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Fuzzy Logic Controller Design And Simulation For Industrial Application

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Abstract

Liquid flow control is a vital requirement in many industrial processes. This essay compares the proportional derivative controller, the traditional PID controller, and the fuzzy logic controller for fluid flow. This study compares the performance of proportional derivative, conventional PID controllers, and fuzzy logic controllers using MATLAB. The comparison of various time domain parameters shows that the fuzzy logic controller performs more quickly and with less overshoot than PID and PD controllers. The most used control approach in industry is the PID controller. PID controllers' widespread use can be attributed in part to their dependable performance and in part to how straightforward their functional design is. The oscillating behaviour of the PID controller in this study harms the system. However, the fuzzy logic controller's response is free of these risky oscillations during the transient phase. As a result, the fuzzy logic controller is superior to the PID controller that is typically utilized.

Keywords: Fuzzy Logic Controller, PID , Matlab/ Simulink.

I. Introduction

For many industrial operations, flow control is essential. Chemical industry regulation keeps the regulated variables under control. In this study, we use three different methods to control the flow: PD, PID, and FLC. One of the earliest control strategies is PD and PID control [1]. Although PID and PD controllers have basic control structures that are straightforward to grasp, they do not respond quickly. Utilizing fuzzy logic controllers, we are able to solve these issues. Utilizing MATLAB and simulink, performance analysis of PID, and FLC has been carried out.

II. DESIGN CONSIDERATION

2.1 DESIGN OF PID CONTROLLER

PID controllers are easy methods that are frequently utilized in industrial control [4]. A higher order system is being constructed with a PID controller. The PID Controller's simulink diagram with unity feedback is shown in Fig. 1.PID controllers are an easy method that are frequently utilized in industrial control [2]. A higher order system is being constructed with a PID controller. The PID Controller's simulink diagram with unity feedback is shown in Fig. 1.

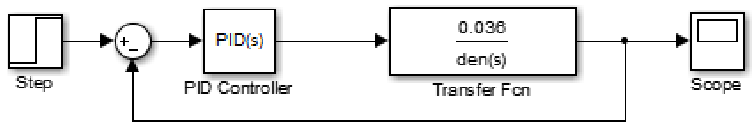

Fig. 1: Simulink diagram of PID Controller

This method's response time is slow and unreliable. We presented the fuzzy controller as a solution to these issues, making the closed loop system exhibit little overshoot and settling time with zero steady state error.

2.2 DESIGN OF FUZZY LOGIC CONTROLLER

2.2.1FUZZY LOGIC

The control law can be defined as a set of straightforward linguistic inference rules thanks to fuzzy logic. Simple fuzzy logic rules don't need complex control algorithms. Systems using fuzzy logic are appropriate for approximative reasoning. In comparison to conventional systems, fuzzy logic systems respond more quickly and smoothly, and their control complexity is lower. A Fuzzifier, Defuzzifier, Inference Engine, and Fuzzy Rule Knowledge Base make up a basic fuzzy system. The fuzzy set theory describes ill-defined or insufficient ideas that are challenging to express mathematically. The rule base, which contains IF-THEN-ELSE rules, serves as the focal point of a fuzzy system. The Defuzzifier translates the output fuzzy sets to crisp output values, whereas the Fuzzifier maps the crisp input to fuzzy sets defined by their membership functions. In situations where precise mathematical formulations are not feasible, fuzzy logic controllers (FLC) are a desirable option [3].

Other benefits include

- It can function with less-accurate inputs.
- Fast processors are not necessary.
- Compared to other non-linear controllers, it is more durable.

2.2.2 Fuzzy Logic Controllers are superior to traditional controllers

Because there is a dearth of quantitative information describing the relationships between input and output, fuzzy control has become one of the most active and productive fields of research, particularly in industrial processes that do not rely on conventional approaches. Fuzzy logic, which is far more similar to human thinking and natural language than traditional logical systems, is the foundation of fuzzy control [3]. A linguistic control strategy based on specialist knowledge can be transformed into an automatic control strategy using a fuzzy logic controller (FLC) based on fuzzy logic. The fuzzy reasoning technique employs fuzzification, defuzzification, and fuzzy control rules [4]. The Fuzzy logic control of refrigerant flow was finished by Kamal et al. In refrigeration and air-conditioning systems, refrigerant is the material that transfers heat from one location to another. For refrigeration and air-conditioning systems to operate more efficiently and last longer, the flow of refrigerant must be controlled. When the fuzzy logic controller's performance is contrasted with that of a well-known commercial controller already in use, the fuzzy logic controller performs better [5]. Fuzzy logic control can handle uncertainty and imprecision.

The fuzzy membership function editor, shown in Figure .3, allows users to select the number and type of membership functions, including trapezoidal, triangular, and Gaussian, depending on the process parameter. It is appropriate to use triangular and trapezoidal shapes in this essay[6].

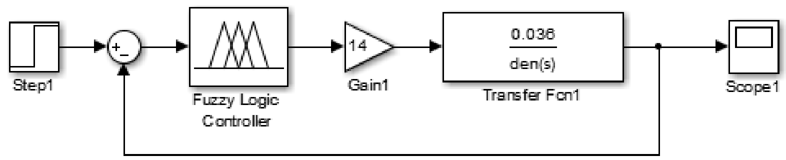

Fig.2: Simulink diagram of Fuzzy Controller

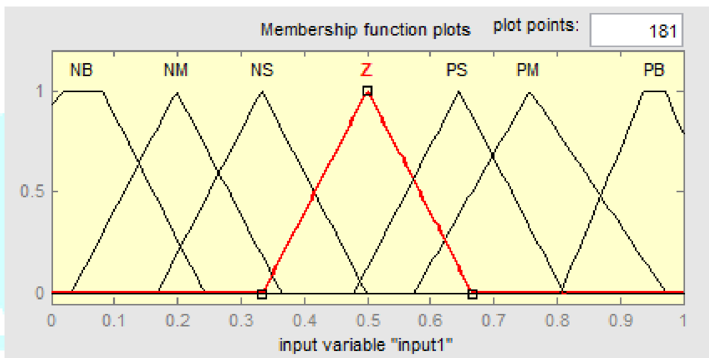

Fig. 3: Membership function for output

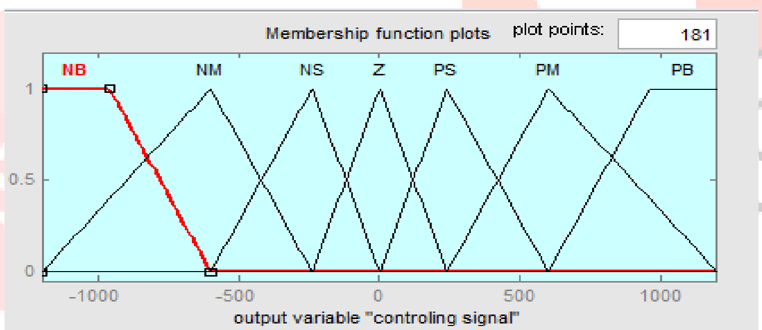

Fig. 4: Membership function for output

III. Simulation Results

The responses of the traditional PID, and fuzzy logic controllers to the step input are shown in Fig. 5.

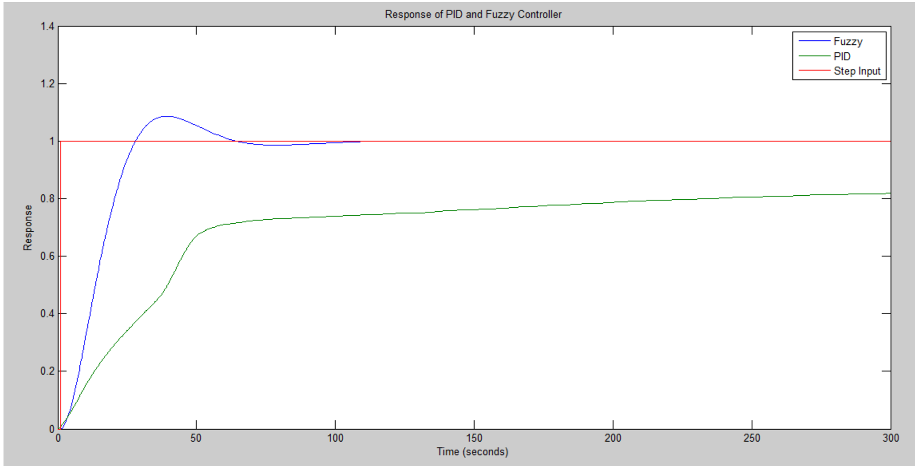

Fig. 5: The step response of PID and Fuzzy controller.

Figure 5 show that, in comparison to PID Controller, the fuzzy logic controller has a modest overshoot and a quick reaction.

IV. Conclusion

In this study, we design two different types of controllers: fuzzy logic, and PID. According to the data in the figure, PID Controller reaction is oscillatory, which might cause system damage. However, during the transitory period, FLC's response is free of these hazardous oscillations. The proposed FLC is therefore superior to PID controller.

Results are used to determine a fuzzy based controller's advantages over a PID controller. The fuzzy controller should offer better control performance, robustness, and overall stability. Since the fuzzy notion is fundamentally just a depiction of how people think and make decisions, it makes more sense to create and tune the FIS than the PID controller. Intelligent control, which modifies the control parameters in response to the error, is created when fuzzy control is paired with a traditional PID controller. Fuzzy controllers are more stable, have less overshoot, and respond quickly.

References

[1] Rahul Malhotra and Tejbeer Kaur, “DC motor control using fuzzy logic controller,” International journal of advanced engineering sciences and technologies vol no. 8, issue no. 2, 291 – 296.

[2] Rem Langari,”Past, present and future of fuzzy control: A case for application of fuzzy logic in hierarchical control,”IEEE, pp.760- 765, 1999.

[3] Chuen Chien Lee, “Fuzzy logic in control systems i.e. fuzzy logic controller,”IEEE Transactions on Systems, man and cybernetics, Vol 20, No.2, March/April 1990.

[4] J.Y.M. Cheung, A.S. Kamal,” Fuzzy Logic Control of refrigerant flow”, UKACC International Conference on Control „96, Conference Publication No. 427, 2-5 September 1996.

[5] Rajanbabu.N, Sreenadhan.S, Fahid K.A, Mohandas K P,”Design and implementation of a neuro-fuzzy controller for a flow system”, presentation at FAE symposium, European university of lefke, Nov 2002.

[6] Philip A. Adewuyi, “DC Motor Speed Control: A Case between PID Controller and Fuzzy Logic Controller,” international journal of multidisciplinary sciences and engineering, vol. 4, no. 4, may 2013.

[7] Zhang Shengyi and Wang Xinming, "Study of Fuzzy-PID Control in MATLAB for Two-phase Hybrid SteppingMotor," Proceedings of the 2nd International Conference On Systems Engineering and Modeling (ICSEM-13).

[8] Awang N.I. Wardana, "PID-Fuzzy Controller for Grate Cooler in Cement Plant," IEEE transaction of fuzzy system, no.7, vol. 32, 2005, 1345-1351.

[9] Farhad Aslam and Gagandeep Kaur, "Comparative Analysis of Conventional, P, PI, PID and Fuzzy Logic Controllers for the Efficient Control of Concentration in CSTR,"International Journal of Computer Applications (0975 – 8887) Volume 17– No.6, March 2011.

[10] D. Puangdownreong, T. Kulworawanichpong, S. Sujitjorn, Input weighting optimization for PID controllers based on the adaptive tabu search, 2004 IEEERegion 10 Conference D (2004) 451–454.

[11] Gaddam Mallesham and Akula Rajani, " Automatic tuning of pid controller using fuzzy logic," 8th International Conference on development and application systems Suceava, Romania, May 25 – 27, 2006.

[12] Gaurav and Amrit Kaur, " Comparison between Conventional PID and Fuzzy Logic Controller for Liquid Flow Control: Performance Evaluation of Fuzzy Logic and PID Controller by Using MATLAB/Simulink," International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-1, Issue-1, June 2012.

[13] S.R.Vaishnav and Z.J.Khan, "Design and Performance of PID and FuzzyLogic Controller with Smaller Rule Set for Higher Order System," Proceedings of the World Congress on Engineering and Computer Science 2007 WCECS 2007, October 24-26, 2007.

[14] Elangeshwaran Pathmanathan and Rosdiazli Ibrahim, "Development and Implementation of Fuzzy Logic Controller for Flow Control Application," Intelligent and Advanced Systems (ICIAS), International Conference on Digital Object Identifier, pp.1-6, 2010.

[15] Gaurav and Amrit Kaur, "Conventional PID controller and Fuzzy logic controller for Liquid flow control: Performance Analysis Using MATLAB/Simulink," International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 3, May – 2012.

[16] Sahil Chandan and Rahul Agnihotri, "Fuzzy logic Controller for Flowing Fluids," International Journal of Advanced Research in Computer Engineering & Technology Volume 1, Issue 4, June 2012.