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A Comparative Analysis of Speed Control of D.C. Motor the use of Intelligence Techniques

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Abstract: ***Now a days, the D.C motor has been broadly used in industries due to its salient functions like reliability, huge variety of torque –speed manipulate variety, excessive efficiency, better starting torque, less electric noise and high weight/torque ratio. For velocity control of DC motor exceptional controllers are used. Mathematical version and simulink version of one after the other excited dc motor is designed. On this paper, the overall performance of DC motor is tested/ evaluated with conventional controller including PID controller and the effects had been in comparison with the fuzzy based PID controller. Whilst compared to traditional controller we determined that Fuzzy primarily based PID controller offers higher velocity response but traditional controller affords higher pace reaction by using changing load on the price of very lengthy settling time. MATLAB/SIMULINK environment is discussed to verify the above investigation.***
Keywords: Separately excited D.C motor, PID controller, fuzzy–PID Controller, speed control.

I. INTRODUCTION

Most of the industries use specifically two varieties of motor: (i) everlasting magnet brushless DC vehicles (PMBLDCM) in which the everlasting magnet provides the specified air gap flux in place of twine wounded field poles (ii) DC motors wherein the flux is supplied by means of the modern thru shunt or area coils of the stationary pole shape. For pace manipulate of DC motor, maximum broadly used controllers are conventional PID controllers [2]. But due to non-linearity of DC motor those controllers faces issues. The issues of non- linearity arises due to armature cutting-edge hassle, trade in masses and drive inertia [1],as a result to acquire favored velocity control traditional PID controllers combines with the intelligence strategies which includes FUZZY good judgment are in broadly use [8] .

II. MATHEMATICALMODELLINGOFSEPARATELYEXCITEDDCMOTOR

The performance characteristics of DC motor with conventional controller as well as combination of intelligent controllers have been investigated.

The armature voltage equation is given by:

$$V_a=E_b+I_aR_a+L_a(dI_a/dt) \quad \text{………..(1.1)}$$

For normal operation, the developed torque must be equal to the load torque plus the friction and inertia, i.e.:

$$T_m=J_m d\omega/dt+B_m\omega+T_L \quad \text{1.2)}$$

Where T_L is load torque ein Nm

Friction in rotor of motor is very small (can be neglected), so$B_m=0$Therefore new torque balance equation will be given by:

$$T_m=J_m d\omega/dt+T_L \quad \text{1.2a)}$$

Taking field flux as Φ and back EMF constant as K. Equation for back emf of the Motor will be:

$$E_b=K\Phi\omega \quad \text{……………(3)}$$

$$T_m=K\Phi I_a \quad \text{……………(4)}$$

Taking la place trans form of the motors armature voltage equation we get:

$$I_a(s)=(V_a-E_b)/(R_a+L_aS) \quad \text{…………(5)}$$

Put Eb in equation(4)now equation become

$$I_a(s) =(V_a- K\Phi\omega)/(R_a+L_aS) \quad \text{…………(6)}$$

$\omega(s)=(T_m-T_L)/JS=(K\Phi I_a-T_L)/J_mS$

(Armature time constant)$T_a=L_a/R_a$

After simplifying the above motor model, the overall transfer function will be

$$\omega(s)/V_a(s)=[K\Phi/R_a]/J_mS(1+T_aS)/[1+(K^2\Phi^2/R_a)/J_mS(1+T_aS)]\ldots(7)$$

III. SPEEDCONTROLOFDCMOTOR

A. PI controller

The transfer function of proportional plus integral controller ins-domain is given by:

$G_c(s) =(sK_P+K_I)$ …………..(8)

e(t) is the instantaneous error in the signal[6].

It is used to decrease the steady state error without effecting stability. Since a pole at origin and a zero is added[3].

B. PID controller

A PID controller is a easy 3 term controller. It's miles used to lower the constant country mistakes and to boom the stableness. Given that pole at beginning and two zeros are delivered. One zero compensate the pole and other 0 will boom the stableness [4]. Switch feature is given with the aid of:

$$G_c(s)=(K_p+K_I/ s+ K_D.s)$$

$$G_c(s)=(K_D.s^2+K_P.s +K_I) /s \quad \ldots\ldots\ldots\ldots\ldots(9$$

C. Fuzzy logic controller (FLC)

FLC based on linguistic manipulate approach uses human interface to optimize the system performance without understanding the mathematical model of the device. Fig(1) indicates the basic configuration of FLC.

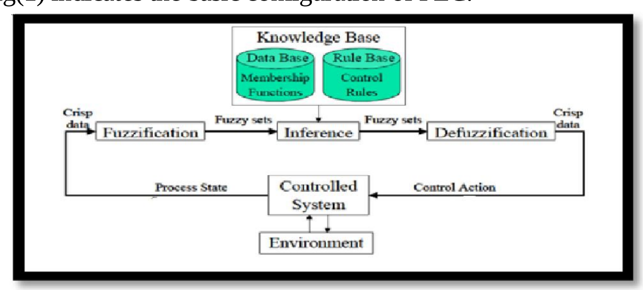

Fig.1:Blockdiagramoffuzzylogicsystem

Table1: Parameter used for simulation of DC motor.

Voltage	220v
Rpm	550rpm
Momen to finertia(J)	0.068kgm^2
Armature resistance(R_a)	7.56ohms
L_a	0.055H
D	0.03475Nms
Torque	40 ms
B_m	0.003Nm/rad/sec

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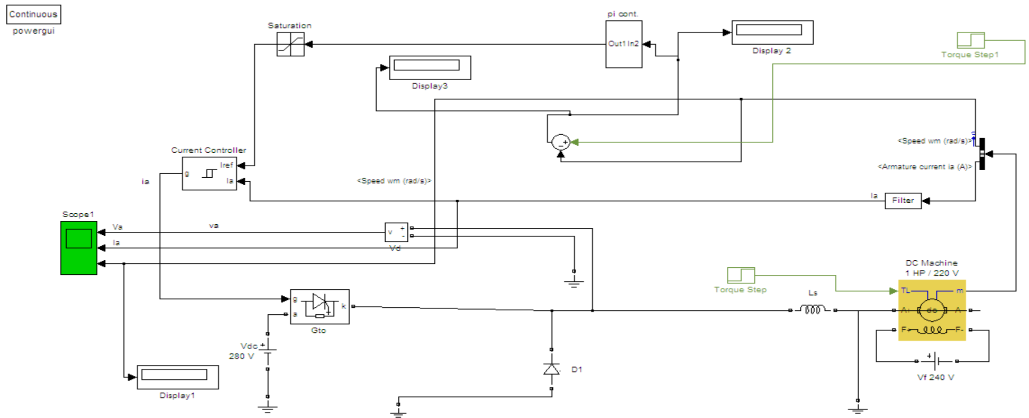


Fig.2:TheSimulinkmodelofFUZZY-PIDcontroller.

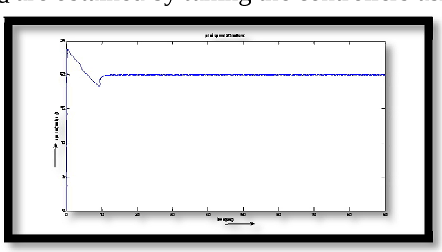
In present work, Mamdani primarily based fuzzy machine has been used. To govern the speed of DC motor, error in velocity and rate of trade in pace are taken as the input variables and the profits (Kp, Ki, Kd) are taken as the output variables. therefore in present paintings a fuzzy gadget with input and three outputs are simulated [5]. The triangular club has been used for its simplicity and extremely good overall performance. every universe of discourse has been advanced into seven fuzzy units including bad huge (NB), bad medium (NM) , bad small (NS), high-quality small (ps), fine medium(PM), nice large (PB). A rule base which include 40 nine rule has been advanced based on the predefined membership capabilities of the two inputs (e is the mistake, ce is the exchange in errors) and the three outputs (Kp, okay, and Kd) [9].

The structure of the rule base used can be visualized from table (2) g iven below.

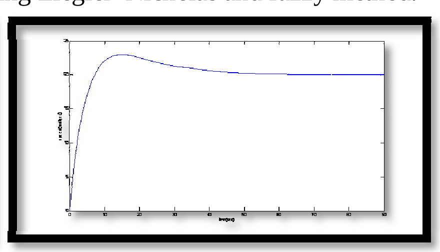
e/e*	NB	NM	NS	Z	PS	PM	PB
NB	NB	NB	NB	NM	NS	Z	PS
NM	NB	NB	NB	NM	Z	PS	PM
NS	NB	NB	NM	NS	Z	PM	PB
Z	NB	NM	NS	Z	PS	PM	PB
PS	NB	NM	Z	PS	PM	PB	PB
PM	NM	NS	Z	PM	PB	PB	PB
PB	NS	Z	PS	PM	PB	PB	PB

IV. SIMULATIONRESULTSANDDISCUSSION

The gain values K_P,K_i, and K_d are obtained by tuning the controllers using Ziegler–Nicholas and fuzzy method.



4(a).PI



4 (b).PID

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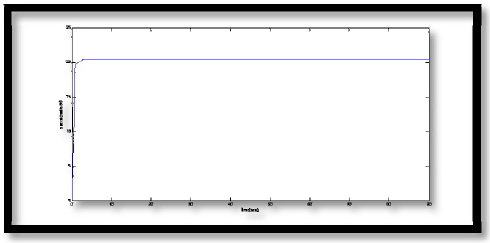

4(c).FUZZY-PID

The speed time characteristics acquired with the assist of different controllers with a reference speed of 20 rad / sec is proven in fig. 4(a), 4(b), 4(c).

In an effort to improve the response, when Ziegler-Nichols tuned PID controller is used, undershoot and overshoots are minimized. Use of adaptive self tuned FLC facilitates to lower settling time however consistent nation error increases with no overshoots and undershoots. Hybrid techniques which includes GA tuned fuzzy PID controller in addition improve the responses. Furthermore, there are not any overshoots and undershoots.

Table3: Summarizes the results obtained with different controllers

Parameters ↓	Controllers →	PI	Pid	selftuned FLC	GA TUNED fuzzyPID
SettlingTime(sec)		9.9	6.8	2.4	0.42
Max.overshoot(rad /sec)		3.58	3.00	00	00
Max.undershoot(rad/sec)		1.63	00	00	00
Steadystateerror(rad/sec)		0.000	0.000	0.42	0.00

V. CONCLUSION

Performance of DC motor with conventional in addition to smart controllers has been simulated and discussed in this paper. From the simulation consequences it has been found that Use of sensible controllers bring about improvement of velocity of response of the machine.

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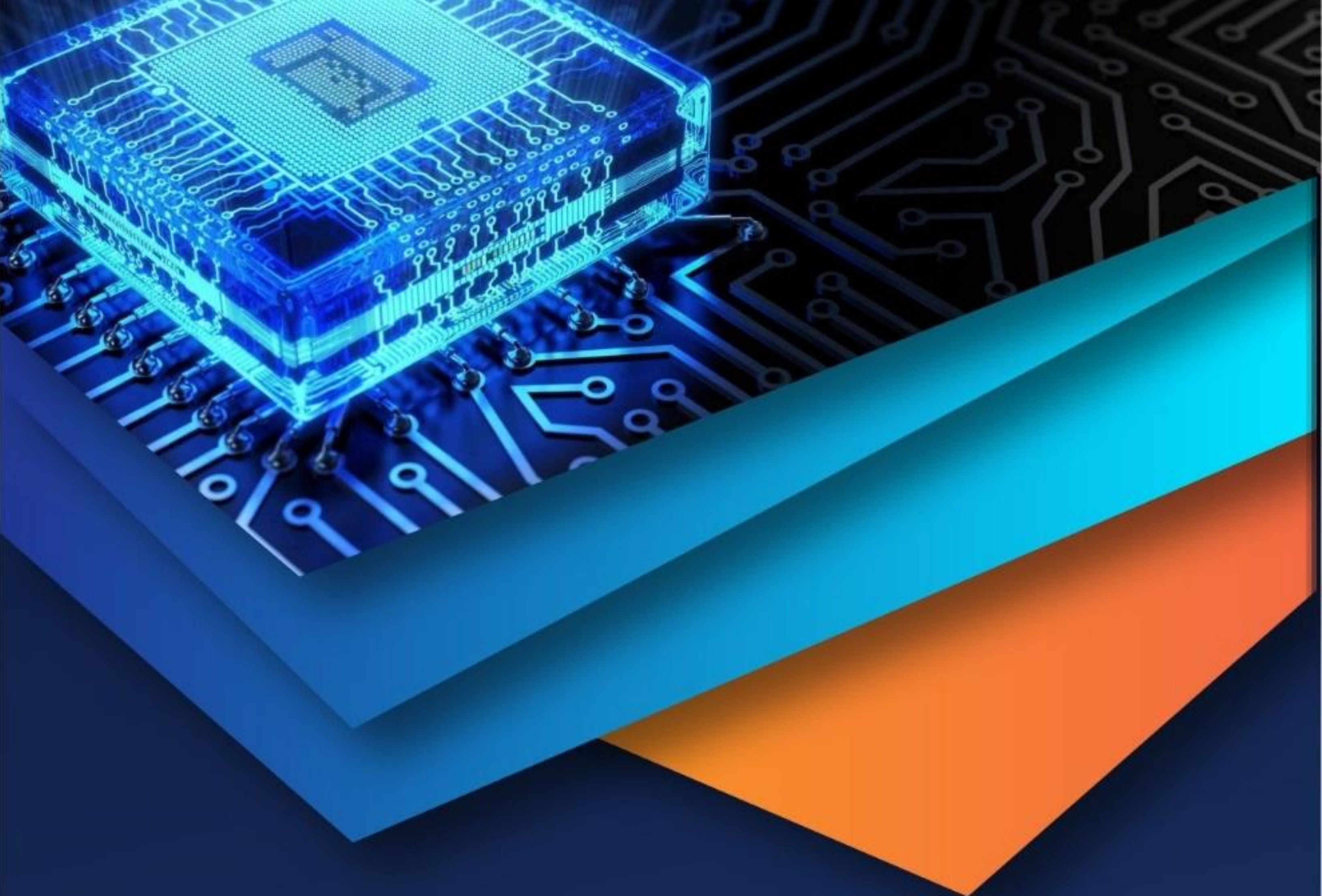

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