Comparative Analysis of P, PI, PID and Fuzzy Logic Controller for Tank Water Level Control System

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Abstract— This paper presents a review study of PID and fuzzy logic controller for level control of the tank. PID controller is widely used in industries for level control and non-linear system but tuning of PID controller is difficult and it use a mathematical model of the system which is also difficult to find for highly nonlinear system. Fuzzy logic controller use linguistic method to control the system it is simple and easy to understand. A comparative analysis of PID and fuzzy logic is done for level control using MATLAB/ Simulink software.

Key words: PID Controller, Fuzzy Logic Controller, MATLAB/Simulink, Coupled Tank System and Valve

I. INTRODUCTION

In many industrial applications control of liquid level is required. Level control system is a complex system because of non-linearity, uncertainty and delay time. Mostly PI and PID controller are used to control level of the liquid. PID control method is simple and easy to understand. PID control method use mathematical model of the system. It is difficult to find parameters for PID controller and it is not suitable for highly non-linear system. Fuzzy logic controller is a linguistic control method it does not need any mathematical model of the system. Fuzzy logic controller is suitable for both linear and non-linear system. A comparative analysis of PID and fuzzy logic controller is done for level control.

II. LITERATURE REVIEW

Maziah Mat Noh et al, 2008, this article describe the "Simulator of water tank level control system using PID controller". P and PID controller characteristics are compared within Microsoft visual basic software and presented a method of automatic control of the tank level using PID controller. Steady state error, overshoot and settling time can be reduced using PID controller.

Zang Haihe, Wang Li, Yu Xinjun, 2010, in this paper a "Fuzzy controller model for drum water level for industrial boil" is proposed which is useful to eliminate false water level error of the boiler. Three impulse fuzzy control structure is designed to overcome the false water level error. First impulse directly controls the level to eliminate the effect of various disturbances on water level. Second overcome the impact of water flow change on drum water level and third overcome the effect of steam flow fluctuation on the drum water level. This proposed control method is compared with conventional PID controller and find that transition time and overshoot can be reduced with this method.

Li Liang, 2011, describes in his article "The application of fuzzy PID controller in coupled tank liquid level control system". A model is designed for fuzzy PID controller for level control of coupled tank. A new method of fuzzy control arithmetic is implemented. Greater error can be reduced with fuzzy logic controller and smaller error can be eliminated using PID controller. A combined effect of PID and fuzzy logic controller is implemented in this method. It is finding that individual PID and fuzzy controller are not much effective as compared to combined control effect.

P Sriniwas, P Durga Prasad Rao, 2012, presented a "Comparative analysis of PID controller and fuzzy controller with various defuzzification method in three tank level control system". Different types of fuzzification AND defuzzification methods are implemented to find the best method for level control of the tank system from this it is find that triangular fuzzification and cetroid defuzzification method gives better response in level control. Response of fuzzy logic controller is compared with conventional PID controller.

Meng Quing Song, Wang Qi, Wei Hongling, 2013, proposed a "Design of fuzzy controller for liquid level control system based on MATLAB/RTW". A design method of fuzzy logic controller in real time workshop is presented in which 1711U acquisition card is used to interface with computer. Electromagnetic valve PSL201 is used for flow control. Performance of fuzzy logic controller is better in smaller overshoot and fast response speed for non-linear large delay system then traditional PI controller.

Davood M Souran et al, 2014, a "performance comparison of classical PID and type 1, type2 fuzzy logic controller in three tank level control system" is done in this paper. Two fuzzy logic control method is defined in which type 1 fuzzy controller design is similar to conventional fuzzy logic controller and type 2 fuzzy logic controller use center of set type reducer. Reducer reduces the selection criterion for membership function for optimum result. Performance of the system can be improved by increasing the types of the fuzzy controller.

Bharat Bhusan et al, 2014, in this paper a "Performance analysis of PID and fuzzy PD+I controller on non-linear system" is performed. A new fuzzy control method is introduced in which Proportional and Derivative parameters are selected using fuzzy controller and integral gain through conventional method. Bell, Pi, Gaussian and Psigmoid membership function is implemented on fuzzy logic controller for performance calculation. Psigmoid method gives best result as compared to other three. Purposed control method gives better control then PID controller.

Mostafa A Fellani, and Aboubaker M Gabaj, 2015, presented a "PID controller design for two tanks liquid level control system using MATLAB". Performance of P, PI, PD and PID controller for tank level control is compared in terms of rise time, settling time, overshoot and steady state error. Various conventional tuning methods are tested for PID controller parameters. It is finding that performance of the controller can be improved with appropriate tuning

technique. PID controller effectively eliminates the offset of the proportional mode and gives fast response.

Lian Li, Wenkuan Ding, 2016, describes the "optimization control strategy of boiler water level based on fuzzy PID". This paper gives a technique of parameter selection for PID controller using fuzzy logic controller. Performance of the level control can be improved with this technique. Range of membership function can be selected as per desired response. PID parameters selection depends on membership function of the fuzzy logic controller.

III. Conclusion

In this paper a brief review of researches and their techniques for level control using PID and fuzzy logic controller is presented. The diversity in various researches relative to PID and fuzzy logic controller for level control have studied and summarized in this paper.

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