Automatic Voltage Regulator Tunned with PID Controller

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Abstract— for obtaining efficient stability and good regulation of different devices in power system and industrial applications, automatic voltage regulators (AVR) are increasingly used. This paper presents on review of automatic voltage regulator for synchronous generator. It is used to obtain for regulation and stability of any electrical equipment. There are many technology/methods were used in automatic voltage regulator as well as different controller used for improving robustness, overshoot, rise time and voltage control, but this paper is about the review of AVR using different techniques.
Keywords: AVR, PID, PSO, GA, COA, TLBO, SA

I. Introduction

The voltage regulator is the intelligence of the system and controls the output of the exciter so that the generated voltage and reactive power change in the desired way. In most modern systems the automatic voltage regulator (AVR) is a controller that senses the generator output voltage (and sometimes the current) then initiates corrective action by changing the exciter control in the desired direction. The speed of the automatic voltage regulator is of great interest in studying stability. Because of the high inductance in the generator field winding, it is difficult to make rapid changes in field current. This introduces a considerable lag in the control function and is one of the major obstacles to be overcome in designing a regulating system [6]. So far, various control methods have been proposed for the AVR systems. One of the preferable controllers proposed in the literature is the proportional plus integral plus derivative (PID) controller because of its simple structure. Therefore, many optimization algorithms including particle swarm optimization (PSO), harmony search algorithm (HSA), and artificial bee colony algorithm (ABC) have been employed to regulate the PID gains of the AVR systems.

II. Automatic Voltage Regulator

The main function of an AVR system is to hold the magnitude of terminal voltage of a synchronous generator at a specified level. Thus, the stability of the AVR system would seriously affected the security of the power system. The Proportional integral Derivative (PID) controller is chosen compared to other controllers because of its uncomplicated and robust behavior.

A simple AVR consist of amplifier, exciter, generator and sensor. The block diagram of AVR with PID controller is shown in Figure 1.The step response of this system without control has oscillation which will reduce the performance of the regulation. Thus, a control technique must be applied to the AVR system. For this reason, the PID block is connected in series with amplifier. Several tuning methods have been proposed for the tuning of control loop [7].

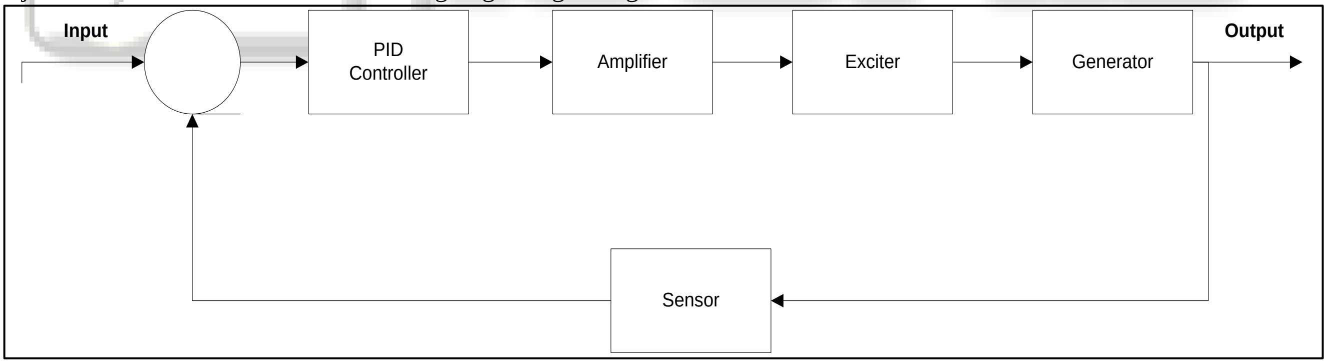

Fig. 1: AVR model with PID Controller

III. Modeling of an AVR system

Automatic voltage regulators are used to control generators output. An AVR consists of diodes, capacitors, resistors and potentiometers or even microcontrollers, all placed on a circuit board. This is then mounted near the generator and connected with wires to measure and adjust the generator.

A simple AVR system consists of four parts: amplifier, exciter, generator and sensor. The four components must be linear, which takes into account time constant and ignores the other nonlinearity. The reasonable transfer function of these components can be given as:

A. Amplifier Model

The amplifier model is represented by a gain K_A and a time constant τ_A. The transfer function is given by:[9].

$$G_A(s) = \frac{K_A}{1 + \tau_A S}$$

B. Exciter Model

The transfer function of an exciter is modeled by a gain of K_E and a time constant of τ_E. The transfer function is represented as:

$$G_E(s) = \frac{K_E}{1 + \tau_E S}$$

C. Generator Model

The generator model can be represented by a gain K_G and a time constant τ_G. The transfer function is given by:

$$G_G(s) = \frac{K_G}{1 + \tau_G S}$$

D. Sensor Model

The sensor model can be represented by a gain K_S and a time constant τ_S, the transfer function is given by:

$$G_S(s) = \frac{K_S}{1 + \tau_S S}$$

IV. Related Works

M F Aranza et.al, In this research, PID controller is applied on AVR (Automatic Voltage Regulator) and tune PID parameters, Proportional Gain (Kp), Integral Gain (Ki) and Derivative Gain (Kd) using PSO. The main purpose of the application of PSO algorithm in PID controller is to determine the price of Kp, Ki and Kd are optimal, so it can improve the performance of PID controllers, and compare results of the application of PSO algorithm with the method ZN (Ziegler-Nichols) and without PID system [1].

Julius Beneoluchi Odili, et.al, In this paper, an attempt is made to apply the African Buffalo Optimization (ABO) to tune the parameters of a PID controller for an effective Automatic Voltage Regulator (AVR). In this research an attempt has to be made to improve the system's gain overshoot and steady steady state errors. Results obtained from the simulation of the PID Controller parameters-tuning using the ABO has compared with the performance of Genetic Algorithm PID (GA-PID), Particle-Swarm Optimization PID (PSO-PID), Ant Colony Optimization PID (ACO-PID) [2].

M. Moradi Zirkohi, In his paper, a Cuckoo optimization algorithm (COA) is proposed for an Automatic Voltage Regulator (AVR) in a power system. In this research, a multi-objective optimization problem including overshoot, settling time, rise time, and steady-state error is formulated. The simulation studies confirm that the Cuckoo optimization shows better performance regarding the model uncertainties. Having applied the Cuckoo optimization algorithm, the rise time and the settling time were found to be improved [3].

Snigdha Priyambada et.al, study in this paper, the analysis of Automatic Voltage Regulator (AVR) using proportional-integral-derivative controller optimized by Teaching Learning Based Optimization method. The optimum gain of the controller for the proposed model is obtained with objective function as Integral Time Absolute Error. Performance of the system is found to be better in every aspect in terms of the settling point, peak overshoot. The transient response analysis and robustness analysis of the AVR system tuned by TLBO algorithm is documented profitably [4].

Rouani Lahcene et.al, presents a new method for optimum tuning of practical FOPID controllers for Automatic Voltage Regulator (AVR) system. A Simulated Annealing (SA) meta-heuristic algorithm is used to minimize the cost function. Comparing this technique with previous recent published works demonstrates that the proposed FOPID controller can provide good control performance with respect to reference input and improve the system robustness with respect to model uncertainties [5].

V. Conclusion

This paper investigates techniques for Automatic Voltage Regulator like PSO, GA, TLBO COA and SA. This paper presents a survey of the work published on the application of various optimization techniques applied to solve the problems of automatic voltage regulator system. In various optimization techniques that tackled the problem are overviewed and classified with their advantages and limitations critically discussed. In this paper, an evolutionary computing approach for determining the optimal values of the PID controller has been studied and presented.

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