International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 4, April 2013)

Fuzzy Logic Based Method of Speed Control of DC Motor

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***Abstract*-- Various method of speed control of DC motor is available in the literature. This paper presents design and implements of fuzzy logic in the speed control of DC motor. Fuzzy logic has found high application as a speed control techniques because of its ability to take into account vague and uncertainties [1]. This paper presents a MATLAB simulink model for speed control of DC motor using fuzzy logic.**

***Keywords*-- Fuzzy Logic, Fuzzy Control, DC Motor.**

I. INTRODUCTION

Recently, Fuzzy logic control has found many applications in the past decade. This is so largely because fuzzy logic control has the capability to control nonlinear, uncertain systems even in the case where no mathematical model is available for the controlled system. A fuzzy logic controller can be regarded as a real-time expert system that employs fuzzy logic to manipulate qualitative variables.

Fuzzy logic control is a control algorithm based on a linguistic control strategy, which is derived from expert knowledge into an automatic control strategy. Fuzzy logic control doesn't need any difficult mathematical calculation like the others control system. While the others control system use difficult mathematical calculation to provide a model of the controlled plant, it only uses simple mathematical calculation to simulate the expert knowledge. Although it doesn't need any difficult mathematical calculation, but it can give good performance in a control system. Thus, it can be one of the best available answers today for a broad class of challenging controls problems.

II. THE MODEL OF DC MOTOR CONTROL

The model presented in this paper did not use the inbuilt MATLAB DC motor from simulink, instead the Dc motor has been designed from its characteristic differential equation and it is shown in Fig.1

III. THE FUZZY LOGIC CONTROL

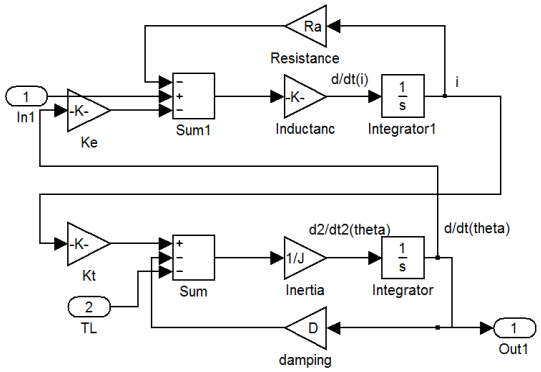

Fig.1

The fuzzy logic foundation is based on the simulation of people's opinions and perceptions to control any system. One of the methods to simplify complex systems is to tolerate to imprecision, vagueness and uncertainty up to some extent [4]. An expert operator develops flexible control mechanism using words like "suitable, not very suitable, high, little high, much and far too much" that are frequently used words in people's life. Fuzzy logic control is constructed on these logical relationships. Fuzzy Sets Theory is first introduced in 1965 by Zadeh to express and process fuzzy knowledge [5, 6]. There is a strong relationship between fuzzy logic and fuzzy set theory that is similar relationship between Boolean logic and classic.

Advantage of using fuzzy technique

1. Inherent approximation capability
2. High degree of tolerance
3. Smooth operation
4. Reduce the effect of Non-linearity Fast adaptation
5. Learning ability

The design procedure of FLC contains three steps as

A. Defining input and output
B. Defining membership functions and rules
C. Adjusting membership functions and rules.

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The block diagram of fuzzy logic control of DC motor is shown in Fig.2

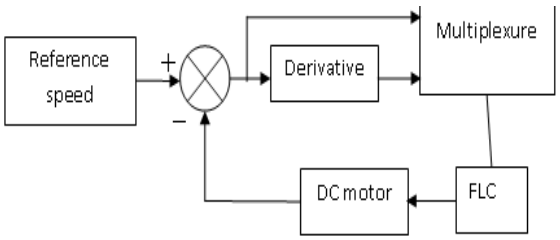

Fig.2

Fuzzy Logic Controller (FLC)

There are specific components characteristic of a fuzzy controller to support a design procedure. Fig.3 shows the controller between the pre-processing block and post processing block.

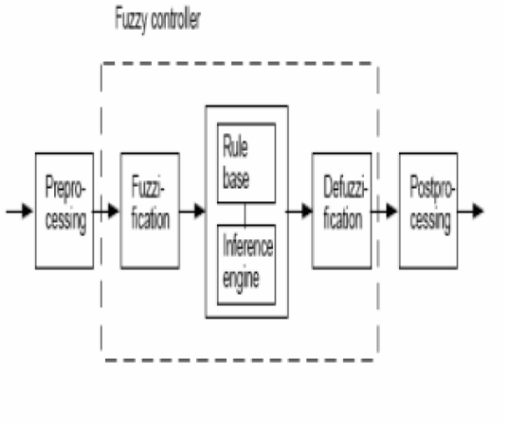

Fig.3

Preprocessing

The inputs are most often hard or crisp measurement from some measuring equipment rather than linguistic. A preprocessor, the first block in Fig. 3 shows the conditions the measurements before enter the controller.

Fuzzification

The first block inside the controller is fuzzification which converts each piece of input data to degrees of membership by a lookup in one or several membership functions.

The fuzzification block matches the input data with the conditions of the rules to determine. There is degree of membership for each linguistic term that applies to the input variable.

Rule Base

The collection of rules is called a rule base. The rules are in "If Then" format and formally the If side is called the conditions and the Then side is called the conclusion. The computer is able to execute the rules and compute a control signal depending on the measured inputs error (e) and change in error, d(e). In a rule based controller the control strategy is stored in a more or less natural language. A rule base controller is easy to understand and easy to maintain for a non- specialist end user and an equivalent controller could be implemented using conventional techniques.

Defuzzification

Defuzzification is when all the actions that have been activated are combined and converted into a single non-fuzzy output signal which is the control signal of the system. The output levels are depending on the rules that the systems have and the positions depending on the non-linearity's existing to the systems. To achieve the result, develop the control curve of the system representing the I/O relation of the systems and based on the information; define the output degree of the membership function with the aim to minimize the effect of the non-linearity.

Post processing

The post processing block often contains an output gain that can be tuned and also become as an integrator.

Fuzzy Membership -Function

The membership function of input, output and error used in this control of DC motor is shown in Figure. 4(a), 4(b) and 4(c).

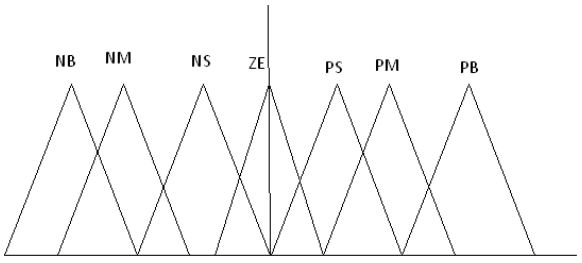

Fig. 4(a)

(Membership function for input)

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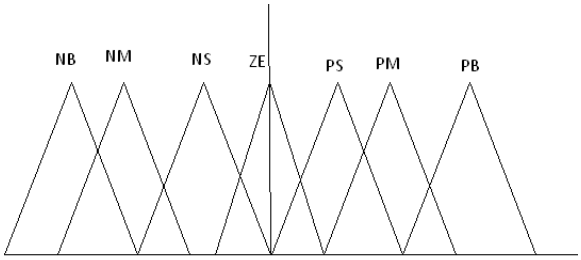


Fig. 4(b)

(Membership function for error)

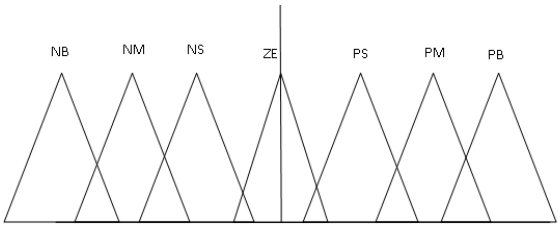


Fig. 4(c)

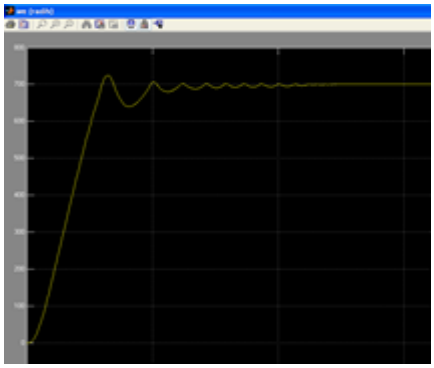
(Membership function for output)

E CE	NB	NM	NS	ZE	PS	PM	PB
PB	NM	NS	NS	NB	PB	PB	PB
PM	NM	NM	NS	NB	PB	PB	PB
PS	NB	NM	NM	ZE	PB	PB	PB
ZE	NB	NB	NM	ZE	PM	PB	PB
NS	NB	NB	NB	ZE	PM	PM	PB
NM	NB	NB	NB	NB	PS	PM	PM
NB	NB	NB	NB	NB	PS	PS	PM

The corresponding fuzzy fule base is shown in Table.1

IV. Result And Output

The speed waveform after the design has been executed is



V. Conclusion

There is a wide range scope of applications of high performance DC motor drives in area such as rolling mills, chemical process, electric trains, robotic manipulators and the home electric appliances.They require speed controllers to perform tasks. Hence, a fuzzy based DC motor speed control system was designed The simulation model is implemented in MATLAB/simulink environment. From the output speed wave form , we can see that the proposed fuzzy logic controller is able to sensitiveness to method gives a smooth speed control with less overshoot and no oscillations. variation of the reference speed attention.

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