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STUDY PAPER ON OPTIMIZATION OF ELECTRICAL POWER TRANSMISSION SYSTEM USING PSO WITH SVC

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Abstract— In recent years, the transmission lines are operated under the heavily stressed condition, hence there is a risk of consequent voltage instability in the power network. There is a multi-functional control device which can be effectively control the load flow distribution and the power transfer capability is the flexible alternating current transmission system (FACTS) device. The facts device performance is depend upon its location and parameter setting. In this paper static var compensator (SVC) is studied on the basis of particle swarm optimization (PSO) technique to minimize load voltage magnitude deviations and network losses using particle swarm optimization have been presented. Particle swarm optimization (PSO) is one of the artificial intelligent search approaches which have the potential to solve such problems. For this study, static var compensator (SVC) is chosen as the compensator device.

Keywords— FACTS Device, optimal location and sizing,Particle swarm optimization(PSO), Voltage deviation, powerloss, Static var compensator (SVC)

I. INTRODUCTION

The power network is more difficult to operate and more insecure due to the ever increasing demand for the electrical power.

On the other hand, Flexible AC transmission system (FACTS) device, which can provide direct and flexible control of power transfer and are very helpful in the operation of power network. The power system performance and the power system stability can be enhanced by using FACTS device. [1] Static var compensator (SVC) is one of the most effective measure device for enhancing the power stability and power transfer capability of transmission network, for this the SVC should be properly installed in the system with appropriate parameter setting. The some factors considering for optimal installation and the optimal parameter of SVC, Which are the Stability margin improvement, power loss reduction, power blackout prevention and the power transmission capacity enhancement.

In last 20 years, there are algorithm have been developed for optimal power flow incorporating with SVC device and for the optimal placement of SVC; such as are Newtons-Raphson load flow algorithm, Genetic algorithm and the Particle swarm optimization technique for optimal location of the FACTS device. [2], [3] & [4]. It is an actual and important subject to appropriately select the suitable location of the FACTS device installation at the viewpoint of the voltage stability enhancement and power loss minimization. The world wide researchers in the power system have retained the interest in this problem. The various method and criteria were proposed and used to optimal allocation of FACTS devices in power network. [5]

In this paper the application of particle swarm optimization (PSO) for the optimal location and optimal sizing of the SVC with consideration of active power loss reduction and voltage deviation minimization in the power system is highlighted.

Particle swarm optimization is a population based stochastic optimization method. This algorithm was inspired from the social behavioral pattern of organisms, such as Bird flocks, fish schools, and sheep herds where aggregated behaviors are met, producing powerful, collision-free, synchronized moves. In such systems, the behavior of each swarm member is based on simple inherent responses, although their collective outcome is rather complex from a macroscopic point of view. 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. The swarms can also react to the predator by rapidly changing their form, breaking into smaller swarms and re-uniting, illustrating a remarkable ability to respond collectively to external stimuli in order to preserve personal integrity. The PSO algorithm consists of a number of particles that collectively move through the search space of the problem in order to find the global optima. Each particle is characterized by its position and fitness. Subsequently, the PSO algorithm updates Particle swarm optimization is a population based stochastic optimization method. This algorithm was inspired from the social behavioral pattern of organisms, such as Bird flocks, fish schools, and sheep herds where aggregated behaviors are met, producing powerful, collision-free, synchronized moves. In such systems, the behavior of each swarm member is based on simple inherent responses, although their collective outcome is rather complex from a macroscopic point of view. For example, the flight of a bird flock can be simulated with relative accuracy by simplify maintaining a target distance between each bird and its immediate neighbors. This distance may depend on its size and desirable behavior. The swarms can also react to the predator by rapidly changing their form, breaking into smaller

swarms and re-uniting, illustrating a remarkable ability to respond collectively to external stimuli in order to preserve personal integrity. The PSO algorithm consists of a number of particles that collectively move through the search space of the problem in order to find the global optima. Each particle is characterized by its position and fitness. Subsequently, the PSO algorithm updates the velocity vector for each particle then adds that velocity to the particle position. The velocity updates are influenced by both the best global solution associated with the highest fitness ever found in the whole swarm, and the best local solute on associated with the highest fitness in the present population.

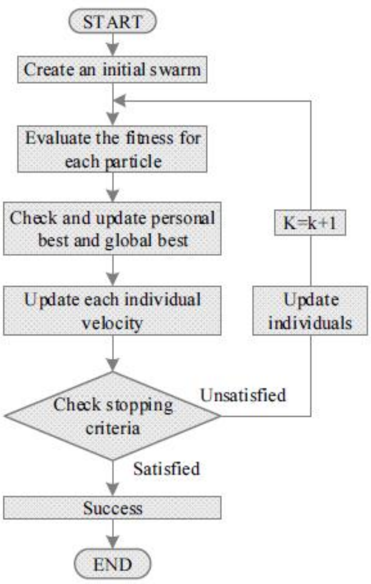

Fig. 1.1

II. PROBLEMFORMULATION

For minimizing the load voltage magnitude deviation and loss of power system the determination of the optimal location and the optimal parameter setting of the SVC in the power network is the main objective. For this the performance index is selected:

Min $F=F_1+F_2= P_{loss}+ VD$

Where,

P_{loss}= network real power loss

V_D= voltage deviation

Equality constraints:

$P_{Gi}-P_{Di}-V_i\sum_{j=1}^{Ng} V_j(G_{ij}\cos(\theta_i-\theta_j) + B_{ij}\sin(\theta_i-\theta_j))=0$

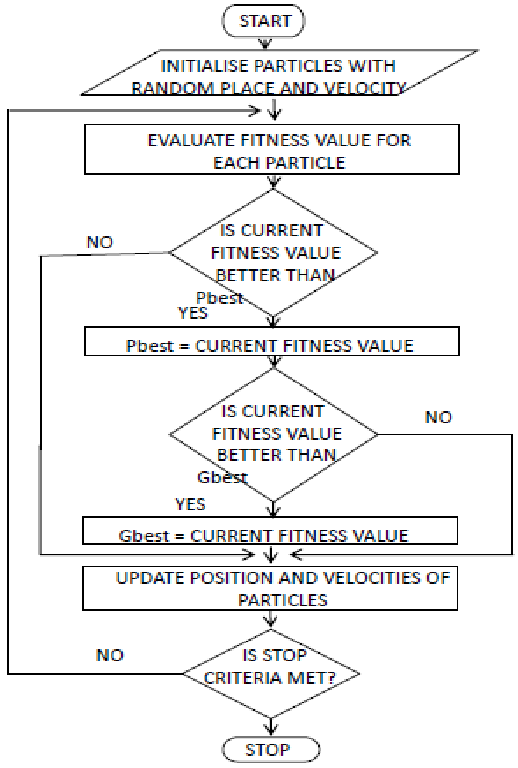

Fig. 2.1

i= 1,2,-----N_B ---- (4)

$Q_{Gi}-Q_{Di}-V_i\sum_{j=1}^{Ng} V_j(G_{ij}\sin\theta_{ij}-B_{ij}\cos\theta_{ij}= 0$

i= 1,2,-----N_B ---- (5)

Inequality constraints:

$P_{gi}^{min} \le P_{gi} \le P_{gi}^{max}$ (6)

$Q_{gi}^{min} \le Q_{gi} \le Q_{gi}^{max}$ (7)

$V_i^{min} \le V_i \le V_i^{max}$ (8)

where,

F isthe objective function.

P_{gi} *is the acrive power generation at bus i .*

Q_{gi} *is the active power load at bus i.*

P_{di} *is the active power load at i.*

Q_{di} *is the reactive power load at bus i.*

V_i *is the voltage magnitude at bus i.*

V_j *is the voltage magnitude at bus j.*

V_{ref} *is the reference voltage magnitude*

Gij, Bij are mutual conductance and susceptance between bus i and bus j . X_{SVC} *is the reactance of SVC* ϑ_{ij} *is voltage angle difference between bus i and j .* N_B *is total number of buses excluding slack bus* N_{PQ} *is number of PQ buses.*

III. PARTICAL SWARM OPTIMIZATION (PSO):

Mr.Kennedy and Mr.Eberhart first introduced the PSO in the year of 1995.[6] PSO has its roots PSO BASED PID CONTROLLER

In PSO algorithm, the system is initialized with a population of random solutions, which are called particles, and each potential solution is also assigned a randomized velocity [19]. PSO relies on the exchange of information between particles of the population called swarm. Each particle adjusts its trajectory towards its best solution (fitness) that is achieved so far. This value is called pbest. Each particle also modifies its trajectory towards the best previous position attained by any member of its neighborhood. This value is called *gbest.* Each particle moves in the search space with an adaptive velocity.
The fitness function evaluates the performance of particles to determine whether the best fitting solution is achieved. During the run, the fitness of the best individual improves over time and typically tends to stagnate towards the end of the run. Ideally, the stagnation of the process coincides with the successful discovery of the global optimum. In artificial life and social.

IV. IMPLEMENTATION OF PSO ALGORITHM

The optimal values of the PID controller parameters Kp, Ki and Kd, is found using PSO. All possible sets of controller parameter rvalues are particles whose values are adjusted so as to minimize the objective function, which in this case is the error criterion, which is discussed in detail. For the PID controller design, it is ensured the controller settings estimated results in a stable closed loop system.

Selection of PSO parameters

To start up with PSO, certain parameters need to be defined. Selection of these parameters decides to a great extent the ability of global minimization. The maximum velocity affects the ability of escaping from local optimization and refining global optimization. The size of swarm balances the requirement of global optimization and computational cost. Initializing the values of the parameters is as per table 4.1.

Population size	*100*
Number of iterations	*100*
Velocity constant c1	*2*
Velocity constant, c2	*2*

Table 4.1

V. RESULTS

Analysis shows that the design of proposed controller gives a better robustness, and, the performance is satisfactory over a wide range of process operations. Simulation results show performance improvement in time domain specifications for a step response. Using the PSO approach, global and local solutions could be simultaneously found for better tuning of the controller parameters.

VI. CONCLUSION

In this paper, a systematic design method aiming at enhancing PID control for complex processes is proposed. It is proposed both analytically and graphically that there is a substantial improvement in the time domain specification in terms of lesser rise time, peak time, settling time as well as a lower overshoot.

PSO presents multiple advantages to a designer by operating with a reduced number of design methods to establish the type of the controller, giving a possibility of configuring the dynamic behavior of the control system with ease, starting the design with a reduced amount of information about the controller (type and allowable range of the parameters), but keeping sight

of the behavior of the control system. The performance of the above said method of tuning a PID controller can even be proved to be better than the method of tuning the controller after approximating the system to a FOPTD model, and using the traditional techniques, regarding which a rich literature is available. So this method of tuning can be applied to any system irrespective of its order and can be proved to be better than the existing traditional techniques of tuning the controller.

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