International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 03 | Mar 2021 www.irjet.net p-ISSN: 2395-0072

Design of Optimally Tuned PID Controller using Particle Swarm Optimization Algorithm

Sofia.T.D

Assistant Professor , Ponjesly College of Engineering

Abstract—*PID Controller (Proportional Integral Derivative) was developed since 1910, yet till today actually is utilized in enterprises, despite the fact that there are numerous sort of current regulators like fluff regulator and neural organization regulator are being created. Execution of PID regulator is rely upon on Proportional Gain (Kp), Integral Gain (Ki) and Derivative Gain (Kd). These increases can be got by utilizing strategy Ziegler-Nichols (ZN), acquire stage edge, Root Locus, Minimum Difference dan Gain Scheduling anyway these strategies are not ideal to control frameworks that nonlinear and have high-orde, furthermore, a few techniques relative hard. To settle those snags, Particle Swarm Optimization (PSO) calculation is proposed to get ideal Kp, Ki and Kd. PSO is proposed on the grounds that PSO has merged outcome and not need numerous cycles. On this examination, PID regulator is applied on AVR (Automatic Voltage Regulator). In light of consequence of dissecting transient, solidness Root Locus and recurrence reaction, execution of PID regulator is better than Ziegler-Nichols.*

Key Words : PID Controller, Particle Swarm Optimization, Automatic Voltage Regulator.

1. INTRODUCTION

PID regulator is one of the regulators of the most generally utilized in enterprises. Despite the fact that there are regulators present day, as of late being produced for instance, fluffy regulator, however regulator PID is still utilized till today [1]. The presentation of PID regulator is rely upon Gain Proportional (Kp), Gain Integral (Ki) and Gain Derivative (Kd), the determination of those qualities are not fitting can make the framework become precarious [2][3]. There are a few techniques to discover the estimation of the increases like Ziegler-Nichols (ZN), acquire stage edge, Root Locus, Minimum Variance and Gain Scheduling. In any case, these techniques were viewed as not exactly ideal for a framework that non-straight and has high orde [4][5][3], other than a few of these strategies in computation relative hard. To address these snags the calculation Molecule Swarm Optimization (PSO) is proposed which is allotted to discover the estimation of Kp, Ki and Kd are streamlined, where regulator PID is applied on programmed voltage controller (AVR). PSO is proposed since it has the consequences of convergence and don't need various cycles, so in family member count relative brisk.

In measure enterprises, numerous significant constant preparing units like Continuous Stirred Tank Reactor (CSTR), biochemical reactor, and circular tank framework are profoundly nonlinear in nature. Tuning of regulators to settle these nonlinear compound cycle circles and bestow satisfactory aggravation dismissal is basic as a result of their mind boggling nature. In view of the working locales, the majority of the substance circles display stable as well as flimsy consistent states.

Regulator tuning is a fundamental primer technique in practically all modern interaction control frameworks. In control writing, various regulator structures are accessible to balance out steady, shaky, and nonlinear cycles [6-10]. Planning regulator for measure with stable working locale is very basic. For temperamental frameworks, there exist least and greatest estimations of regulator acquire, and the normal of this restricting worth is considered to plan the regulator to balance out the framework. The increment in time delay in the process limits the restricting worth and confines the exhibition of shut circle framework leveled out. Also, these frameworks show bizarre overshoot or reverse reaction because of the presence of positive zeros [11].

Customary regulator tuning strategies proposed by the majority of the analysts are model ward, and they require a decreased request models, for example, first-request or second-request measure model with time delay. Especially for unsteady frameworks, the tuning rule proposed for a specific diminished request model won't offer a fitting reaction for different models (higher request models, model with a positive or negative zero, model with a huge postpone time to handle time consistent proportion, and so on) The majority of the old style PID tuning strategies require mathematical

calculations to get the most ideal regulator boundaries. Because of these reasons, as of late, heuristic calculation based regulator tuning has extraordinarily pulled in the scientists.

From ongoing writing, it is seen that heuristic calculation based advancement methodology have arisen as a useful asset for finding the answers for assortment of control designing issues [12]. Heuristic calculations are broadly utilized in measure control on account of their primary straightforwardness, better advancement capacity, and speed of reaction. Heuristic calculations can viably work for higher dimensional enhancement issues contrasted with the current traditional streamlining techniques. Because of their adaptability, they can without much of a stretch adjust to the current traditional regulator plan techniques. They can be utilized as a fundamental instrument to plan old style and changed organized regulators for a class of temperamental interaction models, independent of its model request. Latest heuristic strategies like Genetic Algorithm (GA) [11], Ant Colony Optimization (ACO) [13], Bacterial Foraging Optimization (BFO) [14], and Particle Swarm Optimization (PSO) [16, 15] are broadly tended to by the analysts to tune regulators for a class of interaction models. In this paper, PID regulator boundary tuning is endeavored utilizing the PSO calculation presented by Kennedy and Eberhart [16].

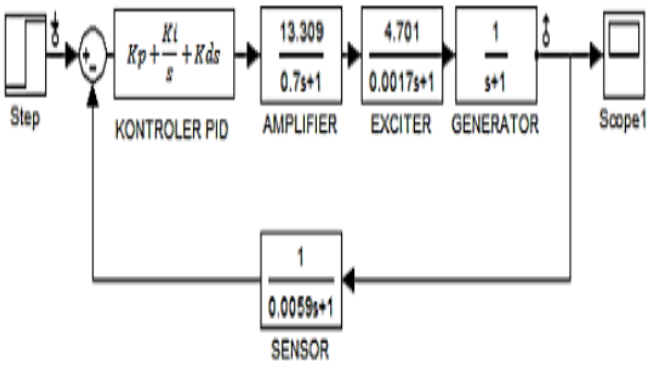

Fig-1 Block Diagram of AVR System

2. METHODOLOGIES

Molecule Swarm Optimization (PSO) procedure, proposed by Kennedy and Eberhart [16], is a transformative sort worldwide advancement method created because of the motivation of social exercises in group of birds and school of fish and is generally applied in different designing issues because of its high computational proficiency [6–10, 20–23]. Contrasted and other populace based stochastic streamlining strategies, for example, GA and ACO, PSO has equivalent or even unrivalled quest execution for some hard advancement issues, with quicker and more steady intermingling rates. It has been end up being a viable ideal device in framework distinguishing proof and PID regulator tuning for a class of cycles [24].

2.1 . PARICLE SWARM OPTIMIZATION

PSO calculation was first presented by Eberhart and Kennedy in 1995 [11]. The birthplace of the PSO terinipirasi of the conduct of a herd of birds or a school of fish while looking for prey [12]. Showing how the Particle Swarm Optimization, to take the case of various patikel (in PSO, people are frequently alluded to patikel), N moving together in a pursuit space S. Every particles of I is kanidat settlement and communicated by the vector xi. Every molecule has a position and speed and will move dependent on experience and data from the social climate and the current position and the molecule. Experience molecule I communicated as pi best position at any point accomplished by these particles. Data from the climate is addressed by particles that have the best position g, in the assortment of the particles, while, the current situation of molecule I is communicated by xi (t-1). Change the speed of the molecule and molecule position (vi, xi) was resolved dependent on two conditions underneath as follows

$$\boldsymbol{v_i = v_i(t-1) + \varphi c_1\big(p_i - x_i(t-1)\big) + \varphi c_2\big(g - x_i(t-1)\big)}$$

First step in PSO is introduction is to decide the quantity of cycles, the quantity of populace (n) inactivity weight (w) and cognetif learning and social learning (c1 and c2), The subsequent stage excited the populace as an irregular lattice with a scope of qualities [0,1] that the measurement (dimensi_masalah.xn). Age populace by composing sinkaks matlab rand (dimensi_masalah, n). From that point forward, the instatement speed and position. In this progression makes the estimation of the speed and position of a molecule to be equivalent to nothing, Than Calculate the blunder (Vref-Vout), The sum utilized for this situation is a power unit (pu) are worth one. Depiction 1 pu approaches yout reference and a generator terminal voltage esteem, at that point mistake = | 1-yout |. The subsequent stage is to figure the estimation of wellness or capacity to be improved. In this paper ITAE (Integrated Time of Weighted Absolute Error) proposed, and proceed with update speed and update position. This cycle continue till emphasis greatest. Subsequent to finishing figure till iterasi

greatest, at long last check whether the aftereffect of figuring as of now combination ? on the off chance that it as of now convergence execute if no attempt again as well as change the initialization

2.2 . OBJECTIVE FUNCTION

The general exhibition (speed of assembly, proficiency, and streamlining precision) of PSO calculation relies upon Objective Function (OF), which screens the improvement search. The OF is picked to augment the space obliges or to limit the inclination compels. During the pursuit, without loss of over-simplification, the compelled streamlining issue limits a scalar capacity "J" of some choice variable vector "D" in a universe "U". The target work is to be outlined by accepting, at any rate, that there exists one bunch of ideal boundaries in "" which fulfills every one of the limitations.

2.3 . CONTROLLER TUNING

The regulator configuration measure is to track down the ideal qualities for regulator boundaries structure the inquiry space that limits the thought about target work. At first, PSO calculation relegates self-assertive qualities for K_p, K_j, K_d and processes the OF. This methodology proceeds until the spans or the last cycle number is reached.

RESULT AND DISCUSSION

Subsequent to figuring upwards of fifty emphasess (50) consequence of significant worth Kp, Ki and Kd. Kp = 1,068; Ki = 0:04 Kd = 0.4011. These worth is picked not just as of now arrive at the counts as much as multiple times (50 emphasess), yet additionally the inclination of convergance

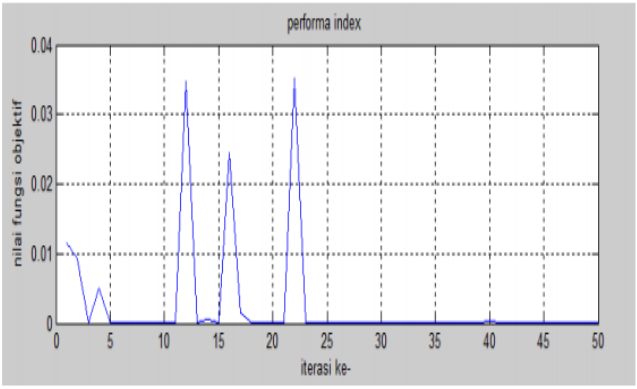

Fig-2 Trendency convergence result

Transient investigation is finished by giving a sign on the framework. The best framework is a framework that has the information and yield signals are indistinguishable. The aftereffects of transient investigation utilizing the calculation PSO has a estimation of overshoot is more modest 15.9% of the framework with the ZN-PID and less 65% of the framework without PID regulator, for frameworks with PSO-PID estimation of busy time 20.3% quicker than the framework without the PID and 73.8% quicker contrasted with ZN-PID framework. Qualities rise time for PSO-PID framework with 37.01% what's more, 7.61% quicker than a framework with ZN-PID and without PID framework. Worth settling time for the framework to PSO PID quicker 398.9% (practically 4x quicker) than the framework without the PID and 239.1% (2x quicker) than a framework with ZN-PID and last worth mistake consistent state for the framework with the PSO-PID is 0 %.

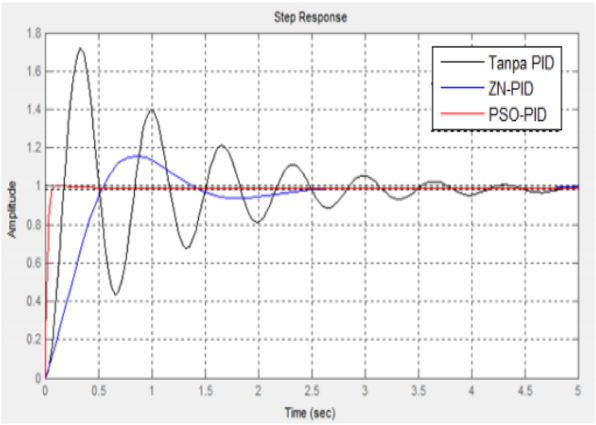

Fig-3 Step response

CONCLUSION

The principle reason for the use of PSO calculation in PID regulator is to decide the cost of Kp, Ki and Kd are ideal, so it can improve the exhibition of PID regulators. Aftereffects of the application of PSO calculation will contrast the outcomes and the technique ZN (Ziegler-Nichols) and without PID framework. Consequences of the transient investigation shows that the PSO-PID overshoot and settling time have the most reduced contrasted with ZN-PID and PID Without a framework. In view of Root Locus damping proportion claimed PSO-PID has the biggest worth really near one and depends on the recurrence reaction utilizing Bode

plots PSO-PID has a transfer speed of the vastest and the cost of the thunderous recurrence of the best, so that both the transient investigation, Root locus and recurrence reaction of the framework by PSO-PID has the best execution among ZN-PID and without PID framework.

REFERENCES

[1] K. H. A. K. H. Ang, G. Chong, and Y. L. Y. Li, "PID control system analysis, design, and technology," IEEE Trans. Control Syst. Technol., vol. 13, no. 4, pp. 559–576, 2005.
[2] Y.-B. W. Y.-B. Wang, X. P. X. Peng, and B.-Z. W. B.-Z. Wei, "A new particle swarm optimization based auto-tuning of PID controller," 2008 Int. Conf. Mach. Learn. Cybern., vol. 4, no. July, pp. 12–15, 2008.
[3] S. Panda, B. K. Sahu, and P. K. Mohanty, "Design and performance analysis of PID controller for an automatic voltage regulator system using simplified particle swarm optimization," IET J. Franklin Inst., vol. 349, no. 8, pp. 2609–2625, 2012. [4] Z.-L. L. Gaing, "A Particle Swarm Optimization Approach for Optimum Design of PID Controller in AVR System," IEEE Trans. Energy Convers., vol. 19, no. 2, pp. 384–391, 2004.
[5] D. D. B. Selvabala, "Real-coded genetic algorithm and fuzzy logic approach for real-time tuning of proportional – integral – derivative controller in automatic voltage regulator system," vol. 3, no. February, pp. 641–649, 2009.
[6] Saadat, H. (1999). Power Stability Analysis. Third Edition. Mcgraw-Hill:New York
[7] Ogata, Katsuhiko. (1985). Teknik Kontrol Automatik Jilid 1. Alih Bahasa oleh Edi Laksono. Jakarta: Erlangga.
[8] C. Wong, S. Li, and H. Wang, "Optimal PID Controller Design for AVR System," vol. 12, no. 3, pp. 259–270, 2009.
[9] B. K. Sahu, P. K. Mohanty, and N. Mishra, "system using Pattern Search algorithm," IEEE Int. Conf. Power Electron. Device Energy Syst. 2012, 2012. [10] N. Madinehi, K. Shaloudegi, M. Abedi, and H. A. Abyaneh, "Optimum design of PID controller in AVR system using intelligent methods," 2011 IEEE PES Trondheim PowerTech Power Technol. a Sustain. Soc. POWERTECH 2011, pp. 1–6, 2011.
[10] S. M. G. Kumar, R. Jain, N. Anantharaman, V. Dharmalingam, and K. M. M. S. Begam, "Genetic algorithm based PID controller tuning for a model bioreactor," *Indian Institute of Chemical Engineers*, vol. 50, no. 3, pp. 214–226, 2008.
[11] M. Zamani, M. Karimi-Ghartemani, N. Sadati, and M. Parniani, "Design of a fractional order PID controller for an AVR using particle swarm optimization," *Control Engineering Practice*, vol. 17, no. 12, pp. 1380–1387, 2009.
[12] I. Chiha, N. Liouane, and P. Borne, "Tuning PID controller using multiobjective ant colony optimization," *Applied Computational Intelligence and Soft Computing*, vol. 2012, Article ID 536326, 7 pages, 2012.
[13] V. Rajinikanth and K. Latha, "Bacterial foraging optimization algorithm based pid controller tuning for time delayedunstable systems," *Mediterranean Journal of Measurement and Control*, vol. 7, no. 1, pp. 197–203, 2011.
[14] V. Rajinikanth and K. Latha, "Identification and control of unstable biochemical reactor," *International Journal of Chemical Engineering Applications*, vol. 1, no. 1, pp. 106–111, 2010.