LOCATION DETERMINATION OF DC SERVO MOTOR BY APPLYING FUZZY LOGIC CONTROLLER

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ABSTRACT

Today Fuzzy logic Controllers have become one of the most successful controllers for developing sophisticated control systems. Fuzzy logic resembles human decision making with ability for generating precise solutions from certain or approximate information available. It bridges an important gap in engineering design methods left vacant by purely mathematical approaches, and purely logic-based approaches of system design. Fuzzy design can accommodate the ambiguities of real-world human language and logic. It provides both an intuitive method for describing systems and automates the conversion of those system specifications into effective models.

Keywords: FKBC, FLC, , Inference Engine, Rule Base

I. INTRODUCTION

The block diagram of a FKBC is shown in figure 1. The principal design parameters of a FKBC include scaling factors, fuzzification and defuzzification methods, rule base etc. The general structure of a FKBC consists of the following components.[1],[2],[3],[4],[5].

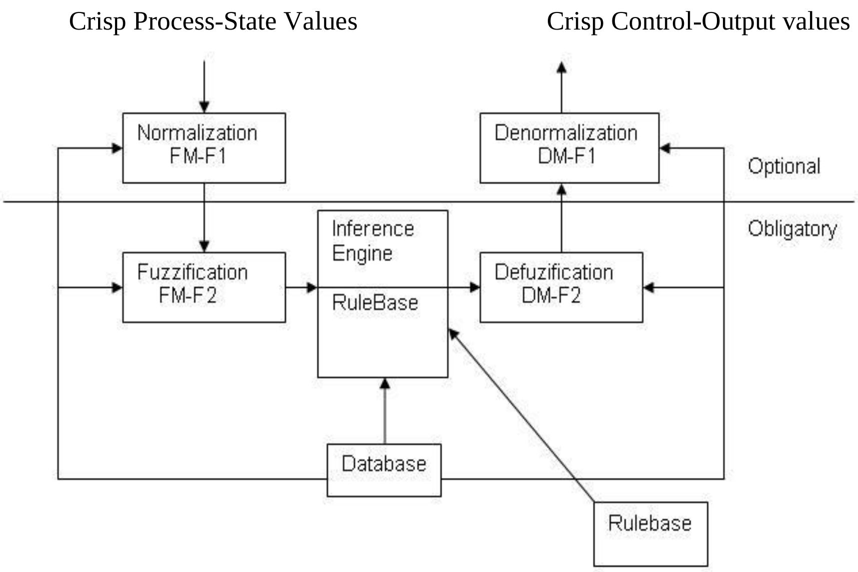

Figure 1: The Structure of an FKBC [4]

1.2 Fuzzification Module (FM)

Fuzzification module, FM-F1, block is used for scale transformation which maps the physical values of the current process state variables into a normalized UOD and also maps the normalized value of the control output variable onto its physical domain called output denormalization). The fuzzification module, FM-F2, block is used for fuzzification, which is the process of converting a crisp, current value of a process state variable into a fuzzy set.

1.3 Knowledge Base

The knowledge base of a FKBC consists of a data base and a rule base. The main function of the data base is to provide the necessary information required for the proper functioning of rule base, fuzzification module and defuzzification module. This information includes Fuzzy sets, that is, membership functions, which represent the meaning of the linguistic values of the process state and control output variables and Physical domain and their normalized counterparts together with scaling factors. The primary function of the rule base is structural way representation of a the control policy of a process operator working in field having rich experience of the field working and / or experienced control engineer in the form of a set of rules such as

If<process state> then <control output>

The if-part of such a production rule is called the rule-antecedent part (premise) and the then-part of such a production rule is called the rule-consequent part (conclusion). [4]

1.3 Inference Engine

The inference engine of the type individual rule based inference computes the overall value of the control output variable on the bases of the individual contributions of each rule in the rule base. Each such individual contribution represents the values of the control output variables as computed by a single rule. The output of the fuzzification module, representing the current, crisp values of the process state variables, is matched to each rule-antecedent and a degree of match or the degree of satisfaction for each rule is established. Based on this degree of match, the value of control output variable in the rule antecedent is modified, i.e. the “clipped ” fuzzy set representing the fuzzy value of control output variable is determined. The set of all clipped control output values of the matched rules represents the overall fuzzy value of the control output.

1.4 Defuzzification Module

The Defuzzification Module (DM), DM-FI, Performs the so-called defuzzification which converts the set of modified control output values in to a single point-wise value. The defuzzifiation module, DM-F2, Performs an output demoralization which maps the point-wise values of the control output onto its physical domain. There is no need of DM-F2, if non-normalized domains are used.

1.5 Rule base

The design parameters of the rule base include choice of- Process state and control output variables, The contents of the rule –antecedent and the rule-consequent, Term-sets for the process state and control output variables, Derivation of the set of rules [4]. The process state variables representing the contents of the rule –antecedent [31] (if –part of a rule) are selected amongst, Error, e , Change –of errors, Δe , and Sum of errors,

δe . The contents of the rule –consequent (then –part of the rule) represented by the control output (process input) variables are selected amongst - Change –of control output, Δu , and Control output, denoted by u .

II. CASE STUDY

The block diagram of a basic control system with FLC is shown in Figure 2. In this study, there is a DC Servo Motor Model whose position control by the use of FLC is done [2],[3],[4],[5]. The transfer function of the DC Servo Motor is given by equation 1. Where θ denotes the position output, and E denotes the applied field voltage to DC Servo Motor. In this section Fuzzy Knowledge Based Controllers (FKBC), the Rule Base for Fuzzy Logic Controllers, and the result obtained by the use of Matlab Simulation are explained.

$$T(s) = \frac{\theta(s)}{E(s)} = \frac{1}{s(s+1)} \quad (1)$$

2.1 Implementation

Figure 2. shows simulink diagram for fuzzy logic controlled system.

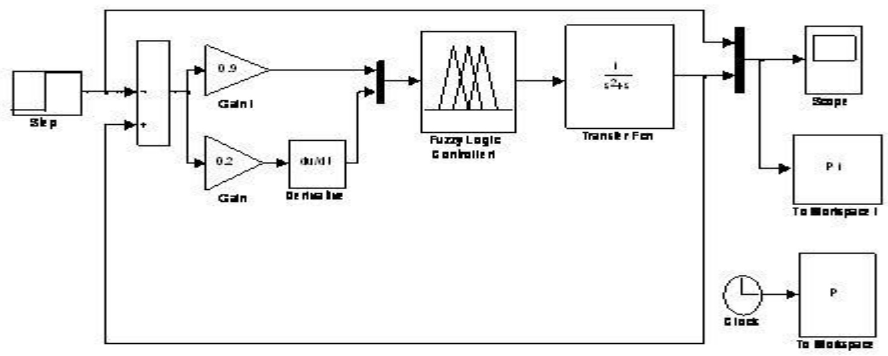

Figure 2: Simulink Diagram for fuzzy controlled system

The simulation result is shown in figure 6. Figure 3 shows Fuzzy Inference System of Fuzzy Logic Controller. Figure 4, shows first input denoted by error „e‟ and its specifications for Fuzzy Inference System. In figure 4, e denotes, error, de denotes change of error, and ca denotes control action. Figure 5 shows rule base scheme for fuzzy logic controller.

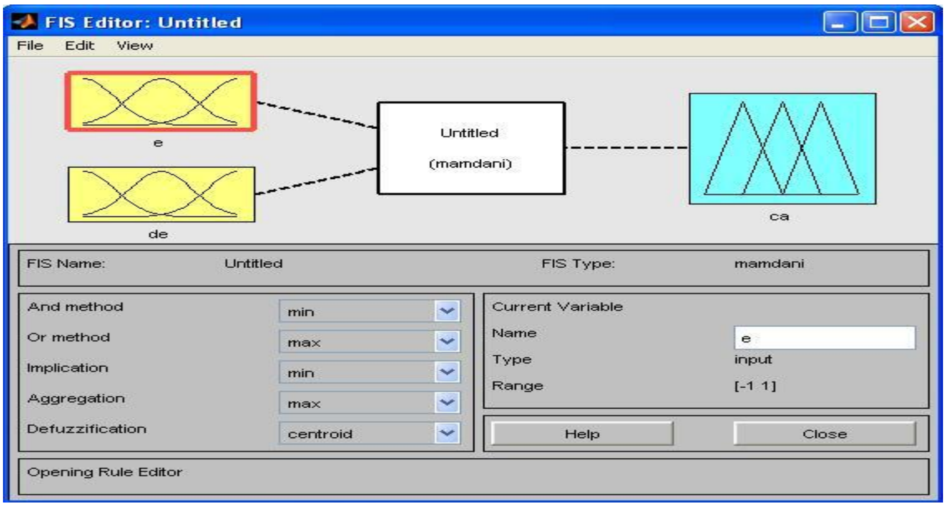

Figure 3: Fuzzy Inference System of Fuzzy Logic Controller

Group0 | Group1 | Group2 | Group3 | Group4

e / Δe	NB	NM	NS	ZO	PS	PM	PB
NB	PB	PB	PB	PB	PM	PS	ZO
NM	PB	PB	PB	PM	PS	ZO	NS
NS	PB	PB	PM	PS	ZO	NS	NM
ZO	PB	PM	PS	ZO	NS	NM	NB
PS	PM	PS	ZO	NS	NM	NB	NB
PM	PS	ZO	NS	NM	NB	NB	NB
PB	ZO	NS	NM	NB	NB	NB	NB

Figure 4: Rule Base Scheme for Fuzzy Logic Controller

The cell defined by the intersection of the first row and the first column represents a rule such as, If $e(k)$ is NB and $\Delta e(k)$ is NB Then $\Delta u(k)$ is PB

III. RESULTS & CONCLUSIONS

The step response is obtained from the figure 2 using Simulink and is found to be stable. Next, we are trying to implement PID controller using Fuzzy Logic and we are also trying to implement artificial intelligent techniques for controller design.

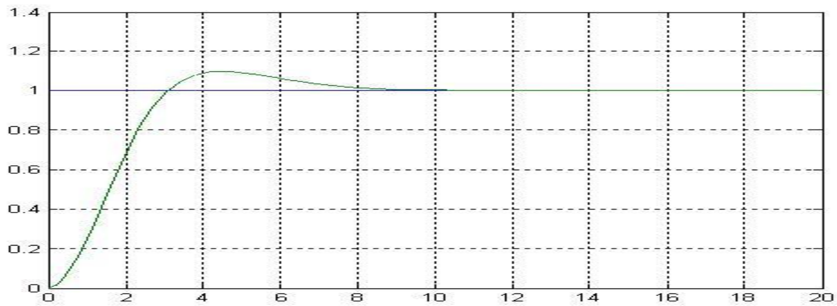

Figure 5: Step Response Obtained from Figure 2 using Fuzzy Logic Controller

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