Speed Control of Separately Excited D.C Motor Using Computational Method

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Abstract— This project presents a comparison of performance of controllers such as PI, PID controller, Self tuned fuzzy controller for DC motor speed control. Simulation results have demonstrated that the use of Self Tuned FIS results in a good dynamic behaviour of the DC motor, a perfect speed tracking with no overshoot, gives better performance and high robustness than those obtained by use of the other controllers. The simulation results are obtained in MATLAB SOFTWARE with different order of the system and controllers.
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Keywords—DC motor; MATLAB; separately excited; PID controller;

I. INTRODUCTION

With the development of power electronics resources, the direct current machine has become more and more useful. The speed of DC motor can be adjusted to a great extent as to provide easy controllability and high performance. There are several conventional as well as intelligent controllers to control the speed of DC motor such as: PID Controller, Fuzzy Logic Controller etc. The Adaptive Fuzzy Inference System (AFIS), developed in the early 90s by Jang, combines the concepts of fuzzy logic that enhances the ability to automatically learn and adapt. Hybrid systems have been used by researchers for modeling and predictions in various engineering systems..

II. MATHEMATICAL MODELING & CONTROLLER DESIGN

Motor to be controlled is a separately excited dc motor (as shown in figure.1.) with name plate ratings of 1 hp, 220v and 550 rpm. Various parameters associated with the motor are:
Moment of Inertia of the motor rotor with attached mechanical load,
J = 0.068 Kg-m2
Torque Constant, K = 3.475 Nm A-1
Armature winding resistance, Ra = 7.56 ohm
Armature winding inductance, La= 0.055 H
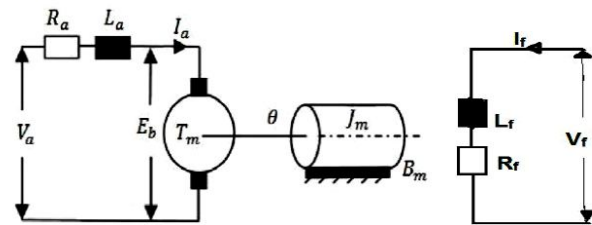Friction coefficient (Bm) = 0.008 N.m/rad/sec
Sampling period, T = 40ms

Figure.1: Separately excited DC motor model

The armature voltage equation is given by:
Va = Eb+ Ia.Ra+ La. (dIa/dt) (1.1)
For normal operation, the developed torque must be equal to the load torque plus the friction and inertia, i.e.:
Tm = Jm. dω/dt +Bm .ω+TL (1.2)
Where: TL is load torque in Nm.

III. DESIGN OF CONTROLLERS

3.1 PID Controller AND TUNING:

A feedback control system measures the output variable and sends the control signal to the controller. The controller compares the value of the output signal with a reference value and gives the control signal to the final control element. The equation of ideal PID controller is

$$u = K_p \left(e + \frac{1}{T_i} \int_0^t e * d\tau + T_d \frac{de}{dt} \right)$$

The real PID controller is

$$u(s) = K_c \left(\frac{1 + \tau_i s}{\tau_i s} \right) \left(\frac{1 + \tau_d s}{1 + \alpha \tau_d s} \right) e(s)$$

The PID controller is traditionally suitable for second and lower order systems. It can also be used for higher order plants with dominant second order behaviour. The Ziegler-Nichols (Z-N) methods rely on open-loop step response or closed-loop frequency response tests. A PID controller is tuned according to a table based on the process response test. According to Zeigler-Nichols frequency response tuning criteria
Kp=0.6 kcu , τi =0.5T and τd =0.125T
For the PID controller used, the values of tuning parameters obtained are
P= 18, I= 12, D=8.0

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3.2 Self Tuned Fuzzy Logic Controller

The Fuzzy controller developed here is a two-input single output controller. The two inputs are the deviation from set point i.e. error, e and error change rate, Δe . The single output is the change of actuating input, Δu.

u(t)		e(t)						
		NB	NM	NS	ZO	PS	PM	PB
$\Delta e(t)$	NB	NB	NB	NB	NB	NM	NS	ZO
	NM	NB	NB	NB	NM	NS	ZO	PS
	NS	NB	NB	NM	NS	NS	PS	PS
	ZO	NB	NM	NS	ZO	ZO	PM	PM
	PS	NM	NS	ZO	PS	PS	PB	PB
	PM	NS	ZO	PS	PM	PM	PB	PB
	PB	ZO	PS	PM	PB	PB	PB	PB

Table1: Inference rules for main fuzzy logic
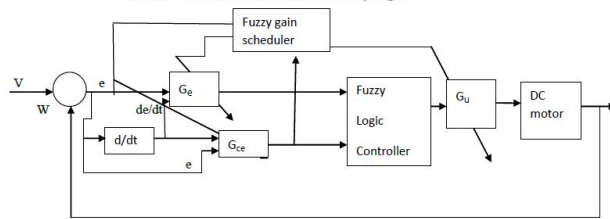
Fig2. Structure of self-tuning FLC

E		NB	NM	NS	ZE	PS	PM	PB
ΔE	G_e							
NB		PB	PB	PB	PB	PM	ZE	ZE
NM		PB	PB	PB	PB	PM	ZE	ZE
NS		PM	PM	PM	PS	ZE	NS	NS
ZE		PM	PM	PS	ZE	NS	NM	NM
PS		PS	PS	ZE	NS	NM	NM	NM
PM		ZE	ZE	NM	NB	NB	NB	NB
PB		ZE	ZE	NM	NB	NB	NB	NB

Table2: Inference rules for tuning the input gain G_e

Simulink models of different controllers are developed & simulated using MATLAB software. To test the robustness of the different controllers, a reference speed of 20 red/sec is chosen. Figures 6 represent the variation of motor speed w.r.t. time , while using PI, PID controller, self tuned fuzzy controller, GA Tuned fuzzy PID & Self tuned ANFIS respectively. Results shows that ANFIS controller provides the best control minimizing overshoots and settling time.
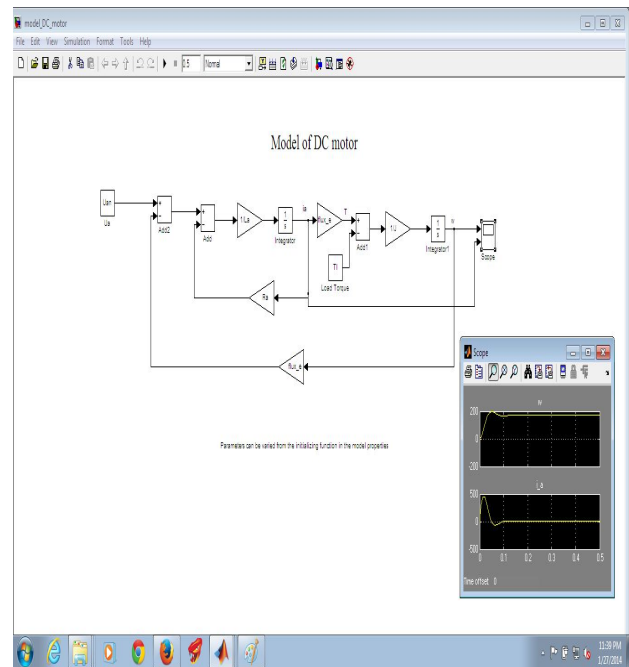

(a) PI   (b)PID

(c)SELF TUNED FUZZY
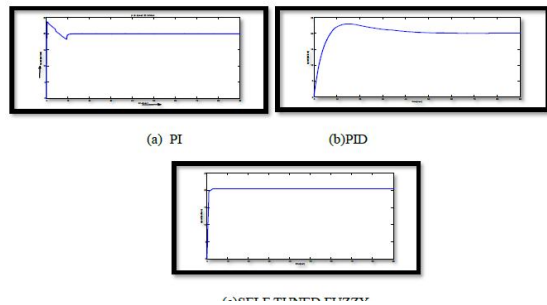
Fig 4: model of dc motor & out put
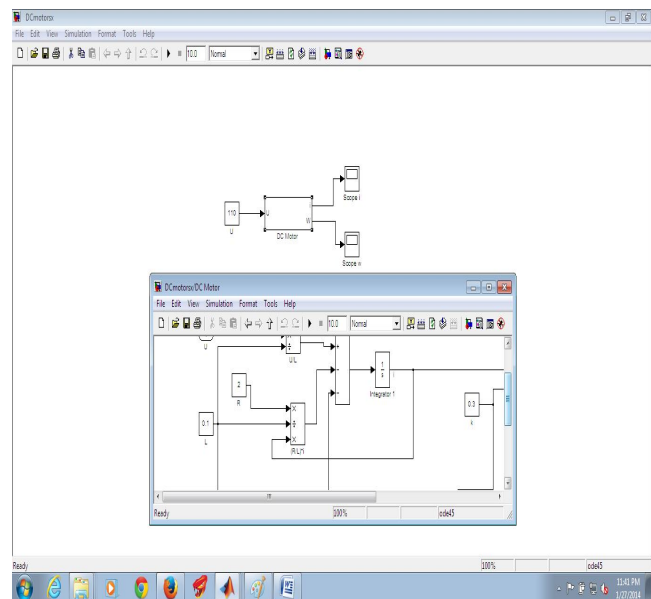

Fig 5: dc motor sub system
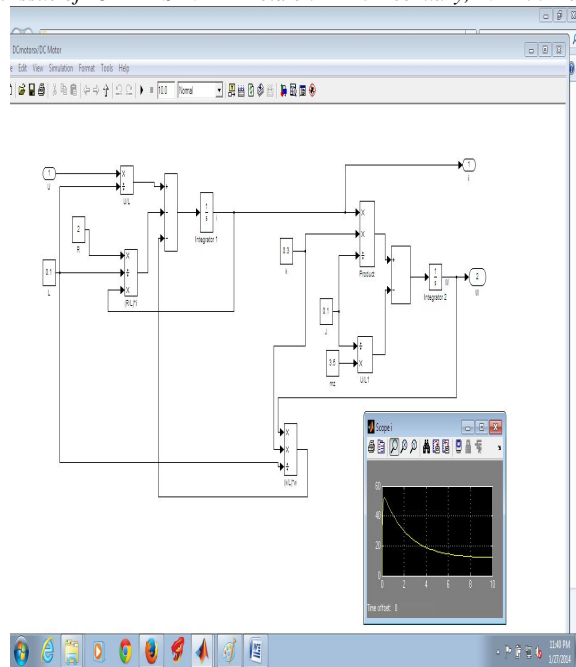
Fig 6: dc motor charectristics

1V.CONCLUSION

In this paper , intelligent techniques such as Fuzzy logic Controllers & their hybrid are used for d.c. motor speed control. From simulations, it is concluded that the use of self tunned FIS reduces design efforts. Also, it results in minimum overshoots & undershoots & increases the speed of response. Its response is even best under variable reference speed which is shown from the results of second set of simulations.

V1.REFERENCES

[1] W. Lord and J. Hwang, " DC motor model parameters ". IEEE Trans. on Industrial electronics and Control Instrumentation, vol. IECI-23, No.3, August, 1977.

[2] R. Schulz, "A frequency for determining the parameters of high performance DC motors".IEEE Trans. on Industrial Electronics, vol. IE-30, No.1, Februray, 1983.

[3] A. Rajkumar and R. Somanahtham, "Determination of DC motor transients using a microcomputer ". IEEE Trans, on Instrumentation and Measurement,vol. 37, No.4, Dec. 1988.

[4] S. Weerasooriya and M. El-Sharkawi, " Identification and control of a DC motor using back-propagation neural networks ". IEEE Trans. on Energy Conversion, vol. 6, No.4, December 1991.

[5] Ahmed Rubaaim and Raj Kotaru. "Online Identification and Control of a DC Motor Using Learning Adaptation of Neural Networks", IEEE Trans. on Energy On industry application, Vol. 36, NO. 3, MAY/JUNE 2000

[6] Abu zaharin and Mohd. Nasir Taib, "A Study On The DC Motor Speed Control By Using Back-EMF Voltage", IEEE Conf. on Sensor, pp. 359-364, 2003.

[7] Ahmed Rubaai, " Design and Implementation of Parallel Fuzzy PID controller for high performance Brushless Motor Drives an integrated environment for rapid control prototyping". IEEE Trans. On industry application, vol.44, No.4, july/August, 2008.

[8] P. Melba Maryand N.S. Marimuthu , "Design of self-tuning fuzzy logic controller for the control of an unknown industrial process", IET Control Theory Appl., Vol. 3, Issue. 4, pp.428–436, 2009.

[9] Wikipedia, The free encyclopedia http://en.wikipedia.org/wiki/Electric motor.

[10] Ogata K., Modern Control Engineering , 2nd ed., Prentice Hall, NJ, 1990.

[11] Kuo B.C., Automatic Control Systems, 6th ed., Prentice Hall, NJ, 1991.

[12] Driankov & M Reinfrank, "An Introduction to Fuzzy Control", Narosa, Publishing house, New Delhi, 1996.