IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 6, Issue 1 (May. - Jun. 2013), PP 01-05
www.iosrjournals.org

Transmission Loss Minimization Using Optimization Technique Based On Pso

Sunil Joseph P.[1],C.DineshBalaji[2]
1. P.G.Student, Paavai Engineering College, Namakkal.
2. Assistant Professor/EEE, Paavai Engineering College, Namakkal

***Abstract**: Power is generated in generating station, transmitted through transmission line and then distributed to consumers.Power system consists of three types of buses. They are generator bus, load bus and slack bus. Each bus is characterized by four parameters. They are bus voltage, phase angle, active power and reactive power. Thesebuses are classified according to known parameters. Unknown parameters are found using load flow studies. In this paper load flow studies are done using Newton-Raphson method. Transmission line is characterized by resistance, inductance and capacitance. This will result in losses. These losses cannot be eliminated but can be reduced.Optimization is a mathematical tool to find the maximum or the minimum of a function subject to some constrains. Using lose function as objective functionsubjected togenerator MW, transformer tapping, reactive power injection and controlled voltage as constrains, optimization technique can be used to minimize transmission losses. Using this we get optimal value for bus parameters such that transmission losses are minimum. In this paper Particle Swarm Optimization (PSO) is employed to solve optimal power flow problems. IEEE 30-bus power systems are used for testing the objective of this paper.*

***Keywords:**Optimal Power Flow (OPF),Penalty factor, Newton-Raphson method,Power Loss Minimization, Particle Swarm Optimization (PSO),Gbest, Pbest*

I. Introduction

Optimization problem was introduction by Carpentier in1962 [1].Optimal power flow is a nonlinear constrainedand is used in optimization problems of power systems.Particle swarm optimal power flow is used to minimize the totalfuel cost and to serve the loaddemand for a particular power system while maintaining minimal loss and the security of the system operation. Theproduction costs of electrical power systems depend on the type of generating station. If losses are reduced generation can be reduced hence production coast can be reduced. So taking loss function as objective function optimization is done

II. Optimal Power Flow Problems

2.1 Problem Formulation

The optimal power flow problem is a nonlinear optimization problem and it consists of a nonlinear objective function subjected to nonlinear constraints.The optimal power flow problem requires the solutionof nonlinear equations, describing optimal and/or secure operation of power systems. The general optimalpower flow problem can be expressed as

Minimize $f(x)$
Subjected to $g(x) = 0$, equality constrain
$h(x) \leq 0$, inequality constrain

By converting both equality and inequality constraints into penalty terms and therefore added toform the penalty function as described in (1) and (2)

$p(x)=f(x)+\alpha(x)$ (1)
$\alpha(x)\rho\{g(x)^2+[max(0,h(x))]^2\}$(2)
where:
$p(x)$ is the penalty function
$\alpha(x)$is the penalty term$\pi\lambda$
$\rho$is the penalty factor

By using a concept of the penalty method [13], theconstrained optimization problem is transformed intoan unconstrained optimization problem.

2.2 Objective Function

In this paper, fuel cost with transmission lossfunction formsthe objective function as below.

Fitness-function$\sum_{i=1}^{n} F_{gi} + \left(\lambda_1 * \left(\sum_{i=j=1}^{n} P_{gi} B_{ij} P_{gj}\right)\right) + (\lambda_2 * (P_g - P_D - P_{loss}))$(3)

Where:

P_{loss}={$\sum_{i=1}^{N_L} g_{i,j}$ {$V_i^2 + V_j^2 - 2V_i V_j cos(\delta_i - \delta_j)$(4)

Where:

V_i is the voltage magnitude at bus i
V_j is the voltage magnitude at bus j
$g_{i,j}$ is the conductance of line i ¡ j
δ_i is the voltage angle at bus i
δ_j is the voltage angle at bus j
N_L is the total number of transmission lines
F_{loss} is the power loss function

2.3 System Constraints

System constrains are generatorMW, controlled voltage, reactive powerinjection from reactive power sources and transformertapping. The objective is to minimize thepower transmission loss function by optimizing thecontrol variables within their limits. Hence there will be noviolation on other quantities (e.g. MVA flow of transmission lines, load bus voltage magnitude, generator MVAR) occurs in normal system operating conditions. These are system constraints to be formed asequality and inequality constraints as follows

1) Equality constraint: Power flow equationsθ

$P_{G,i} - P_{D,i} - \sum_{j=1}^{N_B} |V_i| |V_j| |Y_{i,j}| cos(\theta_{i,j} - \delta_i + \delta_j) = 0$(5)
$Q_{G,i} - Q_{D,i} - \sum_{j=1}^{N_B} |V_i| |V_j| |Y_{i,j}| sin(\theta_{i,j} - \delta_i + \delta_j) = 0$(6)

Where :

$P_{G,i}$ is the real power generation at bus i
$P_{D,I}$ is the real power demand at bus j
$Q_{G,i}$ is the reactive power generation at bus i
$Q_{D,I}$ is the reactive power demand at busi
N_B is the total number of buses
$\theta_{i,j}$ is the angle of bus admittance elementi,j
$Y_{i,j}$ is the magnitude of bus admittance element *i; j*

2) Inequality constraint: Variable limitations

$$V_i^{min} \leq V_i \leq V_i^{max} \quad (7)$$

$$T_i^{min} \leq T_i \leq T_i^{max} \quad (8)$$

$$Q_{comp,i}^{min} \leq Q_{comp.i} \leq Q_{comp,i}^{max} \quad (9)$$

$$P_{G,i}^{min} \leq P_{G.i} \leq P_{G,i}^{max} \quad (10)$$

Where:

V_i^{min} ,V_i^{max} are upper and lower limits of voltage magnitude of bus i

T_i^{min} ,T_i^{max} are upper and lower limit of tap positions of transformer i

$Q_{comp,i}^{min}$, $Q_{comp,i}^{max}$ are upper and lower limits of reactive power source i

$P_{G,i}^{min}$, $P_{G,i}^{max}$ are upper and lower limit of power generated by generator bus i

The penalty function is formulated as

$$P(x) = F_{loss}+\Omega_p+\Omega_Q+\Omega_C+\Omega_T+\Omega_V+\Omega_G \quad (11)$$

Where:

$$\Omega_p=\rho\sum_{1=1}^{N_B}\{P_{G,i} - P_{D,i}-\sum_{j=1}^{N_B}|V_i||V_j||Y_{i,j}|\cos(\theta_{i,j}-\delta_i+\delta_j)\}^2 \quad (12)$$

$$\Omega_Q=\rho\sum_{1=1}^{N_B}\{Q_{G,i} - Q_{D,i}-\sum_{j=1}^{N_B}|V_i||V_j||Y_{i,j}|\sin(\theta_{i,j}-\delta_i+\delta_j)\}^2 \quad (13)$$

$$\Omega_C = \rho\sum_{1=1}^{N_c}\{(\max(0,Q_{comp,i}-Q_{comp,i}^{max})\}^2+ \rho\sum_{1=1}^{N_c}\{(\max(0, Q_{comp,i}^{min}-Q_{comp,i})\}^2 \quad (14)$$

$$\Omega_T =\rho\sum_{1=1}^{N_T}\{(\max(0,T_{i}-T_i^{max})\}^2+ \rho\sum_{1=1}^{N_T}\{(\max(0,T_i^{min} - T_i)\}^2 \quad (15)$$

$$\Omega_V = \rho\sum_{1=1}^{N_B}\{(\max(0,V_{i}-V_i^{max})\}^2+ \rho\sum_{1=1}^{N_B}\{(\max(0, V_i^{min} - V_i)\}^2 \quad (16)$$

$$\Omega_G= \rho\sum_{1=1}^{N_G}\{(\max(0,P_{G,i}-P_{G,i}^{max})\}^2+ \rho\sum_{1=1}^{N_G}\{(\max(0, P_{G,i}^{min} -P_{G,i})\}^2 \quad (17)$$

Where:
N_G is the total number of generators
N_C is the total number of reactive power compensators
N_T is the total number of transformers

III. Particle Swarm Optimization (PSO)

Particle swarm optimization was developed by Kennedy and Eberhart (1995) as a stochastic optimizationalgorithm based on social simulation models.The development of particle swarm optimization was based on concepts and rules that govern socially organized populations in nature, such as bird flocks, fish schools, and animal herds.For example, the flight of a bird flock can be simulated with relative accuracy by simply maintaining a target distance between each bird and its immediate neighbors. This distance may depend on its size and desirable behavior. For instance, fish retain a greater mutual distance when swimming carefree, while they concentrate in very dense groups in the presence of predators. The groups can also react to external threats by rapidly changing their form, breaking in smaller parts and re-uniting, demonstrating a remarkable ability to respond collectively to external stimuli in order to preserve personal integrity.

3.1 Basic Particle Swarm Optimization Algorithm

In the basic particle swarm optimization algorithm, particle swarm consists of "n" particles, and the position of each particle stands for the potential solution in D-dimensional space. The particles change its condition according to thefollowing three principles:
(1) to keep its inertia
(2) to change the condition according to its most optimist position
(3) to change thecondition according to the swarm's most optimist position.

The position of each particle in the swarm is affected both by the most optimist position during its movement(individual experience) and the position of the most optimist particle in its surrounding (near experience). When thewhole particle swarm is surrounding the particle, the most optimist position of the surrounding is equal to the one of thewhole most optimist particle; this algorithm is called the whole PSO. If the narrow surrounding is used in the algorithm,this algorithm is called the partial PSO.Each particle can be shown by its current speed and position, the most optimist position of each individual and the mostoptimist position of the surrounding. In the partial PSO, the speed and position of each particle change according thefollowing equality

$$x_i^{k+1} = x_i^k + v_i^{k+1} \quad (18)$$
$$v_i^{k+1} = v_i^k + \alpha_i(x_i^{lbest} - x_i^k)+\beta_i(x_i^{lgest} - x_i^k) \quad (19)$$

Where:
x_i^k isthe individual i at kth iteration
v_i^k is the update velocity of individual i at kth iteration
α_i,β_i are the uniform random numbers between [0,1]
x_i^{lbest} is the individual best of individual i
x_i^{lgest} is the global best of the swarm

Each particle keeps track of its coordinates in the solution space which are associated with the best solution (fitness) that has achieved so far by that particle. This value is called personal best ,***pbest***.

Another best value that is tracked by the PSO is the best value obtained so far by any particle in the neighborhood of that particle. This value is called ***gbest***.

In this paper fitness function is the loss function given by the equation (10). A particle is a set of unknownvariables in the fitness function and they are (a) unknown parameters of all bus,(b)generatorMW,(c)controlled voltage, (d)reactive powerinjection from reactive power sources and(e) transformertapping. In PSO algorithm N number of particles is chosen. Forzeroth iteration each particle values are arbitrarily chosen. Then it is given to the fitness function to obtain fitness value. Then using velocity function, particle for next iteration is obtained. These are given to the fitness function. Compare each fitness value using particles in present iteration to particles in previous iteration. The particle which gives better fitness valueforms the local best particle. Now fromamong the group of local best, the particlewhich gives best fitness function forms the first entity inis the global best particle group.Then from thelocal best particles usingvelocity function,particles for next iteration is obtained. Then this process is continued. After a finite number of iterations, from the global bestgroup, the particle which gives best fitness is taken as the particle for solution.

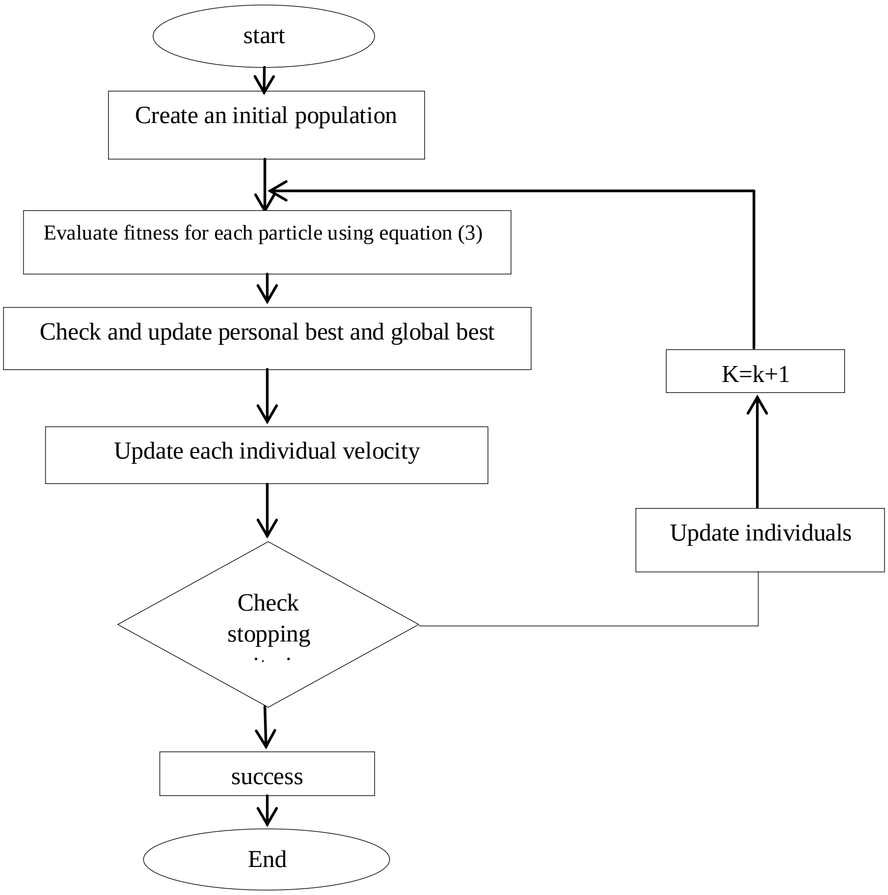

Fig.1 PSO flowchart

IV. Results And Discussion

Several soft computing techniques were used for the problem of transmission loss minimization yet. In this paper particle swarm optimization algorithm is used to minimize the transmission loss as well as total fuel cost. Here this technique is tested with IEEE-30 bus standard six generator system. Results obtained are of best compromising.

Real Power Generation values in MW:
ans = 171.0723 48.6224 22.0935 26.2088 12.0607 12.4800
Generation Voltage values in p.u:
ans = 1.0498 1.0377 1.0076 1.0178 1.0348 1.0409
Transformer ratio values:

ans = 1.0315 0.9733 1.0255 0.9802
Real Power loss in MW:
ans = 9.1378
Total operation Generation Cost in $/hr:
ans = 803.0139

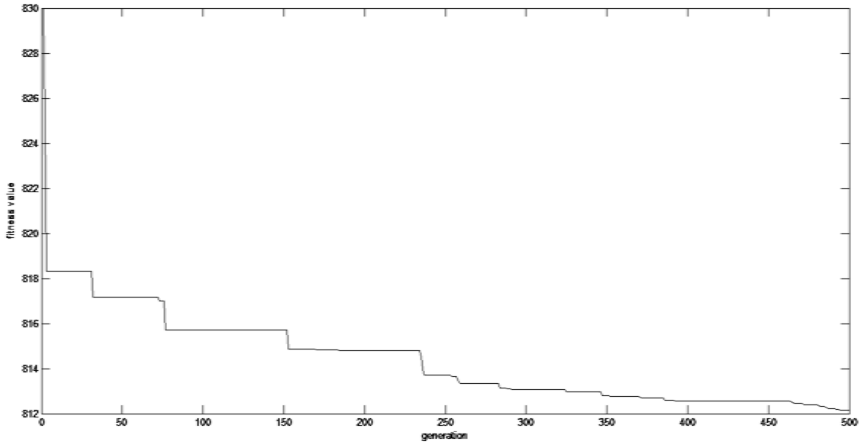

Fig.2Convergence characteristics

References

[1] M.R AlRashidi and M.E El-Hawary, \Hybrid Particle Swarm Optimization Approach for Solving the Discrete OPF Problem Considering the Valve Loading E®ects," IEEE Transactions on Power Systems, Issue 4, Vol. 22, pp.2030 2038, 2007.

[2] B. Zhao, C.X. Guo and Y.J. Cao, \Improved particle swam optimization algorithm for OPF problems," IEEE-PES Power Systems Conference and Exposition, Vol. 1, pp.233 - 238, 10-13 October 2004.

[3] C.A Roa-Sepulveda and B.J. Pavez-Lazo, \A solution to the optimal power flow using simulated annealing," Power Tech Proceedings 2001, Vol.2, pp. 5, 10-13 September 2001.

[4] R.N. Banu and D. Devaraj, \Optimal Power Flow for Steady state security enhancement us- ing Genetic Algorithm with FACTS devices," 3rd International Conference on Industrial and Information Systems, pp. 1 6, 8-10 December 2008.

[5] L.L. Lai and J.T. Ma, \Power flow control in FACTS using evolutionary programming," IEEE International Conference on Evolutionary Computation, pp. 10, 29 November-1 December 1995. [6] C. Gonggui and Y. Junjjie, \A new particle Swarm Optimization Solution to Optimal reactive power Flow Problem," Asia-Paci¯c Power and Energy Engineering Conference, pp.1 4, 27- 31 March 2009."

[7] L. Weibing, L. Min and W. Xianjia, \An improved particle swarm optimization algorithm for optimal power flow," IEEE 6th International Power Electronics and Motion Control Confeence 2009, pp. 2448 2450, 17-20 May 2009.

[8] W. Cui-Ru, Y. He-Jin, H. Zhi-Qiang, Z. Jiang-Wei and S. Chen-Jun, "A modi¯ed particle swarm optimization algorithm and its application in optimal power flow problem," International Conference on Machine Learning and Cybernetics 2005, pp. 2885 2889, 18-21 August 2005.

[9] S. M. Kumari, G. Priyanka and M. Sydulu , \Comparison of Genetic Algorithms and Particle Swarm Optimization for Optimal Power Flow Including FACTS devices," IEEE Power Tech 2007, pp. 1105 - 1110, 1-5 July 2007.

[10] C. Chokpanyasuwant, S. Anantasate1, S.Pothiya ,W. Pattaraprakom and P. Bhasapu-tra1, "Honey Bee Colony Optimization to solve Economic Dispatch Problem with Generator Constraints," ECTI-CON 2009. 6th Internaional Conference, Vol. 1, pp. 200 203, 2009.

[11] S. Anantasate, C.Chokpanyasuwan and P. Bhasaputra, "Optimal Power Flow by using Bees Algorithm," ECTI Conference, pp.459 463, 2010.

[12] U. Leeton, D. Uthitsunthorn, U. Kwannetr, N.Sinsuphun and T. Kulworawanichpong, "power Loss Minimization Using Optimal Power Flow Based on Particle Swarm Optimization," ECTI Conference, pp.469 473, 2010.

[13] P. Dutta and A. K. Sinha, "Voltage Stability Constrained Multi-objective Optimal Power Flow using Particle Swarm Optimization," 1stInternational Conference on Industrial and Information Systems, pp. 161 166, 8-11 August 2006.

[14] Z. Haibo, Z. Lizi and M. Fanling, "Reactivepower optimization based on genetic algorithm,"International Power Conference on Power System Technology, pp.1448 1453, 18-21 August

Author Profile

Sunil Joseph P. –He hasreceived the B.Tech degree in Electrical and Electronics Engineering from Jyothi engineering college, Trissur, Kerala, India under University of Calicut in 2008 and currently perusing M.E. in Power Systems Engineeringfrom Paavai Engineering College,Namakkal, Tamil Nadu, India under Anna University, Chennai (2011-2013).

C.DineshBalaji- He hasreceived BE in electronics and instrumentation engineering from Kongu engineering college, Perundurai ,Erode and M.Tech degree in power electronics and drives from SRM university Chennai. He is currently working as Assistant Professor in EEE Department in Paavai Engineering College, Namakkal, Tamil Nadu, India under Anna University, Chennai.