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Use of optimisation techniques to minimise annual liquidity depletion in power spread the networks through optimal accommodation of spread energy resources

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Abstract

In the electrical power distribution system the network feeds inductive loads for low voltage level, which lead to higher currents and power losses. Therefore, it is mandatory to improve the power system stability and reliability, power factor and voltage profile, which is done by placing active and reactive resources. More power can be transmitted through the existing system. The dynamic load pattern and increasing load demand, it is necessary for many electrical utilities to operate their system closer to the system operating capacity. It can be done by using facts devices - FACTS is one aspect of the power electronics revolution that is taking place in all areas of electric energy. There active power becomes unbalanced and hence reduces voltage level in the system and leads to various power system security problems. So, for enhancement the performance about the structure, lastly technology is used i.e., placing DGs and Shunt Capacitors. When the load is at the rated load or increment in loads, introduces inductive effect in the line, therefore the capacitive effect in the line should be introduced for system stability and vice-versa.

Keywords: Dynamic, Shunt Capacitors, Facts Devices

Introduction

The dependency on electricity is like dependency on air and water. The electricity is not free, because the cost of generation, T&D are considered. The main source of electricity generation is by the thermal station-a conventional or non-renewable energy source, which is not free. Power distribution, transmission, and generating make up the three building components within the power system. The allowable voltage, standardised by IEEE, for dependable power system is intherangeof0.95puto1.05 pu. High-voltage electricity system for transmission and the consumers are connected by the distribution system. The term "DG" stands for “dispersed productions," which is also known as “district energy," "embedded productions," or "on-site productions."

Power loss at various load levels to increase the voltage of the bus system. The MFO is the proposed algorithm used for finding the optimal size and location of DGs and DGs with SCs in the bus system. The primary motivation for this technique comes from the unique diagonal oriented navigation device used by moths. Moths are the insects that belong to the species of butter flies. By using this technique, it is possible to keep an acceptable voltage profile at different buses with different power flows. Recent years have seen advancements in the search for digital computer solutions for the load flow of power systems. The challenge is determining these resources' ideal size and Settings to reduce system power loss. It issue is that to learn-The Best Spot for the DER

- Optimal DER Size
- Lowering of Power Loss
- Enhanced Voltage Profile

The primary objective of the dissertations is to ascertain the optimum position and shaped for DER installation in 33-bus and 69-bus RDS in order to achieve to minimize power losses, raise voltage, and reduce system loss expenses.

The Grasshopper Optimisation algorithms (GOA) and the Moth Flame Optimisation Algorithms (MFO) are optimisation methods employed in this dissertation. These sophisticated strategies are utilised to create results using MATLAB simulation software, and the findings and graphics demonstrate how effective they are for maximising DER in the system.

GOA (Grasshopper optimization algorithm)

It is advisable to draw inspiration from nature because it is the greatest and oldest optimizer on the planet and because "Survival" is the primary objective of all living things in nature. The organisms have been developing and adapting to various means of survival in order to do this. It is a nuisance because it harms agriculture and crops. In nature, a grasshopper is viewed as a unique being. But they band together to form a sizable horde of animals.

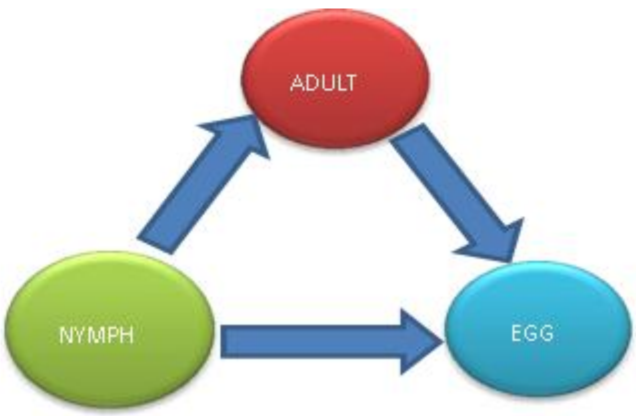


Figure 1: Grasshopper insect and stages of its life

These insects travel long distances using this method, which is a nightmare for framers since the insects consume crops and other agricultural products. The main applications of GOA in various fields such as scheduling, economic dispatch, feature selection, load frequency control, distributed generation, wind energy system, and other engineering problems. Finally, the paper provides some possible future research directions in this area.

Problem Formulations

The following is a presentation of the swarming behaviour of grasshoppers:

$$P_m = S_m + G_m + A_m \quad (1)$$

Where,

- P_m=Position of M^{th} Grasshopper.
- S_m=Social Interaction of M^{th} Grasshopper.

- G_m= Force of Gravity On M^{th} Grasshopper.
- A_m=Wind Advection

The interaction of grasshoppers with one another, the gravitational pull of gravity, and wind advection together define their location.

Equation (1) may be written as follows to represent the random behaviour:

$$P_m = c_1 S_m + c_2 G_m + c_3 A_m \quad (1.1)$$

Here C1, C2, C3 Are Random Numbers In [0, 1]

Social Interaction of Mth Grasshopper:

$$S_m = \sum_{n=1, n\neq m}^{H} s(d_{mn})\, \hat{d}_{mn} \quad (2)$$

Where,

- $d_{mn} = |x_n - x_m|$ = distance between m^{th} and n^{th} grasshopper. (2.1)
- s or $s(c)=Ae^{\frac{-c}{l}} - e^{-c}$ = Strength of social force. (2.2)
- $\hat{d}_{mn}=\frac{X_n - X_m}{d_{mn}}$ =Unit vector from m^{th} grasshopper to n^{th} grasshopper. (2.3)
- A= intensity of attraction.
- l=Attractive length scale.

Force of Gravity on Mth Grasshopper

$$G_m = -G\,\hat{e}_g \quad (3)$$

Wind Advection

$$A_m = d\,\hat{e}_w \quad (4)$$

Where,

- G = constancy of gravity.
- $\hat{e}_g$ = Equality vectors in the direction of the Earth's center.
- d = Constantly Drift
- ew = Equality vector in wind's instruction.

From equation (1) i.e., $P_m=S_m+G_m+A_m$, and (3), (4) we get :

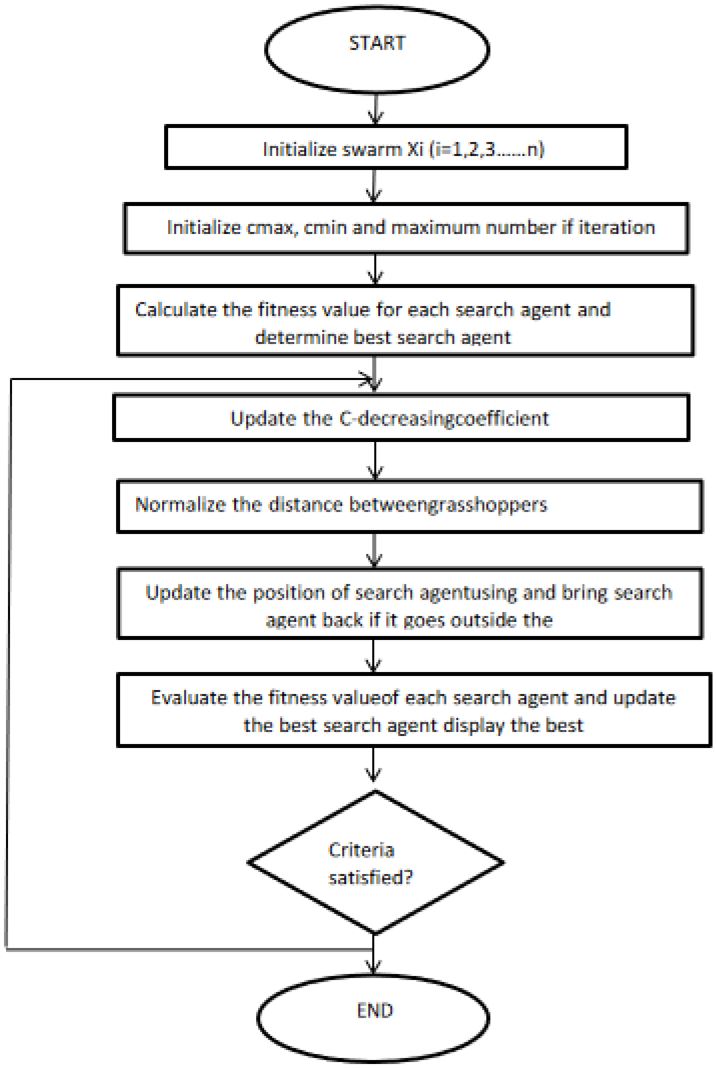
$$P_m = \sum_{n=1, n\neq m}^{H} s(d_{mn})\,\hat{d}_{mn} - G\,\hat{e}_g + d\,\hat{e}_w \quad (5)$$

Because they lack wings, the motions of nymph grasshoppers are significantly connected with wind direction. Therefore, use equation (2.1), (2.2) and (2.3) in (5) we get.

$$P_m = \sum_{\substack{n=1 \\ n\neq m}}^{H} s(|Xn - Xm|)\frac{Xn-Xm}{dmn} - G\hat{e}^{g} + d\hat{e}_{w} \qquad (6)$$

Depicts how grasshopper activity in 2-D and 3-D space may be understood using equation(6)

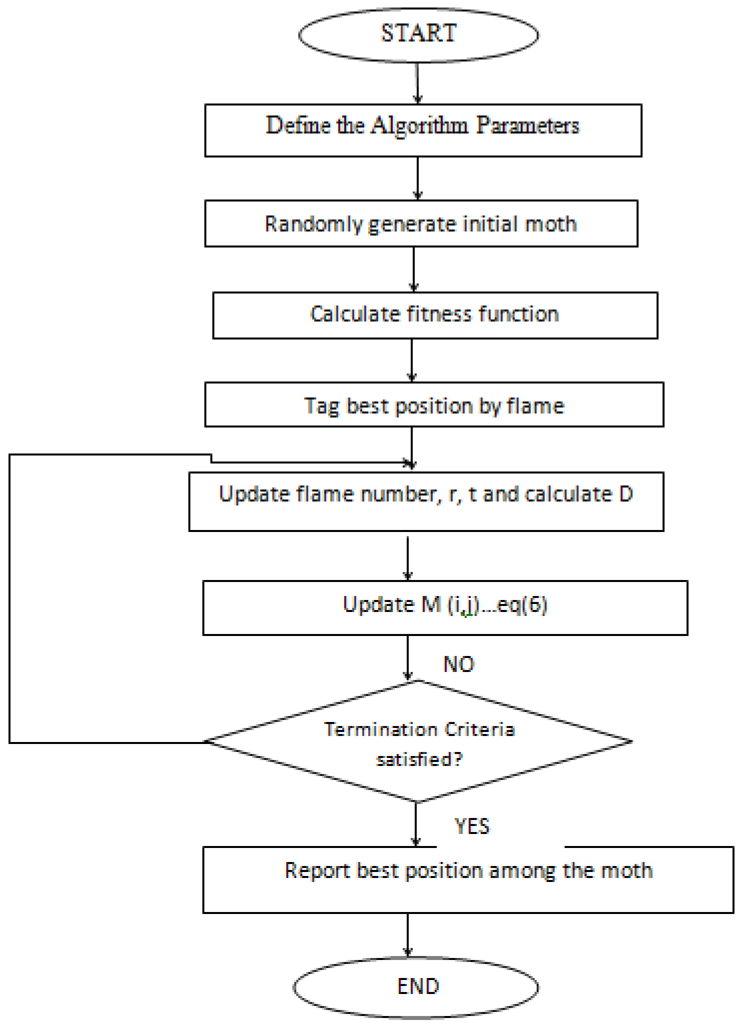
GOA (Grasshopper Optimization Algorithm)



Grass hopper Optimization is a Meta heuristic algorithm that works on the swarming behavior of grasshoppers. It is an insect with long hind legs .These insects have special social interaction which equip them with the predatory strategy. The social interaction have the two type of forces attractive forces that exploit local search and reputation force to explore search space. This algorithm is run for 200 iterations for finding the results for different load level .

MFO (Moth Flame Optimization Algorithm)

The navigation method of moths is the main inspiration of this optimizer. Moths have a very effective mechanism of flying at night and traveling in a straight line by maintaining a fixed angle with respect to the moon. The below flow chart Figure 2: of MFO will explain the mechanism of this algorithm.



The location and size of these resources are provided in this section using the MFO technique. The application was created using MATLAB R2011b (7.13). In addition, this application has a variety of optional features in addition to its main function. Given that our MFO approach makes use of a GUI (Graphical User Interface), providing input parameters for our problem is straightforward. The algorithm has undergone 150 iterations. The parameters are used as input for the textboxes in the MFO-toolbox. System for testing buses: The system for testing buses is defined by a matrix. The many bus types in the system, together with their voltage magnitude and angle, are listed in this matrix. The test system includes the generation, resistance, reactance (pu), active and reactive load, and active and reactive loads of these buses.

Equation 6 is the representation of moth in matrix form.

Equation 6 is the representation of moth in matrix form

$$M=\begin{bmatrix} m1,2 & \cdots & m1,d \\ \vdots & \ddots & \vdots \\ mn,2 & \cdots & mn,d \end{bmatrix} \quad (6)$$

$$F=\begin{bmatrix} F1,2 & \cdots & F1,d \\ \vdots & \ddots & \vdots \\ Fn,1 & \cdots & Fn,d \end{bmatrix} \quad (7)$$

Flame matrix similar to moth matrix.

$$S(M_I, F_J)= D_J \cdot e^{bt} \cdot \cos(2\pi t)+ F_j \quad (8)$$

Di- distance of the i-th moth for the j-th flame,

b- constant for defining the shape of the logarithmic spiral

t -random number in [-1,1].

$$D_i = |Fj - Mi| \quad (9)$$

n-number of moths

d - number of variables (dimension).

Mi - i-th moth,Fj - j-th flame, and Di- distance of the ith moth for the j-th flame.

The above results are shown in the figure:

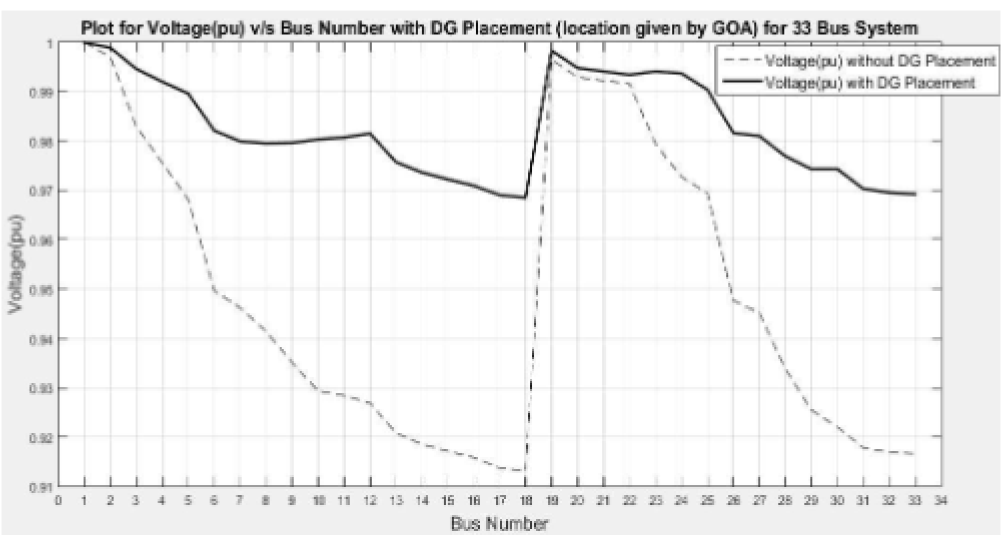


Figure 3: Voltage (pu) on each of the 33 RDS bus system

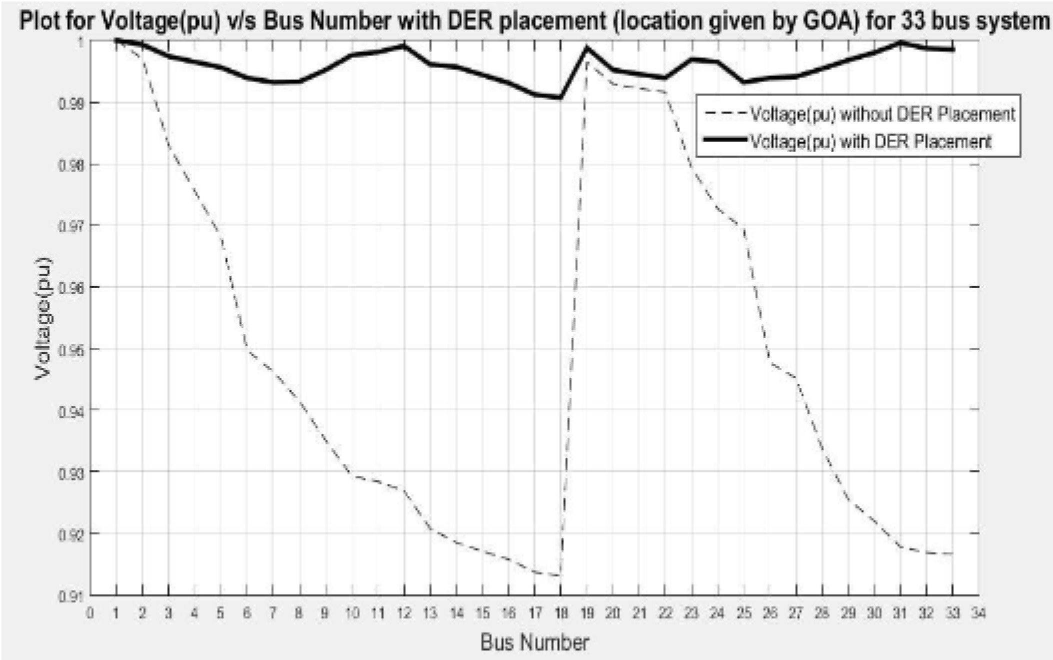


Figure 4: Voltage (pu) on every 33-bus RDS bus system

Conclusion

In this paper present modelling of annual liquidity depletion in power spread and voltage improvement at particular bus on placed. a device that can control voltage at the required bus and improves the voltage profile of the system. increase transmission capacity of the system, increased damping of minor disturbances, power oscillation damping and enables better use of equipment such as transformers and cables, reduced voltage fluctuations and decreased harmonic distortion of the system. This paper presents the optimization techniques to get the optimal locations and sizes of DG and DER for benchmark 69 test bus systems shown in Figure 3. The techniques used are GOA and MFO. The MFO Techniques shows the better result for DG and DER placement over GOA. The best location analyzed by MFO for DGs placement is at 61, 11, 18 bus number that reduces losses from 0.2200MW to 0.0695MW at normal load condition with DG penetration 59.48%-calculated for peak load condition. For DER placement, DGs at bus number 69,61,22 with Shunt Capacitors location at bus number 61,49,12.In this case the losses reduces from 0.2200MW to 0.0054MW at normal load condition with DER penetration 72.27% - calculated for peak load condition. The above graphs and Tables-3 shows that the location analyzed by proposed MFO techniques greatly minimizes the losses, further the annual energy losses(AEL) from 2265.45 MWh, at base case to 674.22 MWh for DGs and 2265.45 MWh, at base case to 52.004 MWh for DERs placement which further reduces the Cost (USD) as well as boost up the voltage of the 69 bus system, that justifies their placement in the power system.

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