =

1.0000
0.9960
0.9770
0.9669
0.9569
0.8886
0.8874
0.8870

CONVERGENCE CURVE

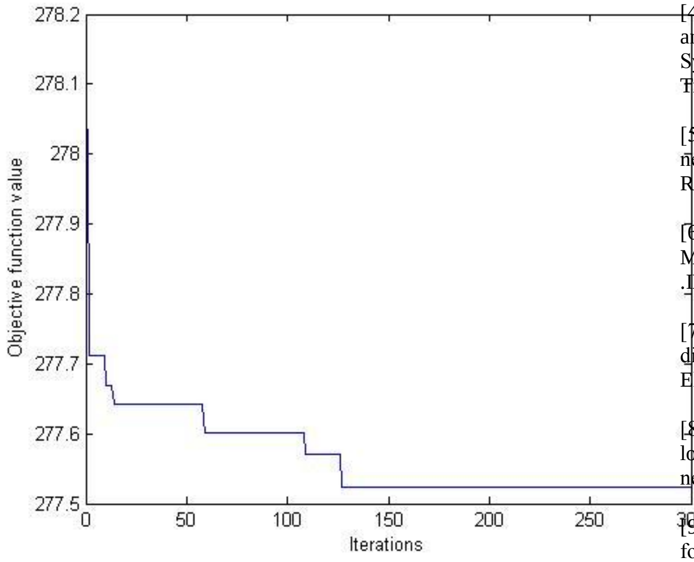

Fig -3 shows the Convergence curve, It is used to identify the losses minimizations before and after optimizations.

CONCLUSION

In this paper, a method of DG units allocation is proposed. This method targets utilizing the DG units to minimize the losses . It considers the probabilistic nature of both loads and renewable DG generation. The candidate buses for the DG units' installation are selected based on the sensitivity to the voltage. Simulation results indicate that DG size and location can have positive impacts on reduce cost. Therefore, an optimization method can be used to determine the locations and sizes of the DG units, to achieve the target of reducing looses. Therefore, the DG units with higher rating might be placed in upper stream of a radial distribution system in order to keep the system operating within the allowed to minimize the losses.

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