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

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ABSTRACT

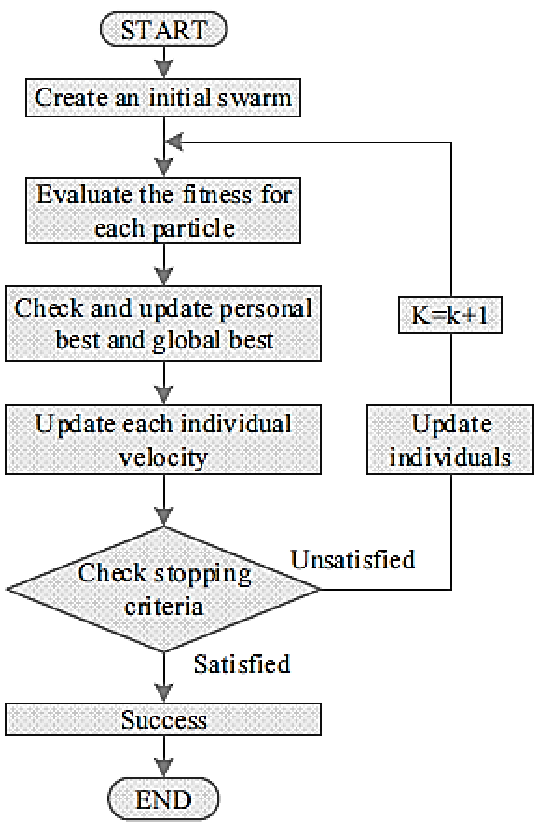
As of late, the transmission lines are worked under the vigorously focused on condition, subsequently there is a danger of resulting voltage unsteadiness in the power organize. There is a multi-useful control gadget which can be successfully control the heap stream appropriation and the power exchange capacity is the adaptable substituting current transmission framework (FACTS) gadget. The certainties gadget execution is rely on its area and parameter setting. In this paper static var compensator (SVC) is examined based on molecule swarm improvement (PSO) strategy to limit stack voltage greatness deviations and system misfortunes utilizing molecule swarm streamlining have been introduced. Molecule swarm enhancement (PSO) is one of the fake astute pursuit approaches which can possibly tackle such issues. For this examination, static var compensator (SVC) is picked as the compensator gadget.

Keywords: - FACTS Device, Optimal Location & Sizing, Particle Swarm Optimization (PSO), Voltage Deviation, Power Loss, Static Var Compensator (SVC), Introduction (Heading 1).

INTRODUCTION

The power network is more difficult to operate and more insecure due to the ever-increasing demand for the electrical power. Then again, Flexible AC transmission framework (FACTS) gadget, which can give immediate and adaptable control of intensity exchange and are extremely useful in the task of intensity arrange. The power framework execution and the power framework steadiness can be upgraded by utilizing FACTS gadget. [1] Static var compensator (SVC) is a standout amongst the best measure gadget for upgrading the power dependability and power exchange capacity of transmission organize, for this the SVC ought to be legitimately introduced in the framework with fitting parameter setting. The a few variables considering for ideal establishment and the ideal parameter of SVC, which are the Stability edge enhancement, control misfortune decrease, influence power outage anticipation and the influence transmission limit improvement. 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 worldwide 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.

Molecule swarm streamlining is a populace based stochastic advancement strategy. This calculation was motivated from the social standard of conduct of living beings, for example, Bird runs, angle schools, and sheep groups where accumulated practices are met, creating amazing, crash free, synchronized moves. In such frameworks, the conduct of each swarm part depends on straightforward innate reactions, although their aggregate result is somewhat perplexing from a perceptible perspective. For instance, the trip of a flying creature run can be mimicked with relative precision by basically keeping up an objective separation between each winged creature and its prompt neighbors. This separation may rely upon its size and alluring conduct. The swarms can likewise respond to the predator by quickly changing their shape, breaking into littler swarms and re-joining together, representing a striking capacity to react altogether to outside boosts so as to protect individual respectability. The PSO calculation comprises of various particles that by and large travel through the hunt space of the issue so as to locate the worldwide optima. Every molecule is described by its position and wellness. Hence, the PSO calculation refreshes the speed vector for every molecule at that point adds that speed to the molecule position. The speed refreshes are impacted by both the best worldwide arrangement 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.



II. PROBLEM FORMULATION

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:

$$\text{Min } F = F_1 + F_2 = P_{loss} + VD \qquad (1)$$

Where,

P_{loss} = network real power loss

VD = Voltage Deviation

Equality constraints:

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

$$i = 1, 2, \text{-----} N_B \qquad \text{----} \quad (4)$$

$$Q_{Gi} - Q_{Di} - V_i \sum_{j=1}^{Ng} V_j \,(G_{ij} \sin\theta_{ij} - B_{ij} \cos\theta_{ij}) = 0 \qquad i = 1, 2, \text{-----} N_B \text{----} \quad (5)$$

Inequality constraints:

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

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

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

where,

F is the objective function.

P_{gi} is the active 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

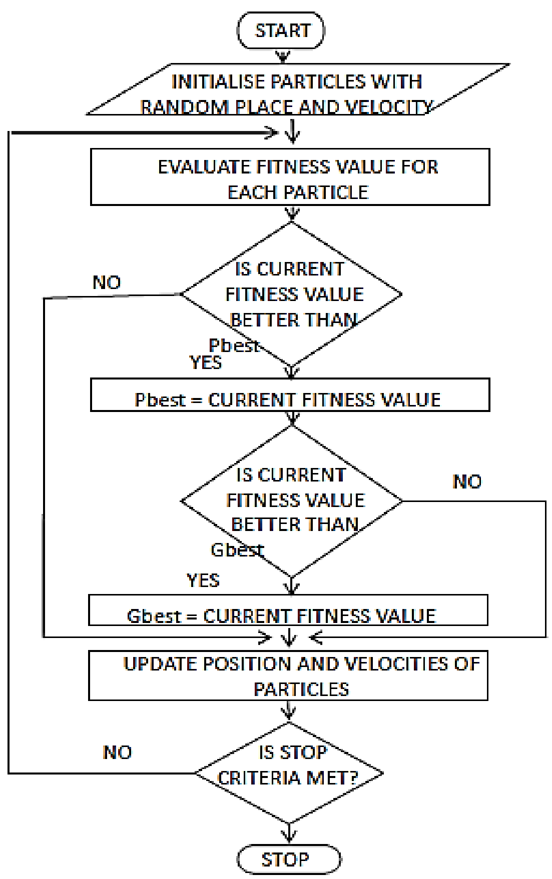
PARTICAL SWARM OPTIMIZATION (PSO):

Mr. Kennedy and Mr. Eberhart first introduced the PSO in the year of 1995.[6] PSO has its roots in artificial life and social psychology as well as in engineering and computer science. It utilizes a population of individuals, called particles, which fly through the problem hyperspace with some given initial velocities. In each iteration the velocities of the particles are stochastically adjusted considering the historical best position of the particles and their neighborhood best position; where these positions are determined according to some predefined fitness function.

III. 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 p_{best}. Each particle also modifies its trajectory towards the best previous position attained by any member of its neighborhood. This value is called g_{best}. 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.



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 values 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.

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

IV. 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.

V. 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.

REFERENCES

[1] M Araki: Control systems, Robotics and Automation-Vol II– PID Control, Kyoto University, Japan

[2] Kim Dong Hwa and Park Jin Ill: Intelligent PID Controller Tuning of AVR system using GA and PSO: Springer-Verlag Berlin Heidelberg: ICIC 2005, Part II, LNCS 3645, pp 366-375. (2005).

[3] K. J. Astrom, T. Hagglund, The future of PID control, Control Eng.Pract.9(11)(2001)1163–1175.

[4] Ziegler, G. and Nichols, N. B, 1942.Optimum settings for automatic controllers, Trans. ASME, 64,759-768.

[5] Astrom, K J.;.Hagglund .T,1984, Automatic tuning of simple regulators with specifications on phase and amplitude margins, Automatica, 20,645-651.

[6] G.H Cohen and G.A Coon: Theoretical Consideration of Retarded Control, Trans ASME 75,pp.827/834,(1953)

[7] Haber, Rodolf., Toro1, Raúl M. and. Alique, José R, ‟Using Simulated Annealing for Optimal Tuning of a PID Controller for Time-Delay Systems. An Application to a High-Performance Drilling Process‟, Springer.

[8] K.E. Parsopoulos and M.N.Vrahatis,“Particle swarm optimizer in noisy and continuously changing environment”, Indianapolis. IN(2001)

[9] Hirotaka Yoshida, Kenichi Kawata, yoshikazu Fukuyana, yosuke Nakanishi, “A particle swarm optimization for reactive power and voltage control considering voltage stability”, IEEE international conference on intelligent system applications to power systems(ISAP‟‟99), Rio de Janeiro, April 4-8 (1999).

[10] Zwe-Lee Gaing, “ A particle swarm optimization approach for optimum design of PID controller in AVR system”, IEEE transactions on energy conversion, November 6,(2002).

[11] Javed Alam Jan and Bohumil Sulc, “Evolutionary computing methods for optimizing virtual reality process models”, International Carpathian control conference ICCC‟‟2002, Malenovice Czechrepublic, May 27-30, (2002).

[12] K.E. Parsopoulos and M.N. Vrahatis, “Recent approaches to global optimization problems through Particle Swarm Optimization, Natural Computing 1: 235–306, (2002).

[13] Thomas Beielstein, K.E. Parsopoulos and Michael N. Vrahatis, “Tuning PSO Parameters Through Sensitivity Analysis, Technical Report of the Collaborative Research Center 531 Computational Intelligence CI--124/02, University of Dortmund, January (2002).

[14] Y Zheng, Liyan Zhang, JixinQianLonghua Ma “Robust PID Controller Design using PSO” International Symposium on Intelligent Control IEEE Oct (2003)

[15] T.Bartz–Beielstein K.E. Parsopoulos and M.N. Vrahatis, “Analysis of Particle Swarm Optimization Using Computational Statistics”, International conference on numerical analysis and applied mathematics ICNAAM- (2004).

[16] Jun Zhao, Tianpeng Li and JixinQian “Application of Particle Swarm Optimization Algorithm on Robust PID controller Tuning”, Springerlink-Verlag Berlin Heidelberg, pp. 948-957, (2005).

[17] Haibing Hu, Qingbo Hu, Zhengyu Lu, DehongXu “Optimal PID controller Design in PMSM Servo System via Particle Swarm Optimization” 31st Annual Conference of IEEE, Industrial Electronics Society.

[18] Rohit Ramachandran, S. Lakshminarayanan and G.P Rangaiah” Process identification using open-loop and closed loop step responses” Journal of the institute of Engineers, Singapore vol.45, Issue6 (2005).