ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 2, Issue 11, November 2015

Power Loss Reduction in Distribution Systems Using Autonomous Group Particle Swarm Optimization (AGPSO) Algorithm

Ch.Silpa[1], V. Usha Reddy[2]

M.Tech Student [PS], Department of EEE, S.V. University College of engineering, Tirupati, India [1]

Assistant Professor, Department of EEE, S.V. University College of engineering, Tirupati, India[2]

Abstract: In the stream of study of power systems, the radial distribution system is considered to be one of the most popular types of distribution systems. Loss minimization, maintenance of good voltage profile is the main objectives of radial distribution system. Autonomous Group Particle Swarm Optimization (AGPSO) is recently employed to achieve the above mentioned objectives. In this algorithm reconfiguration and DG placement were studied, while implementing on a 33-bus radial distribution system at three different load levels and the results were tested. Earlier, Harmony Search Algorithm was employed to achieve the above mentioned objectives, but AGPSO gives better results in comparison. The test results prove that AGPSO algorithm is more efficient, therefore suitable for loss minimization and maintenance of good voltage profile

Keywords: Distributed generation, Distribution system, real power loss, Harmony Search Algorithm, Autonomous Group Particle Swarm Optimization, Reconfiguration.

I. INTRODUCTION

Power plays a key role in day to day life of human being. Power loss is inevitable in any power system. But power loss in power systems is not an encouraging matter especially in distribution systems, as distribution system is nearer to the consumer. To reduce power loss reconfiguration of network was introduced and for backup purpose distributed generators were placed, where the fluctuations of power occurred mostly. By changing the status of sectionalized and tie switches, the topological structure of feeders is altered, thus achieving changeable network configuration. By the aid of reconfiguration real power loss reduce a lot, but due to the presence of dynamic and non linear loads in the power system, the total load is more than generation. So, by applying only reconfiguration, voltage profile can not be improved to required level. To meet the required load demand DG units are installed in the network, thus improving voltage profile. In general, capacities of DG units are from 5kW to 10MW and these are installed nearer to the consumer. It is a complex combinatorial problem to select the size and location of a DG. Economic limits and stability limits should be considered for perfect placement of DG. To simultaneously work with reconfiguration along with DG placement in power system AGPSO is employed. This algorithm solves the problem of slow convergence rate in high dimensional problems.

II. OBJECTIVE FUNCTION

The objective function is to reduce power loss and improve voltage profile in radial distribution systems. Radial distribution system contains single feeder, where along the feeder several loads are tapped from starting to the ending point. The voltage at the far end is less compared to the voltage at nearer end of the supply; this is due to power loss in the feeder line. So it is necessary to reduce the power loss in the radial distribution system. For this purpose DG units are installed at the far end. With only DG placement the better voltage profile could not be obtained. To overcome this drawback network modifications are preferred, this process is called Network reconfiguration. Network reconfiguration is obtained by applying optimal switching combinations to reduce the apparent power loss in the distribution system. Using both reconfiguration and DG placement simultaneously the power loss distribution system is reduced through AGPSO algorithm.

The objective function (power loss reduction) is formulated as given below

$$\text{Maximize } f = \max(\Delta P^{R}_{loss} + \Delta P^{DG}_{loss})$$
$$\text{Subjected to } V_{min} \le |V_k| \le V_{max}$$

Where

V_{min} = Minimum Voltage

V_k =Voltage at K^{th} bus

V_{max} =Maximum Voltage

ΔP^{R}_{loss} =Net power loss reduction through reconfiguration

ΔP^{DG}_{loss} = Net power loss reduction through DG placement

III. PROPOSED METHOD

1. AGPSO ALGORITHM

AGPSO (Autonomous Group Particle Swarm Optimization), which is an improvised form of PSO (Particle Swarm Optimization), was proposed. Trapping in local minima and slow convergence rate are two avoidable problems, which are common for all types of evolutional algorithms, these two problems deteriorate with increase in problem dimensionality.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
Vol. 2, Issue 11, November 2015

For sustenance in a natural colony, it is observed that the individuals (despite being quite dissimilar) pool their diverse intelligence and ability to perform duties. This phenomenon is mainly observed in natural scenario such as bird flocking and insect swarming where different birds and insects have their individual duties but form a colony.

Considering this as an inspiration, the solution for the problem of slow convergence and trapping in local minima was obtained from AGPSO. In AGPSO algorithm it is found that, an autonomous group of particles which have diverse slopes, curvatures and interception points, which are employed to tune social, cognitive parameters to form an autonomous group, termed as AGPSO.

Create and initialize a D-dimensional PSO
Divide particle randomly into autonomous groups
Repeat
Calculate particles fitness, Gbest and Pbest
For each particle:
Extract the particle's group
Use its group strategy to update C1 and C2
Use C1 and C2 to update velocities (1)
Use new velocities to define new positions (2)
End for
Untill stopping condition is satisfied

Algorithm: Pseudo-code for AGPSO Algorithm

2. MATHEMATICAL MODEL OF AGPSO

Finding the global minimum is a common, challenging task among all minimization methods. In population-based optimization methods, the global minimum can be divided into two basic phases. In the early stages of the optimization, the individuals should be encouraged to scatter throughout the entire search space. In other words, they should try to explore the whole search space instead of clustering around local minima. In the latter stages, the individuals have to exploit information gathered to converge on the global minimum.
Considering these points, the autonomous groups concept was proposed as a modification of the conventional PSO. In this method, four groups are determined based on termite colonies which have their own patterns to search the trouble locally and globally. The dynamic coefficients of AGPSO algorithm are presented below.

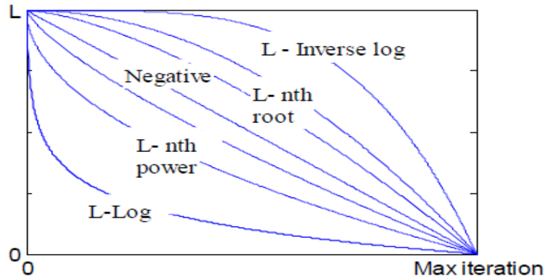
Group 1
C1G1=(-2.05/Max_iteration)*l+2.55
C2G1=(1/Max_iteration)*l+1.25

Group 2
C1G2=(-2.05/Max_iteration)*l+2.55
C2G2=(2*(l^3)/(Max_iteration^3))+0.5

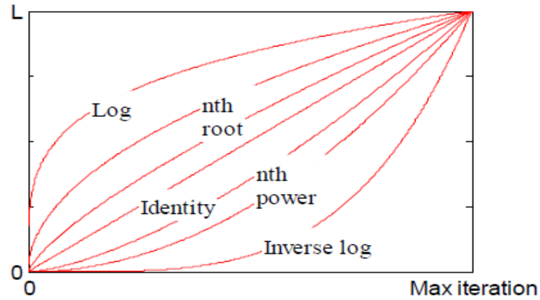
Group 3
C1G3=(-*(l^3)/(Max_iteration^3))+2.5
C2G3=(1/Max_iteration)*l+1.25

Group 4
C1G4=(-2*(l^3)/(Max_iteration^3))+2.5
C2G4=(2*(l^3)/(Max_iteration^3))+0.5

In AGPSO, each group of particles autonomously tries to search the problem space with its own strategy, based on tuning C1G(x) and C2G(x) , (x ranges from 1to 4).With fine-adjusting of the dynamic parameters , global minimum with fast convergence speed was obtained.
Updating strategies of autonomous groups could be implemented with any continuous function whose range is in the interval [0,L].Figure below represents some of the functions that can be used for updating cognitive and social factors. These functions consist of ascending or descending linear and polynomial, as well as exponential and logarithmic functions.



Curve (1)



Curve (2)

The above mentioned curves can be used for updating dynamic coefficients respectively. It is clear that particles tend to have higher local search ability when C1G(x) is greater than C1G(x).. In contrast, particles search the search space more globally when C2G(x) is greater than C1G(x).

3. ALGORITHM STEPS

Step1:- INTIALIZATION OF PARAMETER VALUES AND OBJECTIVE FUNCTION
In general optimization problem is specified as follows
Minimize f(x)
Subjected to x€ X_i i=1, 2, 3,……………..N
N=Number of decision variables
Where f(x) be the objective function, here the objective function is power loss and is to be minimized. x is the set of decision variables and X_i be the possible range of values for each decision variable. In this step, we initialise random switches, number of generations, population size, number of tie switches, maximum and minimum inertia weights (W_{max}, W_{min}), and Acceleration constants C1and C2.

Step 2:-MATRIX FORMATION
The iteration is started such that a matrix is formed of pXn size, where p is population size and n is number of tie switches. For each row load flow is calculated to obtain

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
Vol. 2, Issue 11, November 2015

power loss, stored in fitness. If it is the first iteration go to Step4 otherwise Step3.

Step 3:-REPLACEMENT OF SWITCHES
Here the new power loss values are compared with previous value, if new values are better than previous value, we consider new values, if not the new values are discarded.

Step 4:-UPDATING OF SWITCHES
In this step switches are being updated. For this we calculate new inertia weight by the equation stated below

$W = (W_{max})* ((W_{max} - W_{min})$/number of generations)

Selection of group is done (between 0 to N) through switch command usage.
Group updation is done as given below
Considering x=0 to N
Where N=number of groups (3)

```
Switch mod(i,4)
        case(0)
    update(i,j)=W*v(i,j)+C1G1*rand()*(Pbest(i,j)-X(i,j))+C2G1*rand()*(Gbest(j)-X(i,j));
        case(1)
    update(i,j)=W*v(i,j)+C1G2*rand()*(Pbest(i,j)-X(i,j))+C2G2*rand()*(Gbest(j)-X(i,j));
        case(2)
    update(i,j)=W*v(i,j)+C1G3*rand()*(Pbest(i,j)-X(i,j))+C2G3*rand()*(Gbest(j)-X(i,j));
        case(3)
    update(i,j)=W*v(i,j)+C1G4*rand()*(Pbest(i,j)-X(i,j))+C2G4*rand()*(Gbest(j)-X(i,j));
end
```

Now the new switches are updated in the matrix, go to Step5 for the checking of termination condition

Step 5:- TERMINATION CHECK UP
The above process is repeated until the termination criteria are obtained. Else we go to step 2

4. TEST RESULTS

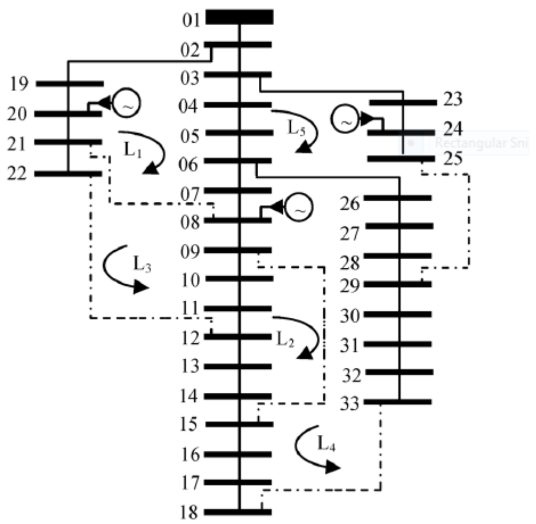


Fig 1.33-bus radial system with tie switches and DG's installed

The parameters considered for HS algorithm are HMS=20, HMCR=0.85, PAR=0.3, number of iterations (N max)=20and number of runs(n)=9.

TABLE I Results of 33 bus system for HSA

scenario		load level		
		light(0.5)	nominal(1)	heavy(1.5)
HSA	Switches opened	7,14,11, 32,27	7,14,10, 28,32	7,14,10, 28,32
	DG in MW(bus number)	0.1954(32) 0.4195(31) 0.2749(33)	0.5258(32) 0.5586(31) 0.5840(33)	0.5724(32) 1.2548(31) 0.9257(33)
	Power loss	17.78	73.05	194.22
	Min voltage (p.u)	0.9859	0.97	0.9516

Test results were obtained from a 33 bus system with five tie switches, numbered as 33,34, 35,36, 37 and 32 sectionalizing switches, these switches were numbered from 1 to 32. The line data and bus data are taken from[4],the total real power loss on the system is 3715kW and the reactive power is 2300kVAR.Parameters considered for test system are given as
W_{max} =0.9, W_{min} =0.4, C1=C2=2

TABLE II Results of 33 bus system for AGPSO

scenario		load level		
		light(0.5)	nominal(1)	heavy(1.5)
AGPSO	Switches opened	6,13,27, 32,35	7,9,14, 31,37	7,10,13, 27,32
	DG in MW(bus number)	0.2340(31) 0.8790(32) 0.1000(33)	0.1000(31) 0.0090(32) 0.1200(33)	1.0548(31) 0.789(32) 0.9997(33)
	Power loss (kW)	13.403	65.890	192.2419

From TABLE II it is found that power loss using AGPSO algorithm is less when compared to HS algorithm. From HSA to AGPSO power loss for light load was improved from 17.78 to 13.403 and for nominal load the power loss was improved from 73.05 to 65.890, similarly for heavy load it is increased from 194.22 to 192.214.

5. VOLTEGE PROFILE

The rapid changes in voltage levels were found at light, nominal and heavy loads respectively, the voltage profile are plotted in the graphs below

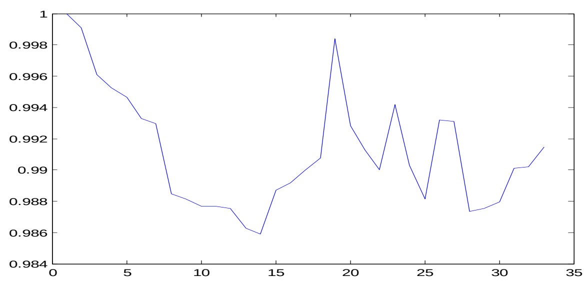


Fig (1)

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 2, Issue 11, November 2015

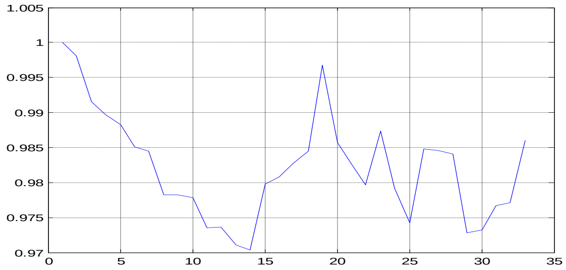


Fig (2)

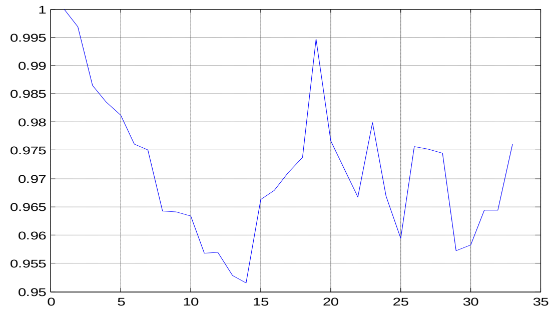


Fig (3)

X axis:-Node number, Y axis:-Voltage Profile

Fig2. Voltage profile of 33 bus system at light, nominal and heavy are given in fig 1, 2 and 3 for HSA

The voltage profiles at all three load levels were almost same for all cases except for the minor change in voltage magnitude

The improvement in voltage profile is necessary; this is because changes in voltages affect the consumers a lot than the changes in the current

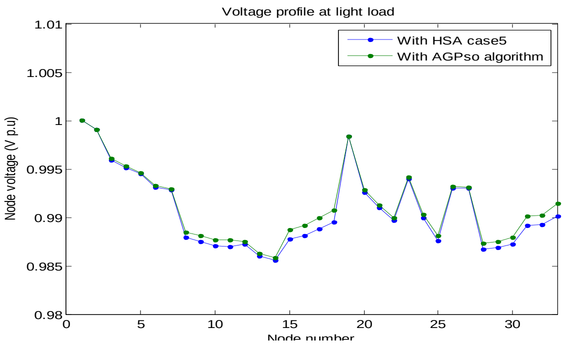


Fig (4)

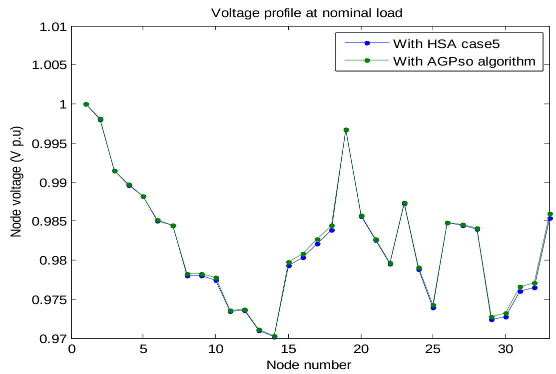


Fig (5)

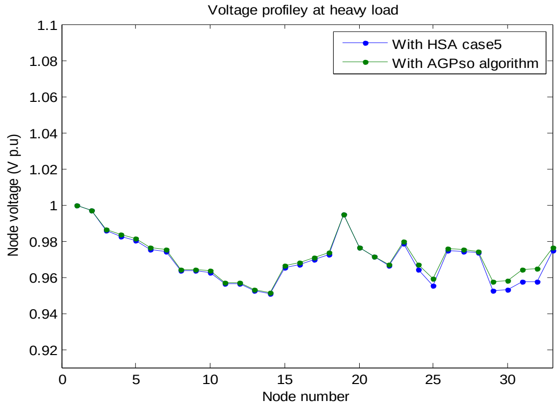


Fig (6)

Fig3. Voltage profile of 33 bus system at light, nominal and heavy are given in fig 4, 5 and 6 for AGPSO

Even during fault conditions change in voltage is not acceptable when compared to change in current, since it is too dangerous for the system to tolerate the fault voltages.

From figure 3 it is found that the voltage profiles were better for AGPSO algorithm under light, nominal and heavy loads. When compared to HSA, power loss reduced a lot and voltage profile is also improved for AGPSO algorithm. So AGPSO (modified form of Particle Swarm Optimization) is more efficient when compared to HSA

IV. CONCLUSION

In this paper AGPSO algorithm is used for the reduction of real power losses in radial distribution system, under the presence of DG along with network reconfiguration (for a 33 bus system). AGPSO is preferred, as it avoids trapping in local minima and has fast rate of convergence when compared to HSA. The comparison results prove that, in a distribution system, by using AGPSO we get better voltage profile with higher efficiency.

REFERENCES

[1] D. Das, "A fuzzy multi-objective approach for network reconfiguration of distribution systems," IEEE Trans. Power Del., vol. 21, no. 1, pp.202–209, Jan. 2006.

[2] K. Nara, A. Shiose, M. Kitagawoa, and T. Ishihara, "Implementation of genetic algorithm for distribution systems loss minimum reconfiguration," IEEE Tra ns. Power Syst., vol. 7, no. 3, pp. 1044–1051, Aug.1992.

[3] J. Z. Zhu, "Optimal reconfiguration of electrical distribution network using the refined genetic algorithm," Elect. Power Syst. Res., vol. 62,pp. 37–42, 2002

[4] R. Srinivasa Rao, S. V. L. Narasimham, M. R. Raju, and A. SrinivasaRao, "Optimal network reconfiguration of large-scale distribution system using harmony search algorithm," IEEE Trans. Power Syst.,vol. 26, no. 3, pp. 1080–1088, Aug. 2011.

[5] W. Rosehart and E. Nowicki, "Optimal placement of distributed generation, "in Proc. 14th Power Systems Computation Conf., Sevillla, 2002,pp. 1–5, Section 11, paper 2.

[6] G. Celli, E. Ghiani, S. Mocci, and F. Pilo, "A multi-objective evolutionary algorithm for the sizing and the sitting of distributed generation,"IEEE Trans. Power Syst., vol. 20, no. 2, pp. 750–757, May 2005.

[7] C. Wang and M. H. Nehrir,"Analytical approaches for optimal placementof distributed generation sources in power systems,"IEEE Trans.Power Syst., vol. 19, no. 4, pp. 2068–2076, Nov. 2004.

 DOI 10.17148/IARJSET.2015.21126

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 2, Issue 11, November 2015

[8] P. Agalgaonkar, S. V. Kulkarni, S. A. Khaparde, and S. A. Soman,"Placement and penetration of distributed generation under standardmarket design," Int. J. Emerg. Elect. Power Syst., vol. 1, no. 1, p. 2004.
[9] Z. W. Geem,"Novel derivative of harmony search algorithm for discretedesign variables," Appl. Math. Computat., vol. 199, no. 1, pp.223–230, 2008.
[10] S. Ghosh and K. S. Sherpa, "An efficient method for load-flow solutionof radial distribution networks," Int. J. Elect. Power Energy Syst. Eng.vol. 1, no. 2, pp. 108–115, 2008.
[11] K. Prakash and M. Sydulu, "Particle swarm optimization based capacitorplacement on radial distribution systems," in Proc. IEEE PowerEngineering Society General Meeting, 2007, pp. 1–5.
[12] Z. W. Geem, J. H. Kim, and G. V. Loganathan, "A new heuristic optimizationalgorithm: Harmony search," Simulation, vol. 76, no. 2, pp.
[13] R. C. Eberhart and J. Kennedy, "A new optimizer using particles swarm theory," in Sixth Int. Symp. on Micro Machine and Human Science, Nagoya, Japan, 1995, pp. 39–43.
[14] M. Mathiyalagan, U. Dhepthie, and S. Sivanandam, "Grid Scheduling Using Enhanced PSO Algorithm," vol. 2, pp. 140-145, 2010.
[15] E. Masehian and D. Sedighizadeh, "A multi-objective PSO-based algorithm for robot path planning," in IEEE International Conference on Industrial Technology Vi a del Mar, 2010, pp. 465 - 470
[16] M. Fayk, H. El Nemr, and M. Moussa, "Particle swarm optimisation based video abstraction," Journal of Advanced Research, vol. 1, pp. 163-167, 2010.