International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 08, August 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354

PERFORMANCE ANALYSIS OF D.C MOTOR USING FUZZY LOGIC CONTROLLER

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ABSTRACT

This report presents a new way of control engineering. Dc motor speed controlled by Fuzzy controller and discusses the advantages and disadvantages of controller under loaded and unloaded scenarios using software MATLAB. The brushless series wound DC motor is very popular in industrial application and control systems because of the high torque density, high efficiency and small size. First suitable equations are developed for DC motor. The fuzzy controller is introduce with a DC. Fuzzy controller outperforms to PID controller in terms of steady state error and smooth step response. Finally speed vs. time response is studied.

Keywords: Fuzzy Controller, Brushless DC Motor, PID Controller.

I. INTRODUCTION

The development of high performance motor drives is very important in industrial as well as other purpose applications. Generally, a high performance motor drive system must have good dynamic speed command tracking and load regulating response. The dc motors are used in various applications such as defense, industries, Robotics etc. DC drives, because of their simplicity, ease of application, reliability and favorable cost have long been a backbone of industrial applications. DC drives are less complex with a single power conversion from AC to DC. DC drives are normally less expensive for most horsepower ratings. DC motors have a long tradition of use as adjustable speed machines and a wide range of options have evolved for this purpose. In these applications, the motor should be precisely controlled to give the desired performance. Many varieties of control schemes such as Proportional(P), Proportional Integral (PI), Proportional Derivation Integral (PID), and Fuzzy Logic Controller (FLCs), have been developed for speed control of dc motors. The proposed controller systems consist of multi-input fuzzy logic controller (FLC) and multi-input Integrated Fuzzy Logic Controller (IFLC) for the speed control.

II. DC MOTOR MODEL

DC motor modeling is done summing the torques acting on the rotor inertia and integrating the acceleration to the velocity and also Kirchhoff's laws to armature circuit.

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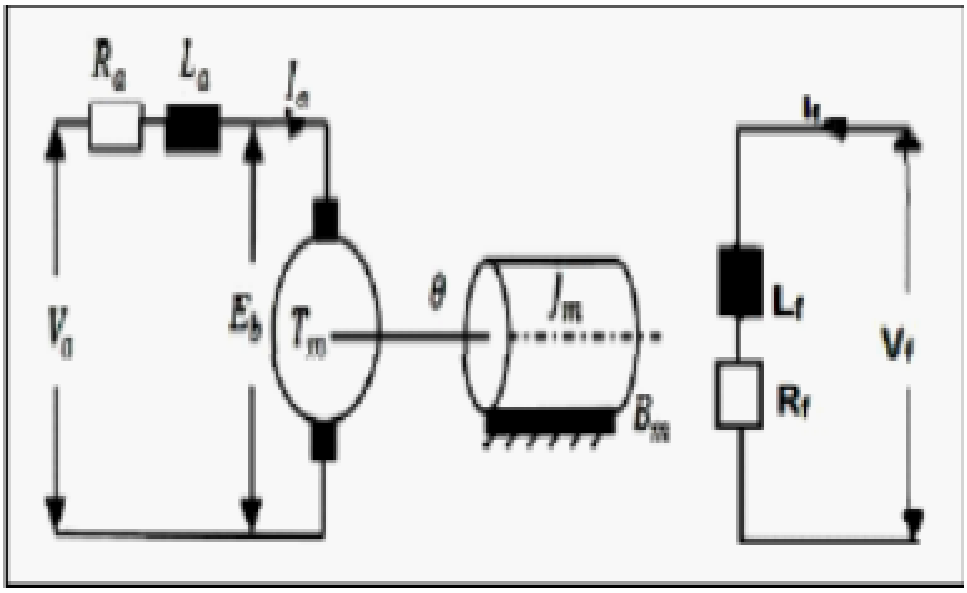

Fig 1 Mechanical Model of DC Motor

The mathematical model of DC motor can be constructed by suing four basic equations of motor.

$$V_a(t) = R_a i_a(t) + L_a \frac{di_a}{dt} + e_b(t)$$

$$e_b(t) = K_b \omega(t)$$

$$T_m(t) = K_t i_a(t)$$

$$T_m(t) = J\frac{d\omega}{dt} + B\omega(t) + T_L(t) + T_f$$

Below figure shows the DC motor model built in Simulink

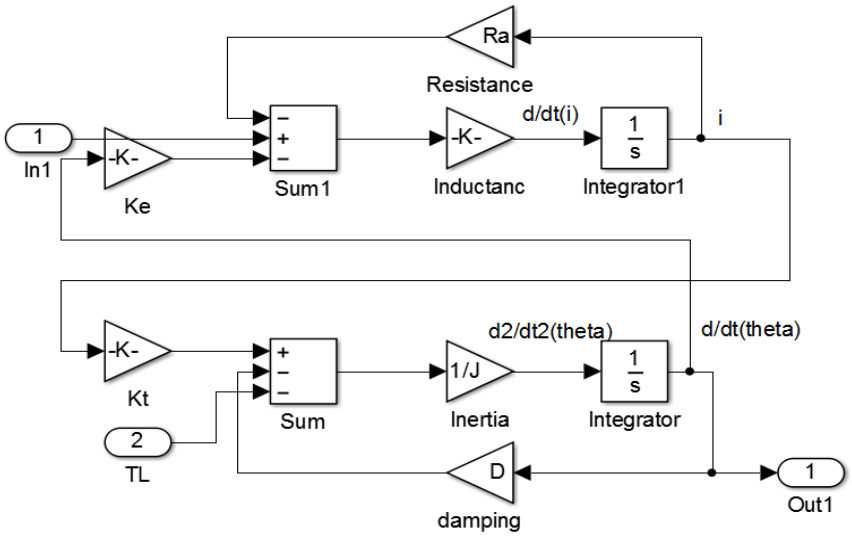

Fig 2 Simulink Model of DC Motor

III. FUZZY LOGIC CONTROLLER

Fuzzy logic is expressed by means of the human language [3].Based on fuzzy logic, a fuzzy controller converts a linguistic control strategy into an automatic control strategy, and fuzzy rules are constructed by expert experience or knowledge database. First, set the error e(t) and the error variation de(t) of the angular velocity to be the input variables of the fuzzy logic controller. The control voltage u(t) is the output variable of the fuzzy logic controller. The linguistic variables are defined as {NB, NS, Z, PS, PB}, where NB means negative big, NS means negative small, Z means zero, PS means positive small and PB means positive big. The fuzzy rules are summarized in Table 1. The type of fuzzy inference engine is Mamdani. The fuzzy inference mechanism in this study follows as:

Table 1: Fuzzy Rule Based Table

du / e / ce	NB	NM	NS	Z	PS	PM	PB
NB	NB	NB	NB	NB	NM	NS	Z
NM	NB	NB	NB	NM	NS	Z	PS
NS	NB	NB	NM	NS	Z	PS	PM
Z	NB	NM	NS	Z	PS	PM	PB
PS	NM	NS	Z	PS	PM	PB	PB
PM	NS	Z	PS	PM	PB	PB	PB
PB	Z	PS	PM	PB	PB	PB	PB

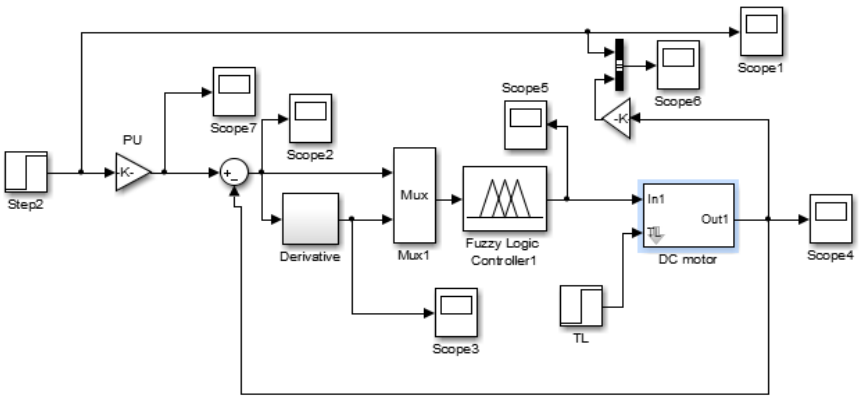

Fig.3 Simulink model of DC motor with fuzzy controller.

IV. SIMULATION AND RESULTS

Parameter of DC motor :

Armature resistance(Ra)	=	1Ω
Armature inductance (La)	=	0.5 H
Armature voltage (Va)	=	400 V
Inertia(jm)	=	0.01 Kg.m2
Damping	=	0.1
Rated speed	=	1500 r.p.m

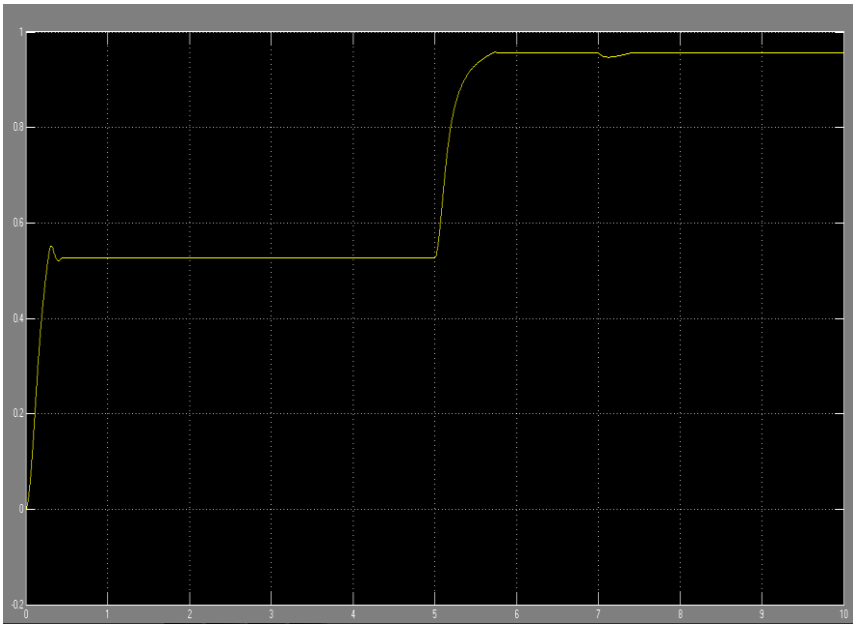

Fig.4 Speed vs Time Response with Fuzzy logic Controller(p.u)

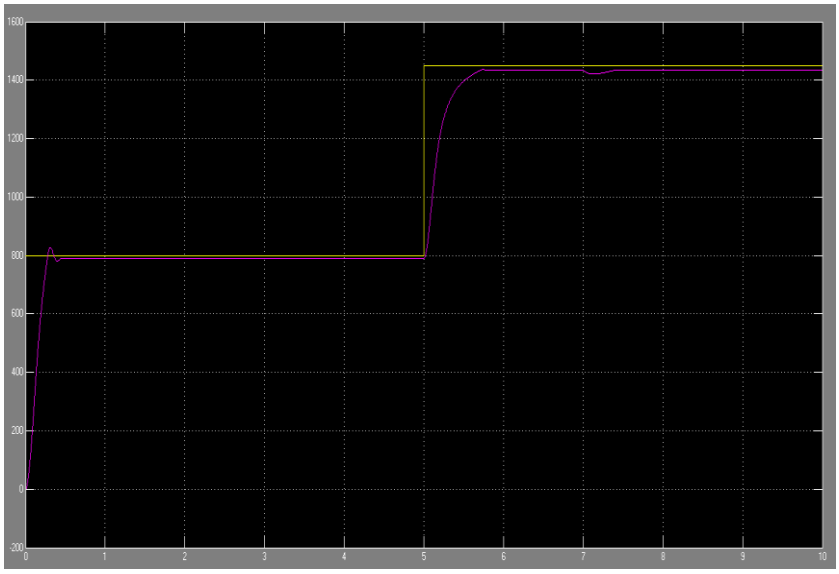

Fig.5 Comparison Between Rated Speed vs Time Response and Actual Speed Vs Time Response.

V. CONCLUSION

The background of DC Motors is studied. The study of Characteristics of DC motor is done. We have studied basic definition and terminology of fuzzy logic and neural network with the help of MATLAB and the other references. Due to simple formulas and computational efficiency, both triangular MFs has been used to design fuzzy industrial controllers especially in real-time implementation. The speed of a DC Motor has been successfully controlled by using fuzzy logic controller technique.

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