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Survey on PID Controller Based Automatic Voltage Regulator

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ABSTRACT: 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 problem is about to survey on Automatic Voltage Regulator. Comparisons studies which are based on PID Controller are performed to show rise time, overshoot, and undershoot according to different research paper analysis.

KEYWORDS: AVR, PID Controller,

I.INTRODUCTION

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. It may use an electromechanical mechanism, or passive or active electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. With the exception of passive shunt regulators, all modern electronic voltage regulators operate by comparing the actual output voltage to some internal fixed reference voltage. Any difference is amplified and used to control the regulation element in such a way as to reduce the voltage error. This forms a negative feedback control loop; increasing the open-loop gain tends to increase regulation accuracy but reduce stability (avoidance of oscillation or ringing during step changes). There will also be a trade-off between stability and the speed of the response to changes [1].

Many researchers are worked in the design and optimized of the AVR. The objective is to maintain the terminal voltage as a constant at the operating points. The main requirements for designing the AVR are fast response, small overshoot and zero steady-state error to the deviation of the reference voltage [6].

II.LITERATURE REVIEW

There are many optimization techniques can be analyzed for AVR but in this survey some optimization techniques will discussed like real-valued genetic algorithm (RGA) , particle swarm optimization (PSO), Taguchi combined genetic algorithm (TCGA) method, modern heuristic optimization algorithms such as Artificial Bee Colony (ABC) algorithm, Many Optimizing Liaisons (MOL) , Differential Evolution (DE) algorithm and teaching–learning based optimization (TLBO) algorithm. There are many controllers can be anlyzed for AVR like Artificial Neural Network intelligent (ANN) and Fuzzy Logic Controllers (FLC).

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Table: 1 Research Summary at a Glance

Sr. No.	Authors Name	Controller	Technology/Methods	Outcome
1.	Pradeep Kumar Mohanty , Binod Kumar Sahu	PID controller optimization	TLBO algorithm and Integral Time Absolute Error	50% robustness
2.	Hany M. Hasanien	PID controller	Taguchi combined genetic algorithm(TCGA)	minimize maximum percentage overshoot, rise time, settling time, and steady-state error
3.	Narendra Kumar Yegireddy,Sidhartha Panda,Papinaidu Tentu, Durgamalleswarao K.	AVR system tuned by NSGA-II	Artificial Bee Colony (ABC) algorithm, PSO, MOL	Time constants of amplifier, exciter, generator and sensor in the range of -50% to +50% insteps of +25%.
4.	K.K.Shyu et al.	PS-PWM	----------	Quick voltage control and lessened aggregate music
5.	V. Rajinikantha, Suresh Chandra Satapathy	1DOFPID, 2DOFPID, AVR	TLBO, PSO,BOF	filter offers smooth reference tracking response

III. AUTOMATIC VOLTAGE REGULATOR

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. The AVR maintain output voltage and control input voltage for exciter of generator. In figure: 1 automatic voltage regulator block diagram and combinations of blocks like PID Controller, Amplifier, exciter, generator and a sensor is connected in feedback of above blocks.

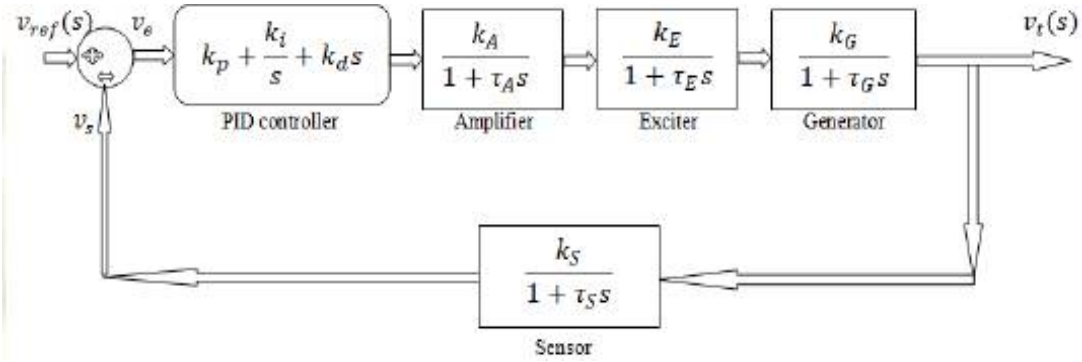

Figure: 1 Automatic Voltage Regulator

In above figure determination of termianl voltage as per transfer function:

$$\Delta V_t(S) = \left[\Delta V_{ref}(S) - \left(\frac{K_A}{1+\tau_A S} \right) \Delta V_t(S) \right] \times \left[\left(\frac{K_A}{1+\tau_A S} \right) \left(\frac{K_E}{1+\tau_E S} \right) \left(\frac{K_G}{1+\tau_G S} \right) \left(K_P + \frac{K_i}{S} + K_d S \right) \right]$$

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The AVR system can be improved through Taguchi combined genetic algorithm method [5]

IV. PID CONTROLLER

There are three coefficients: proportional coefficient, differential coefficient, and integral coefficient in the PID controller. PID controller parameters are tuned by the optimal algorithms such as the Simulated Annealing (SA), Genetic Algorithm (GA), and Particle Swarm Optimization (PSO) algorithm [3].
A proportional-integral-derivative (PID) controller is a generic feedback controller widely used in industrial control systems, process control, motor drive, and instrumentation. The tuning aspect of PID coefficients is a challenge for researchers and plant operators [7].
The GPID controller consists of two parts, i.e. a conventional PID controller together with a gray compensation controller. GPID controller can effectively deal with the uncertainties in AVR system[8].

Table: 2 Controller Coefficients

S. No.	Controller	Kp	Kd	Ki
1.	PIDGA[2]	0.77	0.31	0.72
2.	PIDPSO[2]	0.67	0.26	0.59
3.	PIDRGA[3]	0.02	0.24	0.29

V. CONCLUSION

The controller showed good ratification performance and provide a stable output, transient voltage are established and step response of the AVR system can be improved. The power acceleration and terminal voltage have good damping characteristic with PID-MPC controller. The mechanical angles go to steady state with more damping without any overshoot. Fitness function of any optimization technique like RGA and PSO find a high-quality PID control parameter set effectively, It is based on automatic voltage regulator which is optimized by very novel concept particle swarm optimization is better than compare to other optimized technique. However, with PSO-PID system performance is improved but further have small overshoot and undershoot will be developing using MATALB/Simulink software.

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