

Performance Analysis of ACO based PID Controller in AVR System: A Review

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Abstract- AVR plays a vital role in generating stations. To maintain voltage stability of the generator the terminal voltage should remain constant all the times. In a large interconnected system manual regulation is much complicated and therefore automatic generation and voltage regulation is necessary. So, to maintain a constant voltage level, Automatic voltage regulator (AVR) is used at each generating station. This paper presents a review of the Ant Colony Optimization (ACO) technique used for the tuning of the PID (Proportional, Integral, Derivative) controllers which are used for AVR system. Ant Colony Optimization technique is recognized from the behavior of real ants within the colony to find optimum gain value in shortest time period. In this paper, an attempt has been made to design an optimal PID controller based on ACO algorithm to improve the overall dynamic performance of an AVR system for the control of terminal voltage following disturbance.

Keywords: AVR, PID, ACO, ACO-PID etc

I. INTRODUCTION

An AVR controls the terminal voltage of a synchronous generator. Terminal voltage of the synchronous generators gets affected by the reactive power demand of the load. In power system it is very much essential that the overall voltage profile must be within the permissible limit at all times during the operation of the equipments. Most of the equipments are designed to work in a predetermined value of voltage and frequency of operation. In case of any deviation from these values results in decrease in performance and lifetime of these equipment. Hence for effective operation of the power system the Automatic Voltage Regulators (AVR) are installed at each generating plants. The main objective of AVR system is to maintain the terminal voltage of the alternator in the generating station.

A. PID: In design of PID (Proportional integral derivative) controller the three main parameters requires, namely Proportional gain (K_p), Integral time constant (K_i) and derivative time constant (K_d). By selecting an optimal value for each of the three controller gains, the transient

response increases highly in terms of maximum overshoot (osh), settling time (t_s), rise time (t_r) and the steady state error (ess) of an AVR system. Each of these terms is dependent on the error value between the input and output. Traditionally tuning PID by trial and error method is very tedious and time consuming. To reduces this complexity, Evolutionary algorithm techniques are used. There are Varies methods are adopted like Genetic Algorithm (GA), Simulated Annealing (SA), Fuzzy logic, and Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO).

B. ACO (Ant Colony Optimization) Algorithm: The importance of ACO is that it gives fine tuning to PID controller in AVR system. ACO gives shortest possible path to get optimum tuning the gain of PID controller. ACO is a technique inspired by the natural behavior of ants within a colony searching for shortest path from their nest to a food source. The shortest path is formed by the fact that ants communicate via pheromones disposed on the path and more pheromones path preferred following ants.

C. ACO-PID Controller: ACO algorithm is used to find out optimized gain values and these values are given to the PID controller for the next operation of the plant representing AVR of the power generating system as shown in Figure. The proportional gain makes the controller respond to the error value, the integral gain help to eliminate steady state error and derivative gain to prevent overshoot.

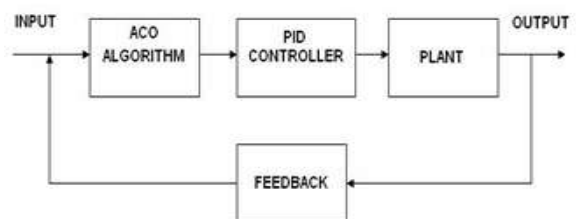


FIG.1

II. PROBLEM STATEMENT

In a power system it is very much essential that the system should operate on steady state condition, i.e. both the voltage and frequency should remain at standard values during operation. To mitigate this requirement PID controllers are used in AVR system. Traditionally tuning of PID by trial and error method is very tedious and time consuming. To reduce this complexity, Evolutionary algorithm techniques can be used which solve a wide range of practical problems. ACO algorithm gives the shortest possible path to get optimum tuning of the gain of PID controller.

III. MATLAB SIMULATION

By developing a MATLAB program for optimum tuning of the parameters of a PID controller for an AVR system and by developing an ACO technique based MATLAB program for optimum tuning of the same PID, the comparison of both the results in MATLAB simulation with respect to settling time, peak overshoot and oscillations, these results will show that better control performance can be achieved in an ACO based PID controller in comparison with a conventional fixed gain PID method. The ACO algorithm is used to optimize the gains, and the values are transferred to the PID controller of the plant.

IV. LITERATURE REVIEW

Zwe-Lee Gaing (2004) presented PSO for optimum design of a PID controller in an AVR system. The simulation results proved the proposed method in improving the step response of an AVR system.[11]

Rohit Kumar presented a PSO based approach to solve the economic load dispatch with line flows and voltage constraints, and concluded that the proposed approach is computationally faster than GA.[12] Yoshida et al. proposed PSO for reactive power and voltage control considering voltage stability. The results reveal that the proposed method generates a solution very near to the global optimum solution. Ying-Tung Hsiao presents an optimum approach for designing of PID controllers using ACO to minimize the integral absolute control error. The experiment results demonstrate that better control performance can be achieved in comparison with a conventional PID method.[6] Duan Hai-bin presented a parameter optimization strategy for a PID controller using an ACO algorithm. The algorithm has been applied to the combinatorial optimization problem, and the results indicate high precision of control and quick response. Mohd. Rozely Kalil, Ismail Musirin proposed an Ant Colony

Optimization (ACO) technique for searching the optimal point of maximum loadability point at a load bus. Hamid Boubertakh, Mohamed Tadjine, Pierre-Yves Glorennec and Salim Labiod has proposed a theory that although conventional PID controllers are the most used in the industrial process, their performance is often limited when it is poorly tuned and/or used for controlling highly complex processes with nonlinearities, complex dynamic behaviors.[3] Ing-Tung Hsiao proposed a solution algorithm based on the ant colony optimization technique to determine the parameters of the PID controller for getting a well performance for a given plant. Simulation results demonstrate that better control performance can be achieved in comparison with known methods.[4] Kiarash, Mehrdad Abedi,(2011) Shuffled frog leaping and particle swarm optimization these two algorithms are used to determine an optimal PID controller in an AVR system and also shows that for tuning a PID controller using various optimization techniques reduces complexity and finds a more realistic result than the trial and error method.[4] Hany M. Hasanien (2013) proposed optimization of a PID controller in an AVR system shows that minimize the maximum percentage overshoot, the rise time, the settling time and oscillation and step response of an AVR system can be changed. Richa Singh (IEEE 2016)-ACO is a popular technique which shows the behavior of real ant colonies to find solutions to discrete optimization problems.[13]

V. CONCLUSION

This paper includes a brief review of current researches and their methods for optimizing the gain value of a PID controller to improve system performance in network delayed systems. In a PID controller there are some parameters that are used for tuning methods and methods as well that are proposed by various researchers practically and theoretically are summarized and studied in this paper.

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