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Performance Analysis of Conventional PI, PD, PID and Fuzzy Logic Controller using Matlab / Simulink for Industrial Applications

[1] R.Gunasekari [2] Sangamesh Mavur [3] Kishor Kumar.K [4] R. Mallikarjuna Reddy [5] Sharana Basava
[1] Assistant Professor [2][3][4][5]Student
[1][2][3][4][5] EEE Department, Sri Sairam College of Engineering, Bengaluru

***Abstract:* -- Measuring the flow of liquid is a critical need in many industrial plants. The aim of this paper is to do the comparative study of Proportional Integral controller, Proportional Derivative controller, conventional PID controller and fuzzy logic controller for flowing fluids. In this paper, performance analysis of proportional derivative, conventional PID controller and fuzzy logic controller has been done by the use of MATLAB and Simulink and in the end comparison of various time domain parameter is done to prove that the fuzzy logic controller has small overshoot and fast response as compared to PID controller and PD, PI controller. PID controller is the most widely used control strategy in industry. The popularity of PID controller can be attributed partly to their robust performance and partly to their functional simplicity. In this paper, the response of the PID and PD, PI controller is oscillatory which damage the system. But the response of the fuzzy logic controller is free from these dangerous oscillations in transient period. Hence the Fuzzy logic controller is better than the conventionally used PID controller.**

***Keywords* - Fuzzy Logic Controller, PI, PD and PID Controller, Matlab/Simulink.**

I. INTRODUCTION

Flow control is critical need in many industrial processes. The control action of chemical industries maintaining the controlled variables. In this paper, we control the flow via four methods: PI, PD, PID and FLC. PI, PD and PID control is one of the earlier control strategies. PID controller has a simple control structure which is easy to understand but the response of PID, PD, PI controller is not fast. To overcome these problems we use fuzzy logic controller. Performance analysis of PI, PD, PID and FLC has been done by the use of MATLAB and Simulink. Comparison of various time domain parameters is done to prove that the FLC has small overshoot and fast response as compared to PI, PD and conventional PID controller. The proportional – integral – derivative (PID) controller operates the majority of the control system in the world. It has been reported that more than 95% of the controllers in the industrial process control applications are of PID type as no other controller match the simplicity, clear functionality, applicability and ease of use offered by the PID controller. The PID controller is used for a wide range of problems like motor drives, automotive, flight control, instrumentation etc. PID controllers provide robust and reliable performance for most systems if the PID parameters are tuned properly.

The field of Fuzzy control has been making rapid progress in recent years. Fuzzy logic control has been widely exploited for nonlinear, high order & time delay system. This paper has two main contributions. Firstly, a PID controller has been designed for higher order system and its performance has been observed. The Ziegler Nichols tuned controller parameters are fine tuned to get satisfactory closed loop performance. Secondly, for the same system a fuzzy logic controller has been proposed with simple approach. Simulation results for a higher order system have been demonstrated. A performance comparison between PID controller and the proposed fuzzy logic controller is presented.

II. DESIGN CONSIDERATION

A PID controller is being designed for a higher order system with transfer function

G(s) = 0.036 / [36.942s2+12.1568s+0.451]

Step response of the controlled second order process is shown in figs. In this paper, seven fuzzy membership functions are used for the two inputs error e and derivative of error ce. The fuzzy membership functions for the output parameter are shown in fig.5, here NB means Negative Big, NM means Negative Medium, NS means Negative Small, Z means Zero and

PB means Positive Big, PM means Positive Medium, PS means Positive Small.

A. *Design of PI Controller*

Figure.1 shows the Simulink model of the PI Controller with unity feedback. Integral controller (Ki) reduces both the overshoot and the settling time.

B. *Design of PD Controller*

Figure.2 shows the Simulink model of the PD Controller with unity feedback. Derivative controller (Kd) reduces both the overshoot and the settling time.

C. Design of Conventional PID Controller

A simple strategy widely used in industrial control is PID controller. A conventional PID Controller is being designed for a higher order system. Figure.3 shows the Simulink Model of the conventional PID Controller with unity feedback. The response of this technique is not fast and reliable. To overcome these problems, we proposed the Fuzzy Controller so that the closed loop system exhibit small overshoot and settling time with zero steady state error.

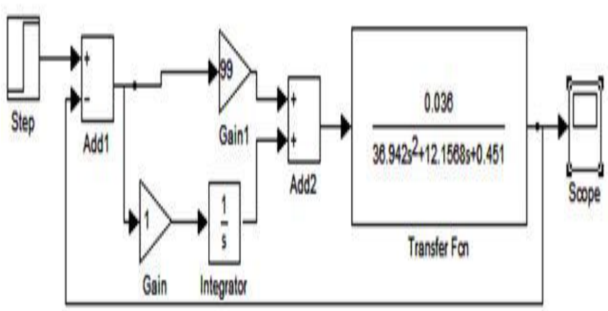

Fig.1: Simulink Model of PI Controller

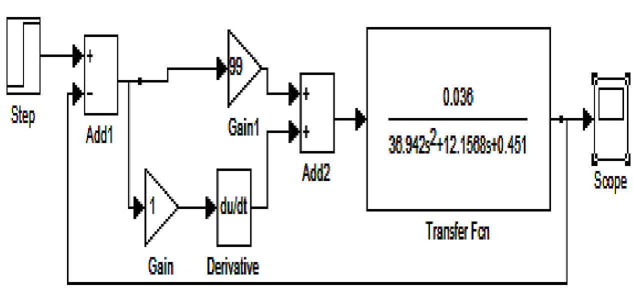

Fig.2: Simulink Model of PD Controller

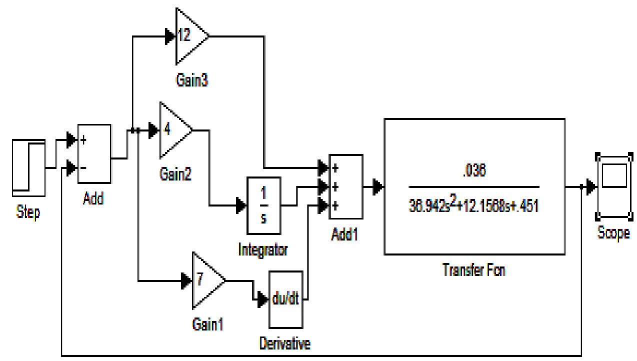

Fig.3: Simulink Model of Conventional PID Controller

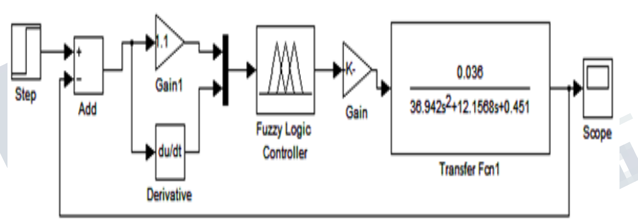

Fig.4: Simulink Model of Fuzzy Logic Controller

D. Design of Fuzzy Logic Controller

Figure.4 shows the Simulink model of the Fuzzy Controller with unity feedback. Figure.5 shows the fuzzy membership function editor where the number of membership function and type of membership function is choose, such as trapezoidal, triangular and Gaussian according to the process parameter. In this Paper, it is suitable to choose triangular and trapezoidal.

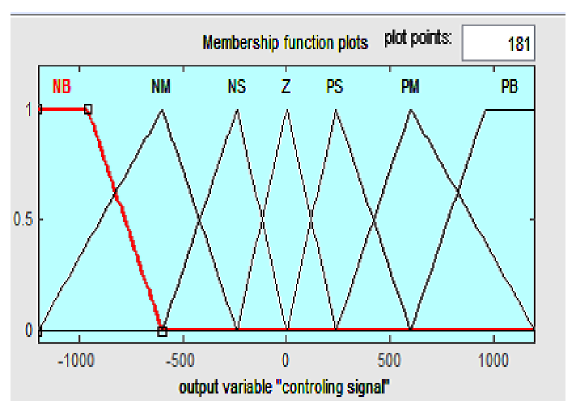

Fig. 6: Membership function for output

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III. SIMULATION RESULTS

The Fig. 7, 8, 9 and 10 shows the response of PI, PD, conventional PID controller and the response of the fuzzy logic controller to the step input.

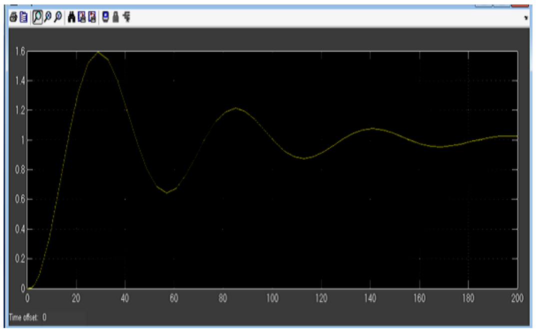

Fig. 7: The Step Response of the PI Controller

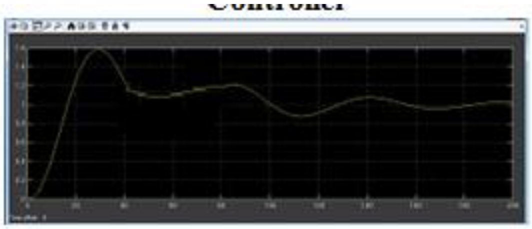

Fig. 8: The Step Response of the PD Controller

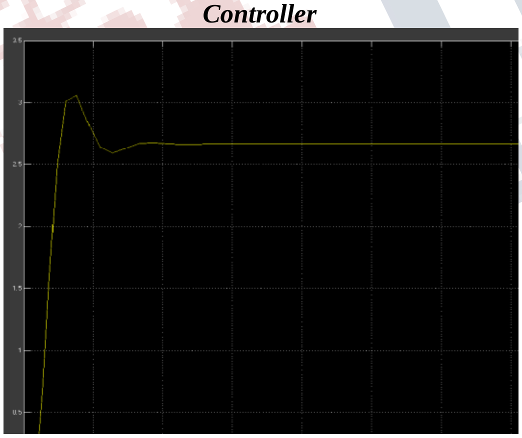

Fig. 9: The Step Response of the PID Controller

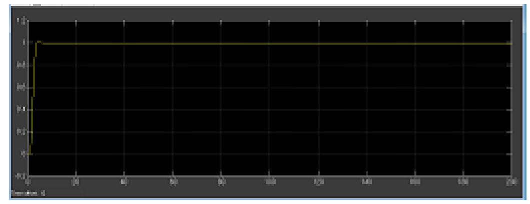

Fig. 10: The Step Response of the Fuzzy Controller

IV.CONCLUSION

In this paper, we design four kinds of controllers which is PI, PD, PID and fuzzy logic controller. From the figure, results show that the response of PI, PD and PID Controller is oscillatory which can damage the system. But the response of FLC is free from these dangerous oscillations in the transient period. Hence the proposed FLC is better than the PI, PD and PID controller. The Fuzzy Logic controller gives no overshoot, zero steady state error and smaller settling time than obtained using conventional controllers. The simulation results confirm that the proposed Fuzzy logic controller with simple design approach.

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