International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 8 Aug. 2022, pp: 1216-1220 www.ijaem.net ISSN: 2395-5252

Chaotic Map Depend Optimization GOA for Tuning of PID Controller Based on AVR System

Prateek Kambar, Kalpana Meena
[1,] Student, Rajasthan Institute of Engineering and Technology,Jaipur, Rajasthan,
[,2]Assistant Professor, Rajasthan Institute of Engineering and Technology,Jaipur, Rajasthan

----
Submitted: 10-08-2022 Revised: 22-08-2022 Accepted: 24-08-2022

ABSTRACT:Despite the popularity, the tuning aspect of proportional–integral-derivative (PID) controllers is an issue for investigators and plant operators. Chaotic optimization techniques as an evolving technique of global optimization have drawn great attention in industrial applications.A striking result for industrial processes is Chaotic optimization algorithms, which have the characteristics of easy implementation, fast execution time and reliable local optimum escape structures. In this article, a tuning method using a chaotic optimization technique is suggested to decide the specifications of GOA-PID regulation for an automatic regulator voltage (AVR) device.Chaos mapping is implemented by the suggested chaotic optimization. Chaotic series that improve its convergence speed and subsequent accuracy. The findings of the experiment are positive and illustrate the feasibility of the suggested solution.The strong performance of chaotic optimization is demonstrated by numerical simulations focused on suggested GOA-PID regulation of an AVR system for nominal process variables and phase boost converter input.

KEYWORDS:PID controller, Voltage control, AVR, GOA-PID controller.

I. INTRODUCTION

The primary power of the buyer in the energy sector is the efficiency of electrical energy. As voltage and frequency are the quality indicators, these variables should be maintained at all times at the desired rate. Usually, in any power grid, the rate refers to the active power flow, whereas the reactive power flow has a greater effect on the impedance level [1]. Consequently, any variation of the voltage from the nominal value requires the flow of the reactive power, which immediately raises system losses. The fluctuations of the voltage could be repressed using multiple devices: serial and parallel capacitor banks, synchronous compensators, tap-changing transformers, reactors, SVC, and AVR [2].

The AVR is the central control loop for the SG voltage regulation, which is the primary component for the output of electric power in the entire power grid. Specifically, by changing its 'exciter voltage[3], the power of the terminal voltage of the power system is accomplished. While providing a steady voltage level at the generator terminals is the primary task of the AVR, it is very critical to enhance the dynamic response of the terminal voltage. Despite the fact that several new control methods have been introduced by the linear programming, the conventional PID controller in the AVR frameworks is by far the most utilized. In particular,the optimal tuning of the controller is regarded. Improving the efficiency of the PID controller for AVR structures is feasible through using chaotic GOA.

The organization of this paper is as follows. A brief overview of the AVR system, along with the performance analysis, is provided in Section II. Section III explain Goa optimization. Section IV demonstrates literature related to GOA-PID parameters optimization is given. Section V explains proposed objectives. Section VI shows results of the propose approach.Conclusions are provided in Section VII.

II. AVR SYSTEM

The main purpose of an AVR device is to preserve the generator's terminal voltage via the excitation current at a steady level [4]. Even so, a synchronous generator doesn't often operate at the equilibrium point because of the various disruptions in the power grid.These oscillations

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 8 Aug. 2022, pp: 1216-1220 www.ijaem.net ISSN: 2395-5252

around the equilibrium state may induce frequency and voltage deviations, which could be quite dangerous to the energy program's general performance. Excitation devices fitted with AVR are used to increase the output reliability of the power grid, as well as to offer amazing progress to customers. The development of an AVR system is a major and demanding assignment along with an essential function.

A typical AVR device comprises of the following elements:

- controller,
- amplifier,
- exciter,
- generator, and
- sensor.

A synchronous generator which terminal voltage is calculated and resolved by the sensor is the entity which tries to ensure in this control system. In the comparator, an error signal is produced, which shows the variance among the expected and the calculated voltage value. The operator is one of the essential aspects that requires to be carefully selected in the AVR system.The controller determines a reference voltage depend on the error signal and the effective control method chosen [12]. The controller is very often known as a microcontroller device whose power consumption is insufficient. The presence of the amplification is important in effort to expand the strength of the control signal.Eventually, an amplified signal is utilized to monitor the synchronous generator excitation mechanism and, thus, to determine the amount of the terminal voltage.

III. GRASSHOPPER OPTIMIZATION ALGORITHM

GOA is a recently suggested single goal, population-based heuristic technique that mimics and mathematically designs the behaviour of grasshopper swarms in nature to fix optimization issues with contentious variables [5]. Repulsion and attraction forces among grasshoppers are simulated by the method. Although repulsion forces allow grasshoppers to expand the search space, they are urged to explore the encouraging areas by attraction forces. GOA has been fitted with a multiplier that reduces the grasshoppers' comfort zone to match cycles of discovery and development over the period of optimization. This allows GOA not to get stuck in the locally optimal and to seek a reliable approximation of the best solution. Grasshoppers have a great chance to find the global optimum by increasing the target over the number of evolutions, as the obvious idea achieved so far by the swarm is treated as an objective to be followed. The GOA formula of position upgrading is given as in

$$X_i^d = r\left(\sum_{\substack{j=1 \\ j\neq i}}^{N} r\frac{ub_d - lb_d}{2} s\left(\left|x_j^d - x_i^d\right|\right)\frac{x_j - x_i}{d_{ij}}\right) + T_d \qquad (1)$$

To keep the transient response of an AVR device stronger, the suggested GOA tuned PID controller, which is named the GOA-PID controller, is provided. The AVR device block structure with the GOA-PID controller is shown in Fig. 1.

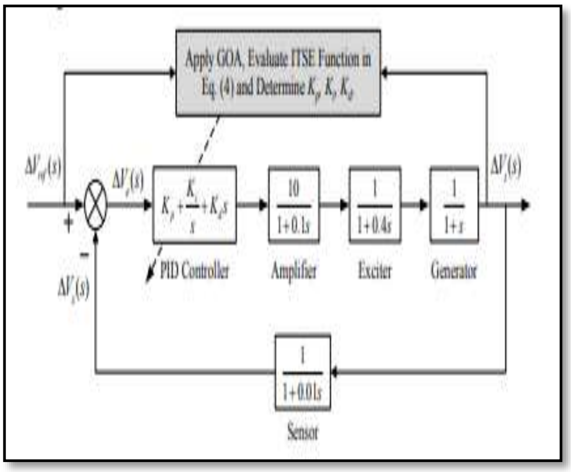

Figure 1: AVR system with GOA-PID controller

IV. LITERATURE SURVEY

Describes the model and deployment of the AVR based on PNN to enhance the power device transient capacity cap. AVR is configured for this work using various MATLAB / Simulink control strategies. Using traditional approach, PID approach, and PNN approach, AVR output is analysed. Effects of the simulation are described using simulations of time domains [7]. Results show that PNN-focused AVRs are robust on PID and traditional AVRs in spite of lower exceed point, ST or rising period.

An excellent model and tuning approach for an AVR device PID controller using a novel heuristic method called the CHLO. The CHLO is applied in MATLAB and the finding of the PID variables for said AVR framework is achieved by specifying the function of model as an issue of development. In order to reducing the IAE requirement with in-built weighted references for transient response features, the research issue is developed. The simulation studies are dedicated both to the application and to the discovery of the CHLO optimizer 's behavioural parameters. Performance tests are performed like temporary reaction indices, root locus evaluation, and bode analysis. The findings of numerical simulation support the suggested algorithm competitiveness and best classification ability than the BBO, PSO, differential evolution method (DEA), and the ABC method in the AVR device parameter identifier [8].

The device solution under the various limits is analysed for secure and reduced error operation with PID controller. The controller 's benefit exposed a recent optimization method from conventional approaches [9]. ECGOA will be introduced for the PID controller AVR device and the transient response, usability, reliability and error output will be contrasted to the current optimization technique. The ECGOA-depend PID technique offers excellent reaction or tested up to ±50 per cent of variance in multiple AVR syste components.

A technique for stable, optimal adjustment of the AVR, FoPID technique. And use the SSA of optimization, optimal tuning of FoPID variables for the AVR method is achieved. The output of the AVR device with an SSA tuned FoPID controller demonstrates the successful results of the system output toward deliberate disturbances. In order to measure the reliability of the device, the norm is found in the effect of various disturbance H. The SSA tuned PID technique AVR device is also modelled using the MATLAB policy. Findings demonstrate that, in the effect of various disruptions at device performance, the AVR device with SSA tuned FoPID technique outperforms the SSA tuned PID controller and displays its disturbance rejection abilities [10].

V. PROPOSED OBJECTIVES

Existing Problem

AVR device is used in an electric power device to regulate terminal voltage magnitude of the engine. The magnitude of this voltage is preserved by regulating the excitation generator to a given degree. In particular, optimum designed controller with classical optimization techniques are difficult to find. Thus, over the past two decades, many heuristic optimization approaches were developed for tuning controller parameters.

Given that the GOA method is not influenced by the Dynamic creation or severity of an issue, here another GO methods usually indicate advance concurrence, seeks optimal answer with quicker convergence high effectively. In traditional work, taking into account these strengths of the GOA method, a GOA-depend PID (GOA-PID) technique was suggested for a high-order AVR method. The suggested GOA tuned PID technique, which is named the GOA-PID technique, was implemented to enhance an AVR system's transient response.

In the process of optimizing PID controller,GOA technique takes the varying input signal which then creates the constant K_p , K_i, K_d values of PID at each iteration [11]. The static output value to differ input value does not result in a more productive method. It is important that extracted features should be dynamic, which may differ based on the varying input value, so that system can function more efficiently and accurately.

Therefore, in order to obtain an effective AVR scheme, the need emerges to update the traditional method.

VI. RESULTS

All the work are analysed in MATLAB R2018a software environment. The code for controller algorithms is implemented in .m file and executed in Intel® core™ i3-4005U CPU of 1.7GHz,4 GB RAM laptop. In this section, the suggested chaotic-GOA tuned PID controller, which is called Chaotic-GOA-PID controller, is provided to make the transient response of an AVR system stronger. The block diagram of AVR system with PID controller is shown in Fig. 2**.**

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 8 Aug. 2022, pp: 1216-1220 www.ijaem.net ISSN: 2395-5252

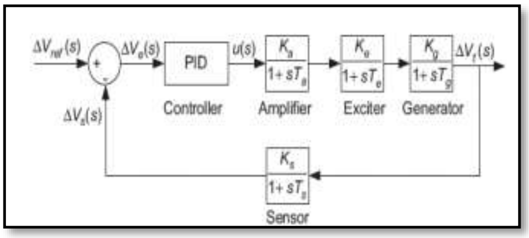

Figure 2: AVR system with PID controller

Figure 2 presents voltage harmonic distortions. The horizontal axis denotes the simulation time whereas vertical line shows the voltage harmonics percentage.
To analyse and design the proposed controller the considered performance index in this paper is the integral of time multiplied squared error (ITSE) and it is given as in

$$\text{ITSE}= \int_0^{\text{tsim}} (\Delta vt - \Delta vref)^2 \, dt$$

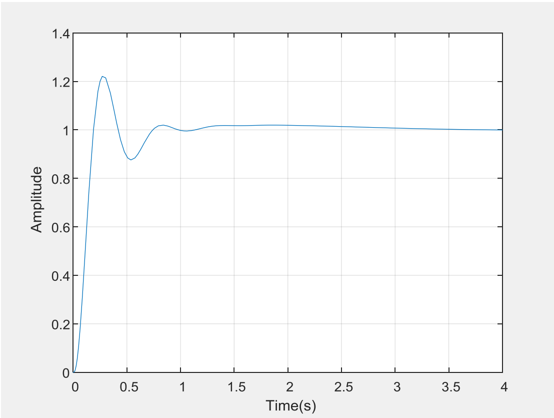

Figure 3: Step response of AVR system of proposed ChaosGOA-PID

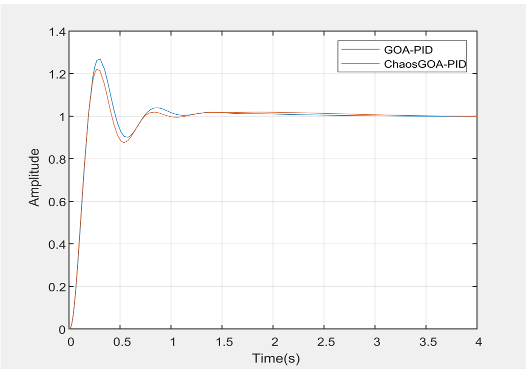

Figure 4: Step response of AVR system of proposed ChaosGOA-PID

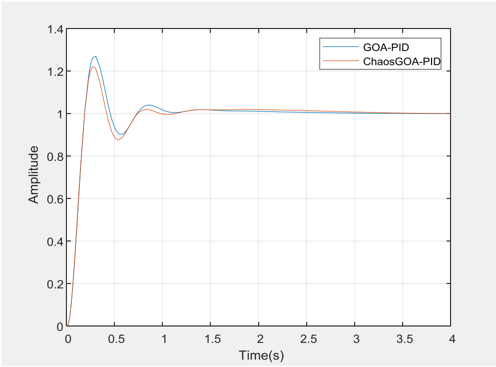

Figure 5: Comparison graph for Step response of AVR system of proposed Chaos GOA-PID and GOA-PID

Fig.6 and 7 demonstrated the Maximum overshoot, settling time, rise time and peak time are the performance features that define the transient response of a unit step input. For maximum overshoot, suggested chaotic-GOA-PID by 0.91 % has better results by as compared to GOA –PID controller. For settling time, of suggested Chaotic GOA-PID by 0.7% has better results as contrasted to Goa-PID. For rise time, suggested chaotic GOA-PID by 0.12 % has better outcomes as contrasted to existing GOA- PID controller. For peak time, chaotic GOA-PID by 0.27 % has better outcomes as contrasted to GOA- PID controller.

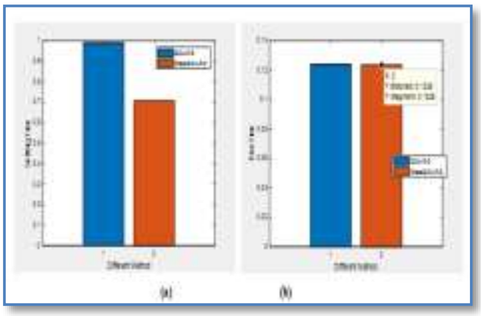

Figure 6: Setting time versus different method

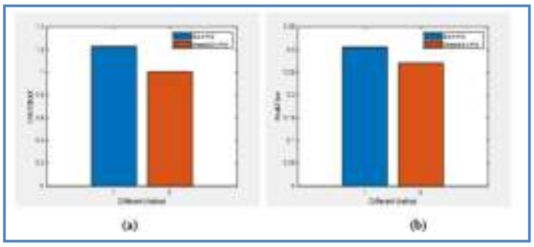

Figure 7: Different outcomes for GOA-PID and ChaosGOA-pid controller

These findings outcomes confirm that the suggested Chaotic controller tuned by GOA has superior performance than the existing GOA-PID controller.

VII. CONCLUSION

This paper suggests a novel optimization technique. In order to optimize the GOA-PID controller variables within the AVR framework. The suggested methodology introduces the GOA and Chaotic Logistic mapping group in order to achieve creative performanceas in many current heuristic methods, Chaotic Logistic mapping could be used instead of free parameters of the populace to decide the original comment in the optimization problem. The article suggests that the convergence of the method is greatly accelerated by a method. - In addition, GOA-PID controller parameters. The findings acquired by implementing the appropriate method with the new objective function implemented in this article offer significantly better voltage response for the AVR method in comparison to many other considered architectures. The phase solution of the AVR device is shown to have absolutely tiny deviations relative to the nominal case in all the findings gathered, which indicates that the model is robust to the inconsistencies in the method.

REFERENCES

[1]. Hasanien H. M., “Design optimization of PID controller in automatic voltage regulatorsystem using Taguchi combinedgenetic algorithm method”, IEEE Systems Journal, Vol.7, pp. 825–831,2013.

[2]. M. S. Rahimian, K. Raahemifar, “Optimal PID controller design for AVR system using particle swarm optimization algorithm,” in Proc. 24th IEEE Canadian Conf. on Electrical and Computer Engineering, pp. 337-340,2011.

[3]. Mosaad, A.M., Attia, M.A., Abdelaziz, A.Y., “Comparative Performance Analysis of AVR Controllers Using Modern Optimization Techniques”, Electr. Power Components System. Vol. 46, pp. 2117–2130,2018

[4]. S.Vivekanandan,G.Saravanan,S.Krishnaprabhu, “Chaotic Differential Evolution Algorithm based PID Controller for Automatic Voltage Regulator system”, International Journal of Scientific and Research Publications, Vol. 5, No. 6, 2015.Lindfield, G., & Penny, J., “The Firefly Algorithm,” Introduction to Nature-Inspired Optimization, pp. 85–100, 2017.

[5]. S. Saremi, S. Mirjalili, A. Lewis, “Grasshopper Optimisation Algorithm: Theory and application,” Advances in Engineering Software, Vol. 105, pp. 30-47, 2017.

[6]. Hekimoglu, B., &Ekinci, S., “Grasshopper optimization algorithm for automatic voltage regulator system”, 5th International Conference on Electrical and Electronic Engineering (ICEEE),2018.

[7]. Azhar Ali Bhutto, Faheem Akhtar Chachar, MuhammadHussain, Darya Khan Bhutto,Sher Elahi Bakhsh, “ Implementation Of Probabilistic Neural Network (Pnn) Based Automatic Voltage Regulator (Avr) For Excitation Control System In Matlab”, International Conference on Computing, Mathematics and Engineering Technologies ICoMET 2019.

[8]. M. Ilyas, L., Noor-ul-A., Ayesha, , “ Continuous Human Learning Optimizer based PID Controller Design of an Automatic Voltage Regulator System”, Australian & New Zealand Control Conference (ANZCC),2018.

[9]. G. Saravanan, D. Sathish Kumar, A., Karthikeyan, “Enhanced Chaotic Grasshopper Optimization Algorithm Based PID Controller for Automatic Voltage Regulator System”, International Journal of Recent Technology and Engineering (IJRTE), Vol. 8, No. 4, 2019.

[10]. Sirsode, P., Tare, A., & Pande, V., “Design of Robust Optimal Fractional-order PID Controller using Salp Swarm Algorithm for Automatic Voltage Regulator (AVR) System”, Sixth Indian Control Conference (ICC),2019.

[11]. K. Meena, K. Jayaswal, and D. K. Palwalia, “Analysis of Dual Active Bridge Converter for Solid State Transformer Application using Single-Phase Shift Control Technique,” Proc. 5th Int. Conf. Inven. Comput. Technol. ICICT 2020, 2020,

[12]. K. Meena and D. K. Palwalia, “Voltage Control of Dual Active Bridge Converter for CO-Amorphous Core Material Based Solid-State Transformer Application,” Ijireeice, vol. 8, no. 10, pp. 33–39, 2020.

[13]. J. Prakash and K. Meena, “Simulation of Selective Radiation Anti-Reflection Coating for Improvement of Emissivity,” no. 03, pp. 1–14, 2022.

[14]. J. Prakash and K. Meena, “Simulation of Anti Reflecting Coating for Improving External Quantum Efficiency of Photovoltaic Cell,” no. 04, pp. 1–12, 2022.