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A Comparative Study of Defuzzification Methods for an Interacting and Non Interacting System

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Abstract: *The main objective of this paper is to compare the various methods of defuzzification for a liquid level system. A three tank Level system is controlled with fuzzy controller by using different types of defuzzification methods. Here the level system is controlled by both Centroid method & Bisector method and the responses of interacting and non interacting system are compared using MATLAB and SIMULINK. This paper mainly organized as follows, modeling of interacting and non interacting system in section II, Methods of defuzzification in section III, Comparison of simulation results in section IV.*

Keywords: FLC, defuzzification, level system

I. INTRODUCTION

Fuzzy logic is a superset of conventional logic that has been extended to handle the concepts of 'completely true' and 'completely false' values. As its name suggests, it is the logic underlying modes of reasoning which are approximate rather than exact. The importance of Fuzzy logic derives from the fact that most modes of human reasoning and especially common sense reasoning are appropriate in nature. Fuzzy logic is having many values. Here these appropriate values are not fixed time traditional binary sets. So, it is having a truth value that ranges in degree between 0 and 1. Therefore this type of logic system is able to address the values of variables those lie between completely truths and completely false. The variables are called the linguistic variables and each linguistic variable is described by a membership function which gives the probable decision making is an important part of the fuzzy logic. The decision making is mainly the combination of concepts of fuzzy set theory, fuzzy IF-THEN rules and fuzzy reasoning. The fuzzy system makes use of if then statements and with the help of connecters (such as AND gate) necessary rules are constructed. The fuzzy logic controller (FLC) has been proposed to get better performance in conventional PID controller and for the purpose of fuzzification and defuzzification the Mamdani fuzzy system and mean of maximum methods are used respectively.

II. INTERACTING AND NON-INTERACTING SYSTEM

A. Mathematical Modeling

To analyze the behavior of a process, a mathematical representation of the physical place in it is essential and this representation constitutes the mathematical model.

B. Experimental Setup

The experimental set up shown in Figure 1 consists of water supply tank, pump, Plunger pump, level transmitter, pressure transmitter, Process tanks, Venturimeter, orifice meters with differential pressure transmitters, rotameter, pneumatic control valve, I/P converter, Pressure gauges. The pneumatic control valve is air to close, adjusts the flow of the water pumped to the cylindrical tank from the water reservoir. The level of the water in the tank is measured by means of the differential pressure transmitter and is transmitted in the form of (4-20) mA to the interfacing with the Personal Computer (PC).

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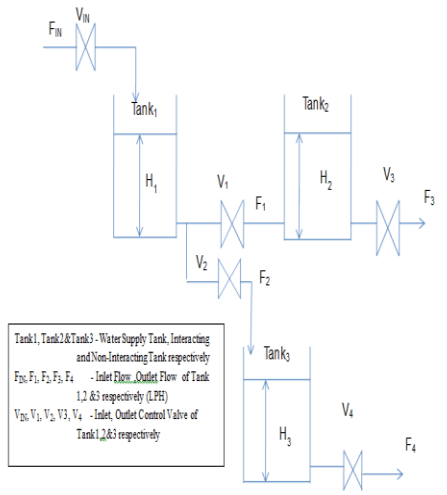

Fig.1. Interacting and Non-Interacting Liquid Level System

C. Transfer Function

The transfer function for the three tank Interacting and Non Interacting System is obtained as given below.

$$G(S) = \frac{1}{s^3+3s^2+3s+1} \qquad \text{(Non- Interacting)}$$

$$G(S) = \frac{1}{s^3+4s^2+4s+1} \qquad \text{(Interacting)}$$

III. METHODS OF DEFUZZIFICATION

A fuzzy logic system (FLS) can be defined as the nonlinear mapping of an input data set to a scalar output data. A FLS consists of four main parts: fuzzifier, rules, inference engine, and defuzzifier. The process of fuzzy logic is as follows: Firstly, a crisp set of input data are gathered and converted to a fuzzy set using fuzzy linguistic variables, fuzzy linguistic terms and membership functions. This step is known as fuzzification. Afterwards, an inference is made based on a set of rules. Lastly, the resulting fuzzy output is mapped to a crisp output using the membership functions, in the defuzzification step. Linguistic variables are the input or output variables of the system whose values are words or sentences from a natural language, instead of numerical values. A linguistic variable is generally decomposed into a set of linguistic terms. Membership functions are used in the fuzzification and defuzzification steps of a FLS, to map the non-fuzzy input values to fuzzy linguistic terms and vice versa. A membership function is used to quantify a linguistic term. There are different forms of membership functions such as triangular, trapezoidal, piecewise linear, Gaussian, or singleton. The most common types of membership functions are triangular, trapezoidal, and Gaussian shapes. The type of the membership function can be context dependent and it is generally chosen arbitrarily according to the user experience. In a FLS, a rule base is constructed to control the output variable. A fuzzy rule is a simple IF-THEN rule with a condition and a conclusion. The evaluations of the fuzzy rules and the combination of the results of the individual rules are performed using fuzzy set operations. The operations on fuzzy sets are different than the operations on non-fuzzy sets. The mostly used operations for OR and AND operators are max and min, respectively. The rule table for the Fuzzy control is given in table 1. After evaluating the result of each rule, these results should be combined to obtain a final result. This process is called inference. The results of individual rules can be combined in different ways. Defuzzification: after the inference step, the overall result is a fuzzy value. This result should be defuzzified to obtain a final crisp output. This is the purpose of the defuzzifier component of a FLS. Defuzzification is performed according to the membership function of the output variable. There are different methods for defuzzification too. The defuzzification methods are (i) Centre of area method(COA) / Centroid method (ii) Mean of Maximum method (MOM) (iii) Bisector method (iv) Largest of maximum (LOM) (v) Smallest of maximum (SOM)

Table 1: RULE TABLE FOR FUZZY CONTROL

e \ ce	NB	NS	Z	PS	PB
NB	NB	NB	NS	NS	Z
NS	NB	NS	NS	Z	PS
Z	NS	NS	Z	PS	PS
PS	NS	Z	PS	PS	PB
PB	Z	PS	PS	PB	PB

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In this paper the fuzzy controller for level system is tried with two different types of defuzzification methods. They are (i) Centre of area method (COA) / Centroid method (ii) Bisector method. The responses of both the defuzzification methods are compared.

IV. SIMULATION RESULTS

The simulink model of Interacting level system with Centroid and Bisector method of defuzzification is shown in fig 2.

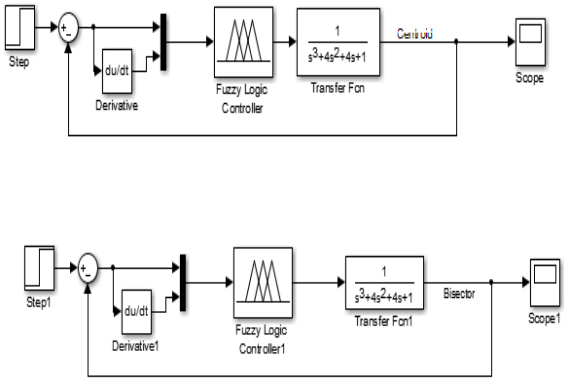

Fig.2.Simulink model of Interacting system

The simulink model of Non Interacting level system with Centroid and Bisector method of defuzzification is shown in figure 3.The simulation results of both the interacting and Non interacting systems are shown in fig 4 and fig 5 respectively.

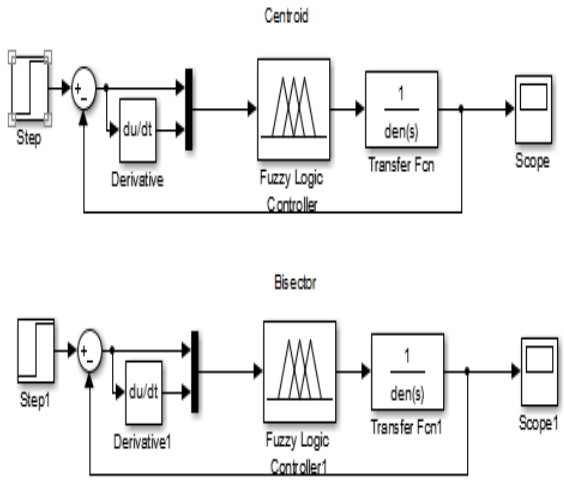

Fig.3.Simulink model of Non Interacting system

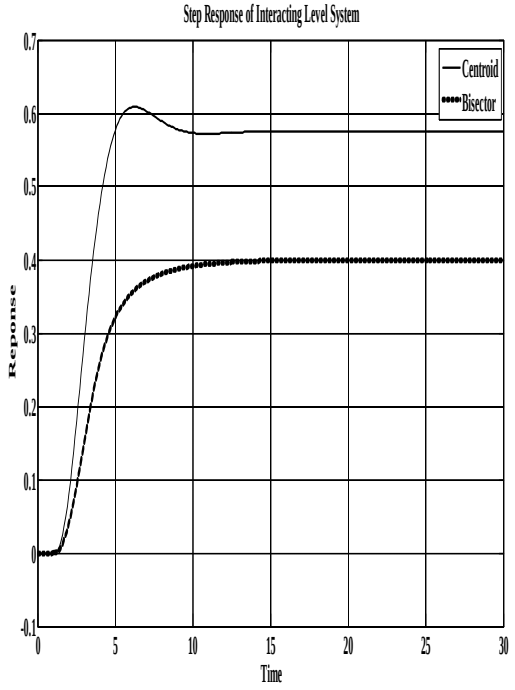

Fig.4. Response of the system for Centroid and Bisector method for Interacting system

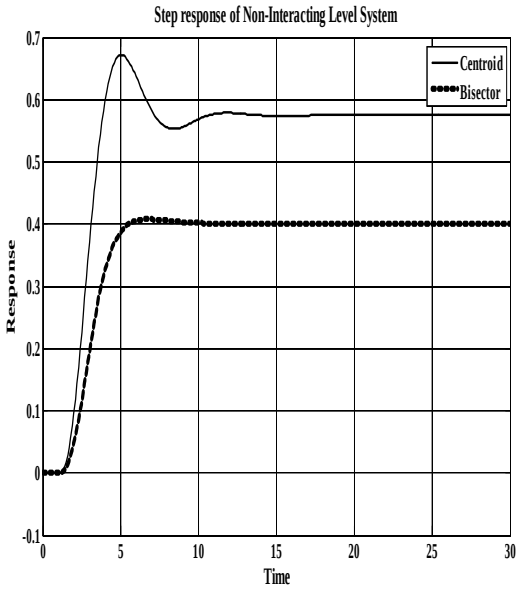

Fig.5. Response of the system for Centroid and Bisector method for Non Interacting system

V. CONCLUSION

It is found to be that the response of Centroid method of fuzzy controller is better than the Bisector method of fuzzy controller for interacting system and Non interacting system. From the simulation results it shows that the Centroid method of defuzzification satisfies the Time Domain Characteristics when compared with Bisector method of defuzzification.

REFERENCES

[1] V.R.Ravi,T.Thyagarajan, "Application of Adaptive control technique to interacting nonlinear systems",proceedings of ICETECT,2011.

[2]S.Saju,R.Revathi,K.ParkaviSuganya,"Modeling and control of liquid level interacting and non-interacting system",international journal of advanced research in electrical,electronics and instrumentation engineering(vol.3, Issue3),march2014.

[3]M.Kandasamy,K.Muthukumaran, "design of auto-tuning adaptive PID controller for two tank conical system",ISSN No 2277- 8179(vol.3,issue1)jan2014.

[4]D.Angeline,K.Vivetha,K.Gandhimathi,T.Praveena, "Model based controller design for conical tank system",international journal of computer application 0975-8887(vol.85 no12),jan2014.

[5]S.K.Lakshmanaprabu,U.SaburaBanu,C.Bharanitharan, "Linear quadratic Gaussian control for two interacting conical tank process" International Journal of Computer Applications (0975 – 8887),CiQS-2014.

[6]S.Vadivazhagi,Dr.N.Jaya, "Modeling and simulation of interacting conical tank systems"IJIRSET(vol.3,issue6)june2014

[7]P.Aravind,M.Valluvan,S.Ranganathan,"Modeling and simulation of non-linear tank",IJAREEIE(vol.2Issue2)feb2013.

[8]D.Mercy,S.M.Girirajkumar, "Tuning of controllers for non linear process using intelligent techniques",IJAREEIE(vol.2,Issue9)sept2013.

[9]Gunaselvi Manohar, V. Elakkiya, Pearley Stanley and R.Sudha, "Neural network based level control in two tank conical interacting system"IEEEconf978·1·4673-4603-0/12, 2013.

[10]D.Hariharan,S.Vijayachitra, "Modelling and real time control of two conical tank systems of non-interacting and interacting type"IJAREEIE(vol.2,issue11)nov2013.

[11]Sukanya R. Warier, SivanandamVenkatesh, "Design of Controllers based on MPC for a Conical Tank System"IEEEconf978-81-909042-2- 3,march2012.

[12]V.R.Ravi,T.Thyagarajan, S.Yammunapriyadharshni, "Gain Scheduling Adaptive Model Predictive Controller for Two Conical Tank Interacting Level System",IEEEICCCNT conf,july2012.

[13]S. Vadivazhagi, Dr. N. Jaya, "Design of Model based controller for Two Conical Tank Interacting Level systems", IJMER(VOL.4,ISSUE6)/pp 65-71,june2014.

[14] Guan Tien Tan, Min-Sen Chiu,"A multiple-model approach to decentralized internal model control design",Elsevier,Chemical Engineering Science 56 (2001) 6651–6660.

[15]V.R.RaviT.Thyagarajan,"A Decentralized PID Controller for Interacting Non Linear Systems"IEEEconf978-1-4244-7926-9/11.

[16]Y.R.Ravi,T.Thyagarajan,B.Puviyarasi,"Centralised Neuro Controller for Two Conical Tank Interacting Level System",IEEE ICACCCT ISBN No. 978-1-4673-2048-1/12.

[17]N.Deepa, S.Arulselvi, D.Rathikarani,"Comparative Study of MRAC and Fuzzy Control of Two-Tank Interacting Level Process",IJEIT(vol.3,issue9)march2014.