www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 3 Issue 6 June, 2014 Page No. 6555-6560

Analysis of Load Flow Study Using Pso And Compensate The System Using Facts Device

Sushil Kumar[1] Seraj Ahmad[2] Aziz Ahmad[3]

Department of Electrical Engg. AFSET, Faridabad (HR)-121006

Sushil.aggarwal562@gmail.com

s Department of Electrical Engg. GNIT, Greater Noida(UP)

Serajahmad786@gmail.com

Assistant Professor & HOD

Department of EEE ,AFSET Dhaunj,Faridabad (HR)-1210006

Hodeee4@gmail.com

***Abstract*—Load flow study is one of the important part of power system network because all the power flow parameters we can find out by this study .There are many methods to solve the load flow problems but accuracy and speed are the main problems in all techniques. By using the PSO we can find the better accuracy and speed then another method. By using PSO techniques we find the optimal location in the system at which we can set the reactive power compensating device .The paper conclude analysis of a load flow system bus network and find out the optimal location at which voltage deviation is minimum and use the power electronics device and compensate the reactive power as per requirements.**

***Keywords*— Load flow analysis, Particle swarm optimization ,STATCOM**

1.INTRODUCTION

Power flow analysis is the backbone of power system analysis and design. Power flow study is the one of the most frequently study performed by power utilities at almost all stages of power system planning ,optimization ,operation and control. They are necessary for planning, operation, economic scheduling and exchange of power between utilities. Power flow analysis is required for many other analyses such as transient stability, optimal power flow and contingency studies. The principal information of power flow analysis is to find the magnitude and phase angle of voltage at each bus and the real and reactive power flowing in each transmission lines.

There are some of conventional method i.e. gauss seidal method , newton raphson method for analysis the load flow study but due to continues growth and complexity of power system network soft computing techniques are better then conventional method in which the speed of operation and accuracy are the main advantages. With the advent of artificial intelligence in last recent years. Neural network , fuzzy logic and decision tree like methodology have been applied to the power system problems. Among all the soft computing techniques have shown great promises in power system engineering due to their ability to synthesize the complex mapping ,accurately and rapidly. The computational intelligence algorithms have drawn researcher's attention to the area of artificial intelligence as they have became more interested in focusing into the application of these algorithms in Electrical Engineering themes. Among these techniques, Particle Swarm Optimization (PSO) is highlighted .PSO based on the behavior of the animals living in groups and having some ability to interact with one other and with the environment in which they are inserted . PSO is a Swarm Intelligence algorithm employed to functions optimization, developed through the simulation of simplified social models.

PSO algorithms are used in functions optimization and are currently applied in several themes related to electrical power systems, such as: Optimal Power Flow Power System Restoration and Voltage and Reactive Power Control. PSO algorithms can provide accurate convergence properties associated to simple implementation and reduced computational time .Particle Swarm consist of many particles, where each particle keeps track if its position, velocity, best position, best fitness, current fitness and neighboring particles. The particle's best neighbor and global best particle are used to guide the particle new solutions. At the end the global best particle's position serves as the answer.

PSO algorithm are used in function optimization and are currently applied in several themes related to electrical power system like optimal power flow ,power system restoration and load flow study etc.

In this paper ,authors used the PSO techniques for analysis the load flow study ,find the optimal location and used the STATCOM for compensate the reactive power.

2. FLAXIBLE AC TRANSMISSION

Flexible transmission system is akin to high voltage dc and related thyristors developed designed to overcome the limitations of the present mechanically controlled ac power transmission system. Use of high speed power electronics controllers, gives 5 opportunities for increased efficiency.

- Greater control of power so that it flows in the prescribed transmission routes.
- Secure loading (but not overloading) of transmission lines to levels nearer their required limits.
- Greater ability to transfer power between controlled areas, so that the generator reserve margin- typically 18 % may be reduced to 15 % or less.
- Prevention of cascading outages by limiting the effects of faults and equipment failure.
- Damping of power system oscillations, which could damage equipment and or limit usable transmission capacity

2.1 STATCOM :-

The STATCOM (Static synchronous Compensator) is a shunt connected reactive compensation equipment which is capable of generating and absorbing reactive power that its output can be varied so as to maintain control of specific parameters of electric power system. STATCOM is normally consisting of voltage source inverter with dc-link capacitor. It is normally interfaced to a system through a transformer. The transformer serves the purpose of stepping up the STATCOM voltage and also its leakage reactance helps prevent short circuit of the dc-link capacitor. Hence when using multilevel STATCOM where by the STATCOM voltage could be built from a number of dc-link to that of the system voltage, interface reactor is required to serve as the transformer leakage reactance. Basically STATCOM can be modeled as a synchronous generator that absorbs/injects reactive power but does not generate any real power rather absorbed real power to cater for its internal and interface losses. Z STATCOM represents the impedance of the STATCOM. The imaginary part represents the transformer leakage reactance/interface reactor and the real part forms the ohmic losses of the STATCOM.

Assuming multilevel Inverter STATCOM, in this model, the ohmic resistance is excluded from the admittance matrix. This is due to the fact that, various switching techniques can be employed. Main switching techniques are PWM and fundamental frequency switching (FFS) where the switching losses are different. The real power losses of the STATCOM are computed before the load flow depending on the reactive power specified at the STATCOM bus. The bus introduced four parameters, the same number as the system buses.

The bus the STATCOM is connected to remains a load bus and so is the STATCOM bus. In the lagging power factor, the sign of the STATCOM reactive power is the same as that of the load but opposite in leading power factor .

3. LOAD FLOW REVIEW

In the power system analysis there are many methods to solve the load flow problems i.e. Gauss Seidal Method , Newton raphson method , Decoupled Method ,Fast decoupled method etc.

3.1 GUASS SEIDAL METHOD :-

The Gauss-Seidel iteration is an important method to solve the load Flow problems even today.The Gauss-Seidel iteration was the starting point for the successive over-relaxation methods which dominated much of the literature on iterative methods for a big part of the second half of this century. The methods were initiated in the 19th century, originally by Gauss in the mid 1820s and then later by Seidel in 1874. This method as it was developed in the 19th century was a relaxation technique. In this methods we have given the real and reactive power of pv bus

The general description of the Gauss-Seidel method is as follows:

1. It is a iterative method Before solving the bus voltage, we should assign the initial value $V(0)$ to unknown values;
2. Solve a new value to each bus voltage from the real and reactive Power specified;
3. A new set of values for the voltage at each bus is used to calculate another bus voltage at the next iteration;
4. The process is repeated until voltage differences at each bus are less than the tolerance value.

Formulas for manually determine the value of bus voltage, δ and reactive power.

For determine the value of bus voltage e.g. we taking Bus no. 2 for determine the bus voltage ,following formula implemented –

$$V_2 = \frac{1}{Y_{22}}\left[\frac{(P_2 - jQ_2)}{V_2^*} - (Y_{11})(V_1) - (Y_{23})(V_3) - (Y_{2n})(Vn)\right]$$

The iteration will continue till the value of consecutive two iteration are same. For determine the value of next bus i.e. Bus No.3 the value of V2 is considered the latest value of last iteration.

For finding the value of angle **δ** the value of bus voltage convert in polar form and the value of angle is δ of the respective bus.

For determine the value of reactive power of PV buses the formula is…i.e. we are taking bus no. 2 for determine the value of reactive power.

$$Q_2 = -[V_2]spec.[Y_{21}(V_1)SIN(\delta_1+Y_{12}-\delta_2)] + [Y_{22}(V_{2l})SIN(\delta_2+Y_{22}-\delta_2)] + \ldots \ldots [Y_{2n}(V_2)SIN(\delta n+Y_{22}-\delta_2)]$$

3.2 Newton Raphson Method

Newton Raphson method is one of another useful method for study the load flow problem.

The Newton-Raphson method is an iterative technique for solving systems of simultaneous equations in the general form:

$f_1(\varkappa_1,\ldots\ldots\varkappa_n,\ldots\ldots\varkappa_r) = K_1$

$f_j(\varkappa_1,\ldots\ldots\varkappa_n,\ldots\ldots\varkappa_r) = K_n$

$f_n(\varkappa_1,\ldots\ldots\varkappa_n,\ldots\ldots\varkappa_r) = K_r$

where $f_1,\ldots f_n \ldots f_r$ are differentiable functions of the variables $\varkappa_1,\ldots\varkappa_n,\ldots\varkappa_r$ and $K_1,\ldots K_n..K_r$ are constants.

Applied to the load flow problem, the variables are the nodal voltage magnitudes and phase angles, the functions are the relationships between power, reactive power and node voltages, while the constants are the specified values of power and reactive power at the generator and load nodes.

In this method only 5 iterations are needed to generate results which are stable to three decimal places, even though the initial estimates of all three unknowns are far from the correct value.

When making comparisons with other methods of solution, it is important to realize that each iterative cycle of the Newton Raphson method involves considerable computational effort, notably to invert the Jacobian.

3.3 Artificial Neural Network Based load Flow :-

This method is based on a three-layered neural network. The inputs of the neural network are active and reactive power of loads and PQ DG units, voltage magnitude of PV DG units and their active power injected. The outputs of the third layer are the magnitude and angle of PQ nodes voltages, reactive power and voltage angle of PV DG units and power loss of the distribution network. For example, a modified NR load flow is run for several times to give various input-output patterns. Then the neural network is trained by back propagation method. As a result, the trained neural network can model the nonlinear load flow system and obtain the results of load flow for other different inputs.

The advantage of ANNB load flow is its less computation time cost for online problems. On the other hand, ANNB method is more flexible.

Experimental tests show that capability of ANNB load flow allows it to produce a correct output even when it is given an input vector that is partially incomplete or partially incorrect .

It is suitable for online modern distribution network management as a challenge in smart grid. However, if the injected power by DG units changes in a wide range, ANNB is not useful. So it may not be helpful in renewable DG integrated networks.

Moreover, selecting of initial patterns to train the neural network is a challenge in this method. Using chaotic neurons controlled by heuristic methods in ANN can improve the disadvantages of ANNB load flow.

3.4 Particle Swarm Optimaization Applied to the Power Flow Computation :-

There are many evolutionary technique in which by which we can find the optimal location of STATCOM such as generic algorithm (GA) evolutionary programming Particle swarm optimization (PSO). Particle swarm optimization (PSO) is a population based stochastic optimization technique developed by Dr.Eberhart, Dr.Kennedy and Dr.shi in 1995, inspired by social behavior of bird flocking or fish schooling. Particle swarm adaptation is an optimization paradigm that simulates the ability of human societies to process knowledge. The PSO is a is an efficient global optimizer for continuous variable problems The algorithm models the exploration of a problem space by a population of individuals; individuals' successes influence their searches and those of their peers. Particle swarm optimization successfully optimizes network weights, simulating the adaptive sharing of representations among social collaborators. Particle swarm optimization has roots in two main component methodologies. Perhaps more obvious are its ties to artificial life (A-life) in general, and to bird flocking, fish schooling, and swarming theory in particular. It is also related, however, to evolutionary computation, and has ties to both genetic algorithms and evolutionary programming.

Swarm intelligence is a kind of artificial intelligence based on the behavior of the animals living in groups and having ability to interact with one other and with the environment in which they are inserted . This techniques use a set of particles in which each one of them is a candidate to the solution of the treated problem. All these particles have a position and velocity in an n dimensional space The best individual position of a particle is defined as local best and the position of all particle is called global best . The particle's best neighbor and global best particle are used to guide the particle new solutions .At the end the global best particle's position serve as a answer. PSOB load flow is also suitable for offline problems. Basic algorithm as proposed by Kennedy and Eberhat Position of individual particles updated as follows:

x_k^i = particle position

v_k^i = particle velocity

p_k^i = Best "remembered" individual particle p

p_k^g = Best "remembered" swarm position

c_1, c_2 = Cognitive and social parameters

r_1, r_2 = Random numbers between 0 and 1

Position of individual particles updated as follows :-

$$x_{k+1}^i = x_k^i + v_{k+1}^i$$

with the velocity calculated as follows :-

$$v_{k+1}^i = v_k^i + c_1 r_1 (p_k^i - x_k^i) + c_2 r_2 (p_k^g - x_k^i)$$

3.4.1. Bus System

For our research work we have taken IEEE 57 bus sytem :-
Line data of IEEE 57 bus system is given in table -1. We use these data to calculate the YBUS of IEEE 57 test bus system which is further use in Newton-Raphson load flow analysis of IEEE 57 bus system. As we see from the standard IEEE 57 bus data the bus system has

a) 1 slack bus

b) 4 generator or PV buses

c) 52 load or PQ buses

By using the load data and bus data we calculate the voltage at each bus by Newton Raphson load flow method.

Table 1.1

BUS NO.	*VOLTAGE*
1	1.0400
2	1.0500
3	1.0450
4	1.0459
5	1.0444
6	1.0400
7	1.0532
8	1.0463
9	1.0400
10	1.0598
11	1.0555
12	1.0570
13	1.0559
14	1.0571
15	1.0564
16	1.0545
17	1.0491
18	1.0793
19	1.1002
20	1.1109
21	1.1671
22	1.1689
23	1.1697
24	1.1780
25	1.2149
26	1.1270
27	1.1143
28	1.1077
29	1.1012
30	1.2256
31	1.2349
32	1.2213
33	1.2318
34	1.1774
35	1.1744
36	1.1707
37	1.1697
38	1.1677
39	1.1693
40	1.1689
41	1.1481
42	1.1709
43	1.1153
44	1.1555
45	1.1274
46	1.1734
47	1.1716
48	1.1706
49	1.1730
50	1.1626
51	1.1447
52	1.1181
53	1.1251
54	1.1211
55	1.1143
56	1.1806
57	1.1873

3.4.2. OBJECTIVE FUNCTION

Objective function (J) is a RMS value of voltage deviation. It is given by

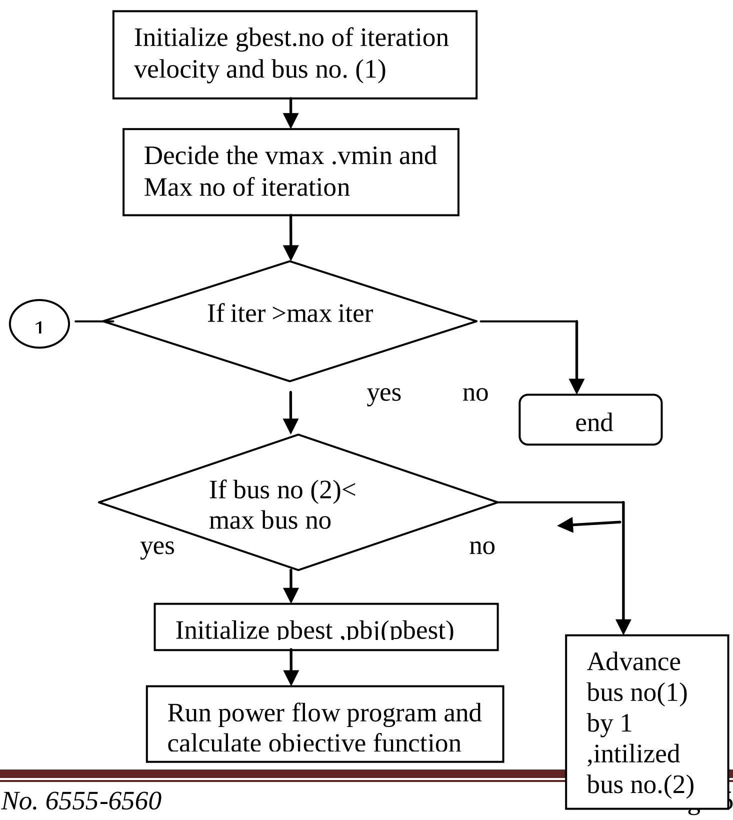
$$V_d = \sqrt{\sum_{i=1}^{N} (V_i - 1)^2}$$

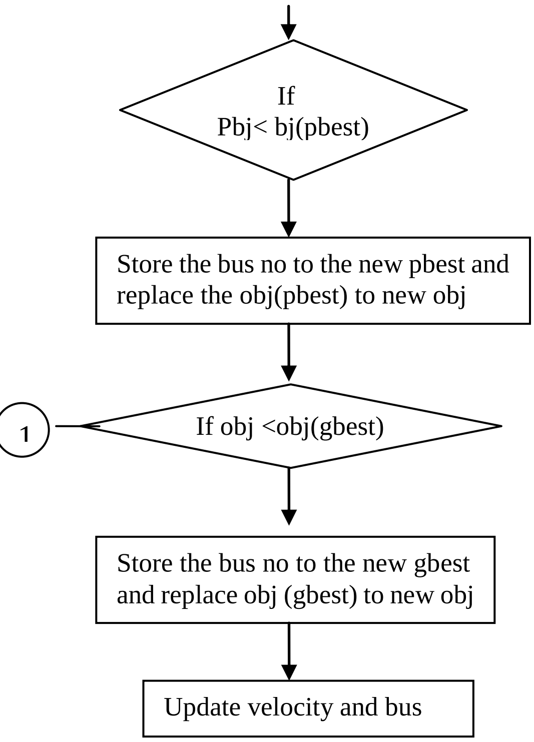
Our main objective is to minimize the objective function because less objective function means less voltage deviation and good stability. Without using STATCOM the objective function of the IEEE 57 bus is **1.0975.**

But our main objective is to minimize the voltage deviation as well as objective function and specially focus is to minimize the size of STATCOM for the point of view of cost so that with minimum cost we can compensate the system.

In the next step we also include the size of STATCOM when we calculate the objective function .

3.4.3 Algorithm of PSO





3.4.4. PSO Parameter

We take the following PSO parameter by applying hit and trail method.

Inertia weight: we can take inertia weight in three manner

a) Constant inertia weight- the inertia weight can be taken constant throughout the process but it seems somewhat unconvincing because as the particle reach near the final solution the impact of pbest and gbest should be increase to avoid to trap in local minima.

b) Linearly decreasing inertia weight –we can tan take inertia weight as linearly decreasing but it has also problem to trap in local minima.

c) Randomly decrease inertia weight- in our thesis we take inertia weight as randomly decreasing inertia weight as it has not any problem to trap in local minima.

So for our study we take inertia weight as a function which decrease randomly from .9 to .1.

It is given by following

$$W_i = 0.9-0.8* \frac{iter -1}{max\ iter-1}$$

No. of of particle: we have taken 5 particle with the random initial STACOM position.

Acceleration constant: there are two accelerations constant we use.

a) Individual acceleration constant- this acceleration constant is used for show the impact of individual particle best position gain by particle it self on the next value of velocity of that particle. It is denoted by c1. For our study we take c1=2.6

b) Social acceleration constant- the social acceleration constant is used to show the effect of best position gained by any particle(gbest) on the next value of velocity of that particle. It is denoted by c2. For our study we take c2=1.4.

No of iteration: 10 iterations is sufficient while we deal with single STATCOM and when we use 2 STATCOM we need minimum 30 iterations.

4. RESULT

4.1 By using STATCOM:-

4.1.1. Without Using PSO

Without using PSO we have to calculate the objective function while apply the STATCOM on every bus one by one and then we can choose the optimal bus location with the minimum objective function. while we use only single STATCOM it is very easy to find the optimal location of a 57 bus load flow system.

As we see that when we connected the STATCOM without using the PSO the min value of objective function is 0.9553 .we get the minimum value of objective function which is 0.9553 which is very less in comparison of other previous objective function without using STATCOM then 1.0957

4.2.2. By using PSO

When we use the particle swarm optimization techniques the min. objective value is 0.9020 and the optimal location is bus no. 15.And the no of iteration is also reduced to only 10.

5. CONCLUSION :-

The conclusion of this paper is that when we analyze the load flow study while the system is very complex i.e. 57 bus ,117 bus and further more ,the conventional method of load flow study like Guass seidal ,Newton Raphson are more complex and having a lots of computational works but if we use the PSO techniques we save a lots of time in computational techniques as well as there is less chance of errors and the analysis having more accuracy .

6.FUTURE SCOPE :-

The research can be carried out on other FACTS devices such as TCSC ,SVC etc.The PSO-based optimization frameworks can be adapted to consider unbalanced system conditions and faults . The allocation can be carried out accounting the size of STATCOM

7.ACKNOWLEDGMENT

The author gratefully acknowledges the omnipotent GOD because without the blessings of him nothing is possible in this world. After that author greatfully thanks to Mr. Aziz Ahmad, HOD and Assistant Professor in Electrical Engg Deptt ,AFSET , Farridabad , who helped develop the methods reported in this paper. Author would like to thanks Mr.Swarnjeet Singh Sidhu for Training of MATLAB.The author also thanks to our family members for free him from homework during this work.

8. REFRENCES

[1] *N.G.Hingorani* and Laszlo Gyugyi "Understanding FACTS" IEEE press ,New York

[2] Avnish Singh, Shishir Dixit & L. Srivastava, Particle Swarm Optimization- Artificial Neural Network For Power System Load Flow international Journal of Power System Operation and Energy Management, ISSN (PRINT): 2231–4407, Volume-1, Issue-2, 2011

[3] Camila Paes Salomon, A Hybrid Particle Swarm Optimization Aproach For Load-Flow Compuatation, International Journal of Innovative Computing , Information and Control ICIC International journal 2013 ISSN 1349-4198Volume **9**, Number **11**, November **2013**

[4]. Optimal Location of STATCOM Using PSO in IEEE 30 BUS SYSTEM , http://www.ijarse.com IJARSE, Vol. No.2, Issue No.5, May 2013 ISSN-2319-8354(E)

[5] J. Kennedy, "*The particle swarm: social adaptation of knowledge*," in Proc. IEEE Int. Conf. Evolutionary Computation, 1997, pp. 303-308.

9. AUTHORS

Sushil Kumar received the B.tech . (Electrical Engg.) degree from The YMCA Institute of Engg . and Technology , Faridabad (HR).He is currently pursuing the M.Tech (Power System Analysis)degree from Al Flah School of Engg and Technology , Faridabad(Hr) affiliated by MDU Rohtak ,Haryana ,India. His research interests are power system and Non conventional Energy Resources .

Seraj Ahamad received the B.Tech (Electrical Engg.) Degree from Uttar Pradesh Technical University, Lucknow, India. He is currently pursuing the M.Tech (Power System) Degree in the Department of Electrical & Electronics Engineering, AFSET, MDU Rohtak, Haryana India . His research interests are Power System , Special Electrical Machines, Switch Gear & Protection.

Prof. Aziz Ahmed received the B.Tech (Electrical Engg.) Degree from Jamia Milia Islamia, New Delhi,.and M.Tech(Control System) Degree from Delhi Technical Univesity. He is currently pursuing the Phd Degree in the Department of Electrical Engineering, from Jamia Milia Islamia, New Delhi India . He is currently working as Professor & HOD in the Department of Electrical & Electronics Engineering, AFSET Faridabad Haryana. His research interests are Facts , Power System , Special Electrical Machines, Switch Gear & Protection.