MATLAB/SIMULINK OF AUTOMATIC VOLTAGE REGULATOR USING PSO-PID CONTROLLER

Rakesh Singh Lodhi[1], Abhishek Saraf[2]

[1]*Associate Professor, Department of Electrical & Electronics Engineering, Oriental University, Indore, MP, India*
[2]*M.Tech Research Scholar, Department of Electrical & Electronics Engineering, Oriental University, Indore, MP, India*

Abstract

This paper presents on MATLAB/Simulink of automatic voltage regulator for synchronous generator with PID Controller. 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 in this paper PSO based PID controller with Automatic Voltage Regulator and stabilizer are used to determine performance parameter of Maximum overshoot (23%), undershoot (10%), settling time (2sec), the rise time (0.4498) and steady state error (0).

Keywords: *MATLAB/Simulink AVR, PID Controller*

----------***----------

1. INTRODUCTION

Paragraph comes content here. Paragraph an automatic voltage regulator is prepared with reference voltage source without any controller through transfer function model. The model is initially considered with PID controller and then with PSO-PID controller, the simulink model using MATLAB software and results are obtained in this section and discussion in carried out. Different configurations are taken for AVR like:

- Automatic Voltage Regulators Without Controller
- Automatic Voltage Regulators With PID Controller
- Automatic Voltage Regulators With PSO-PID Controller
- Proposed Automatic Voltage Regulators System With Stabilizer.

2. PSO-PID Based AVR

Automatic voltage regulators are used to control generators output. 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.

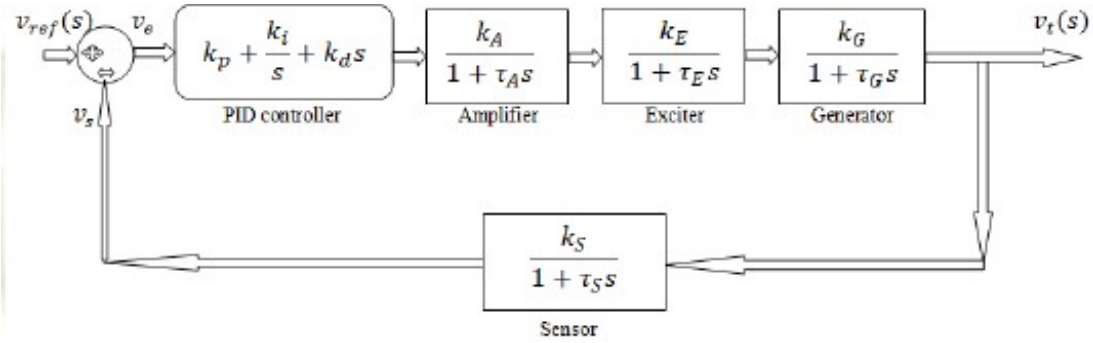

Fig-1: Automatic Voltage Regulator

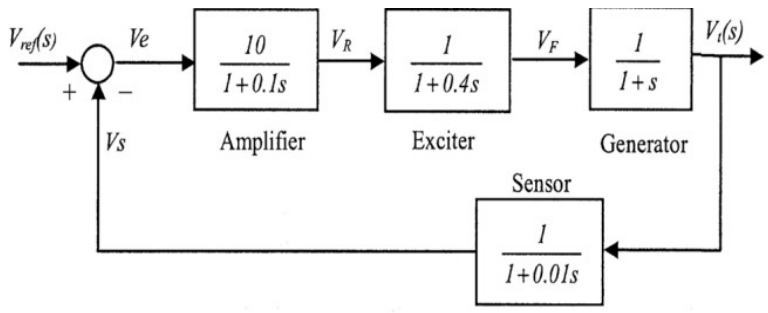

Fig-2: Transfer Function model of Automatic Voltage Regulator

3. PROBLEM IDENTIFICATION & PROPOSED METHODOLOGY

Particle swarm optimization is used in automatic voltage regulator. First generate the population according to the requirement of automatic voltage regulator. Reset the iteration according to change the limit of automatic voltage regulator. Set counter 0 for initiate the system and after that calculate maximum and minimum overshoot. For update the result updates the particle size until reach desired requirement.

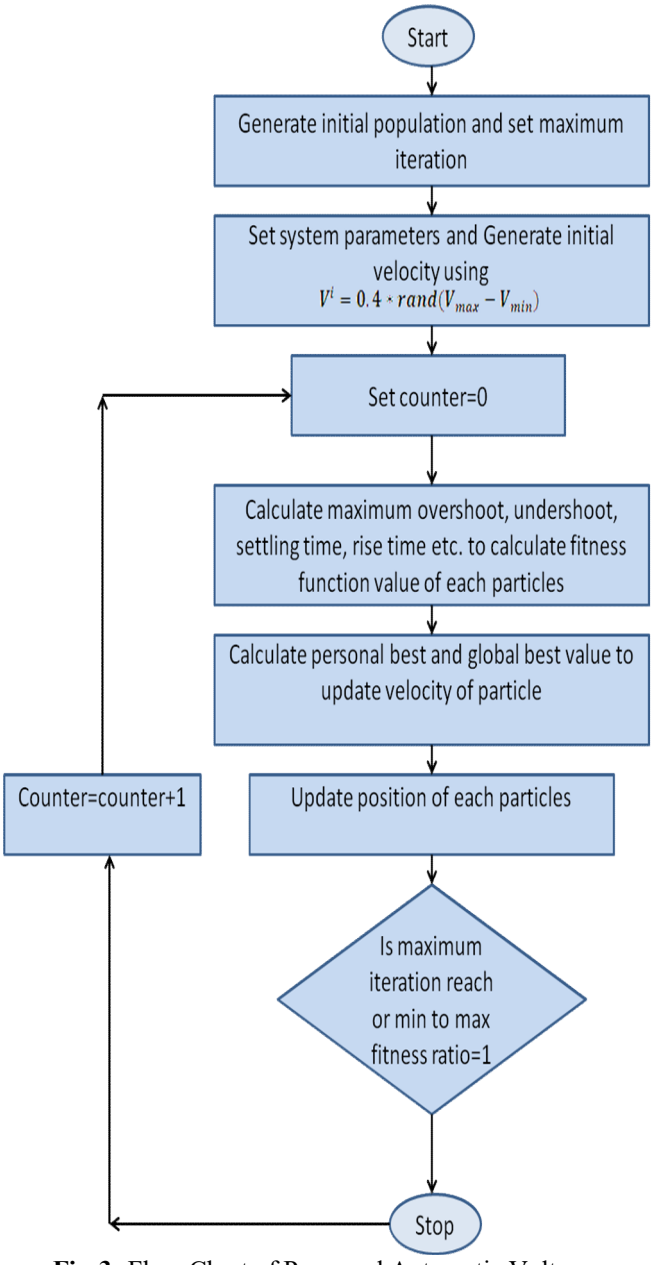

Fig-3: Flow Chart of Proposed Automatic Voltage Regulator with PSO-PID

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-1: 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

4. SIMULINK OF PSO-PID BASED AVR & RESULT

PSO-PID system performances are improved but further have small overshoot and undershoot. Particle swarm optimization PID controller of AVR model is Simulink through transfer function of amplifier, exciter and generator. In figure 4 shows MATLAB model of Automatic Voltage Regulator with and without stabilizer. Different categories of results are determining like AVR without controller, with controller and without PID, with PID, so comparison is very easy for better performance of AVR with stabilizer.

In figure 5 response of system has large maximum overshoot (67%), settling time (18sec) and oscillation. Comparative analysis for automatic voltage regulator is shown in figure-7. With stabilizer overshoot of system is reduces to zero and settling time is set at 3.98 sec as shown in figure-7. Comparative analysis of these responses is shown in Table-2

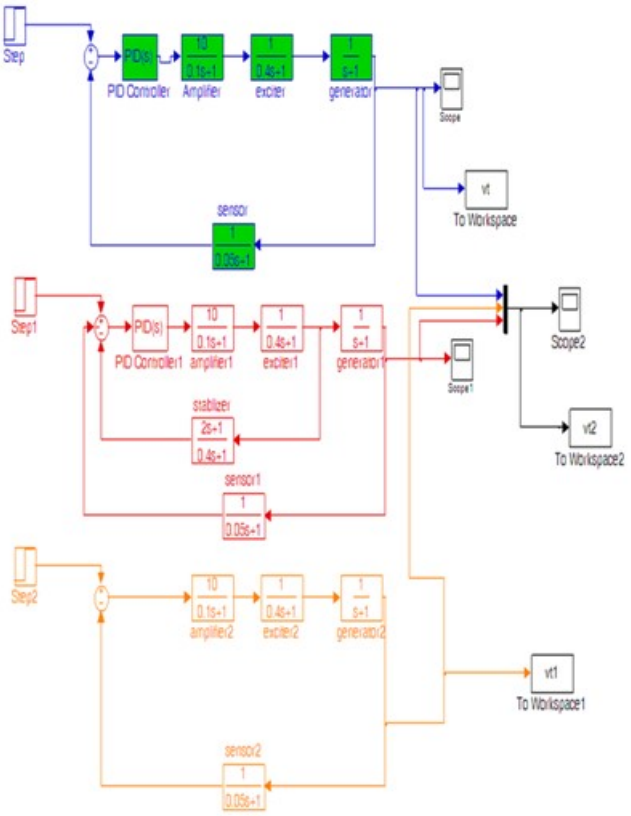

Fig-4: MATLAB/Simulink model of Automatic Voltage Regulator with and without stabilizer

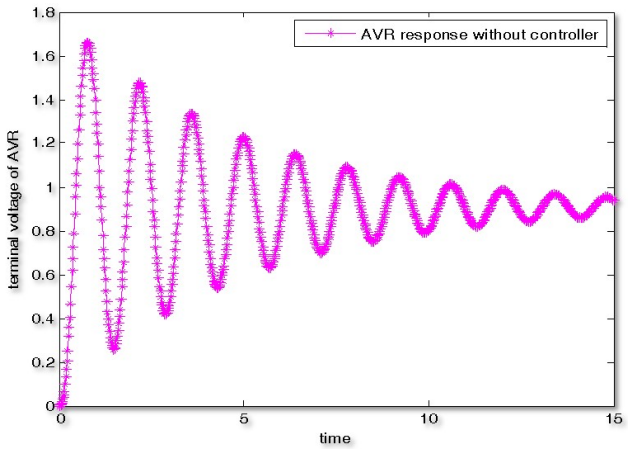

Fig-5: Simulink Result of Automatic Voltage Regulator without controller

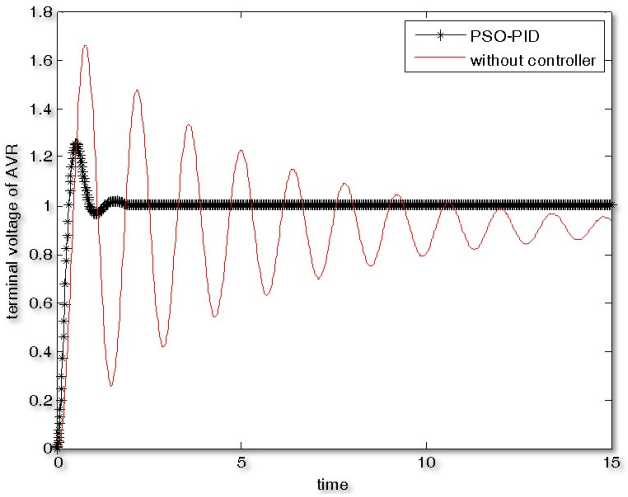

Fig-6: Simulink Result of Automatic Voltage Regulator without PID and with PSO-PID controller

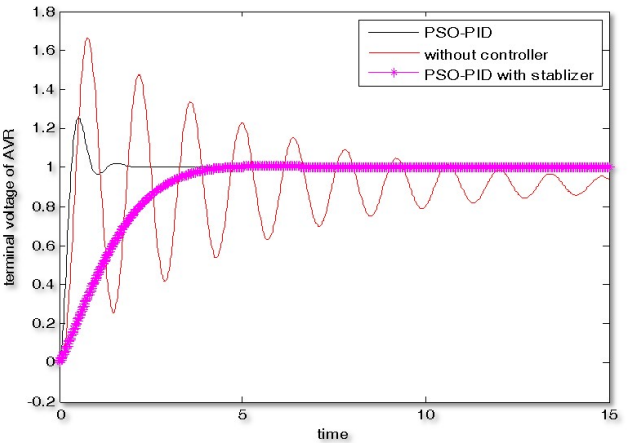

Fig-7: Simulink Result of Automatic Voltage Regulator without PID and with PSO-PID controller and PSO-PID with stabilizer

5. 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 PSO-PID controller. The mechanical angles go to steady state with more damping without any overshoot. Fitness function of any optimization technique like 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 with stabilizer is better than PSO-PID controller in AVR.

system	Overshoot (%)	Undershoot (%)	settling time (sec)	Rise Time (sec)	ESS
without controller	67	37	18.67	8.34	0.01
with PSOPID (kp=0.7964, ki=0.6743, kd=0.2132)	23	10	2	0.4498	0
with stabilizer	0	0	3.98	2.45	0

ACKNOWLEDGEMENT

The authors can acknowledge any person/authorities in this section. This is not mandatory.

REFERENCES

[1] M. RabiulAlam, RajibBaran Roy, S.M. Jahangir Alam , DewanJuel Rahman "Single Phase Automatic Voltage Regulator Design for Synchronous Generator" International Journal of Electrical & Computer Sciences IJECS-IJENS Vol 11 year 2011.

[2] Rakesh Singh Lodhi, H.K.Verma and D.P. Kothari "Analysis and Design of PID Controller for chopper fed separately excited dc motor" ECOMM-11, 8-9 April, 2011

[3] Gaing, Z. L., "A Particle Swarm Optimization Approach for Optimum Design of PID Controller in AVR System," IEEE Transactions on Energy Conversion, Volume 19, pp. 384-394 year 2004.

[4] Ching-Chang Wong, Shih-An Li ,Hou-Yi Wang "Optimal PID Controller Design for AVR System" Tamkang Journal of Science and Engineering, Volume 12, pp. 259-270 year 2009.

[5] S. Panda,B.K. Sahu ,P.K. Mohanty "Design And Performance Analysis Of PID Controller for An Automatic Voltage Regulator System Using Simplified Particle Swarm Optimization" Volume 349, Issue 8, Page 2609–2625 October 2012.

[6] Hany M. Hasanien "Design Optimization of PID Controller in Automatic Voltage Regulator System Using Taguchi Combined Genetic Algorithm Method" IEEE Transaction Volume 07 Year 2012.

[7] Mohammad SadeghRahimian, KaamranRaahemifar "Optimal PID Controller Design For AVR System Using Particle Swarm Optimization Algorithm" Electrical and Computer Engineering (CCECE), 2011 24th Canadian Conference Pages 337 – 340 year 8-11 May 2011.
[8] Yinggan Tang, Liheng Zhao, Zhenzhen Han, Xiangwei Bi, Xinping Guan "Optimal gray PID controller design for automatic voltage regulator system via imperialist competitive algorithm" International Journal of Machine Learning and Cybernetics Volume 7, Issue 2, pp 229–240 year April 2016.
[9] J. Kennedy and R. Eberhart, "Particle Swarm Optimization" in Proceding IEEE International Conference Neural Networks, vol. IV, Perth, Australia, , pp. 1942–1948 year 1995
[10] Y. Shi and R. Eberhart, "A Modified Particle Swarm Optimizer," in Proceding IEEE International Conference pp. 69–73 May 1998.
[11] Y. Shi and R. C. Eberhart, "Empirical Study of Particle Swarm Optimization," in Proceding IEEE International Conference Washington, DC pp. 1945–1950, July 1999.
[12] R. C. Eberhart and Y. Shi, "Comparison between Genetic Algorithms and Particle Swarm Optimization" in Proceding IEEE International Conference, pp. 611–616 May 1998.
[13] Rakesh Singh Lodhi, AbhishekSaraf "Survey on PID Controller Based Automatic Voltage Regulator" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering ISSN 2278 – 8875, September 2016.
[14] A. H. M. S. Ula and A. R. Hasan, "Design and Implementation Of A Personal Computer Based Automatic Voltage Regulator for a Synchronous Generator", IEEE Transaction Energy Converters, vol. 7, pp. 125-131, 1992
[15] [14] K. J. Astrom and T. Hagglund, "The Future of PID Control", Control Engineering Practice, vol. 9, pp. 1163-1175, 2001
[16] A. Visioli, "Tuning Of PID Controllers with Fuzzylogic", IEE Proceding Control Theory Application, vol. 148, pp. 1-8, 2001
[17] X.H. Li , H. B. Yu , M. Z. Yuan and J. Wang, "Design of robust optimalproportional-integral-derivative controller based on new interval polynomial stability criterion and Lyapunov theorem inthe multiple parameters\' perturbations circumstance", IET Control TheoryAppl., vol. 4, no. 11, pp. 2427-2440, 2010
[18] R. A. Krohling and J. P. Rey, "Design of optimal disturbance rejection PID controllers using geneticalgorithms", IEEE Trans. Evol. Comput., vol. 5, pp. 78-82, 2001
[19] J. S. Chiou and M.-T. Liu, "Numerical simulation for fuzzy-PIDcontrollers and helping EP reproduction with PSO hybrid algorithm", Simulation ModelingPractice Theory, vol. 17, no. 10, pp. 1555-1565, 2009
[20] A. M. Omekanda, "Robust torque and torque-per-inertiaoptimization of a switched reluctance motor using the Taguchi methods", IEEE Trans. Ind.Appl., vol. 42, no. 2, pp. 473-478, 2006
[21] C.-C. Hwang, L.-Y. Lyu, C.-T. Liu and P.-L. Li, "Optimal design of an SPM motor using geneticalgorithms and Taguchi method", IEEE Trans. Magn., vol. 44, pp. 4325-4328, 2008
[22] B.J. Chalmers, "Influence of saturation in brushless permanent-magnet motor drives," IEE Proc. B, Electr. Power Appl., vol. 139, no. 1, pp.51- 52, 1992.
[23] C. T. Johnson and R.d. Lorenz, "Experimental identification of friction and its compensation in precise, position controlled mechanisms," IEEE Trans. Ind. Applicat., vol.28, no. 6,pp. 1392-1398,1992.
[24] Bevrani H, Watanabe M, MitaniY."Power system monitoring and control" Wiley-IEEE Press, New York, USA 2014

BIOGRAPHIES

Rakesh Singh Lodhi is working as Associate Professor and Head in Department of Electrical & Electronics Engineering, Oriental University, Indore (M.P.) India. His area of research is automatic voltage regulator, particle swarm optimization, Control System, stabilizer and Power System.

Abhishek Saraf is pursuing M.Tech research scholar in Electrical Power System from department of electrical & electronics engineering, Oriental University, Indore under the guidance of academicians of University. He is working on area of automatic voltage regulator and PSO-PID Controller and comparison between PSO-PID without and with controller.