Volume 4, Issue 4, October 2017 ISSN: 2348-8565 (Online)
International Journal of Modern Engineering and Research Technology
Website: http://www.ijmert.org Email: editor.ijmert@gmail.com

An Efficient Usage of Intelligence Techniques to Analyze the Speed Control of D.C Motor

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ABSTRACT

Now a days, the D.C motor has been loosely utilized in industries owing to its salient functions like dependability, immense sort of force –speed manipulate selection, excessive potency, higher beginning force, less electrical noise and high weight/torque magnitude relation. For rate management of DC motor exceptional controllers square measure used. Mathematical version and simulink version of 1 once the opposite excited dc motor is meant. On this paper, the performance of DC motor is tested/ evaluated with typical controller as well as pelvic inflammatory disease controller and also the effects had been as compared with the fuzzy based mostly pelvic inflammatory disease controller. While compared to ancient controller we have a tendency to determined that Fuzzy based pelvic inflammatory disease controller offers higher rate response however ancient controller affords higher pace reaction by victimization dynamical load on the worth of terribly extended subsiding time. MATLAB/SIMULINK atmosphere is mentioned to verify the on top of investigation.

Keywords:—*Separately excited D.C motor, PID controller, fuzzy–PID Controller, speed control.*

I. INTRODUCTION

Most of the industries use specifically 2 sorts of motor:

1. Everlasting magnet brushless DC vehicles (PMBLDCM) within which the everlasting magnet provides the desired air gap flux in situ of twine wounded field poles

2. DC motors whereby the flux is equipped by means that of the fashionable through shunt or space coils of the stationary pole form. For pace manipulate of DC motor, most generally used controllers square measure typical PID controllers [2].

However thanks to non-linearity of DC motor those controllers faces problems. the problems of non- dimensionality arises thanks to coil fashionable trouble, exchange plenty and drive inertia [1], as a result to amass favored speed management ancient PID controllers combines with the intelligence methods which incorporates FUZZY common sense square measure in generally use [8]

II. MATHEMATICAL MODELING OF SEPARATELY EXCITED DC MOTOR

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:

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

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

Where TL is load torque in NmFriction in rotor of motor is very small(can be neglected), so Bm= 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 EMconstant 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 Laplace transform of the motors armature voltage equation we get

$$I_a(s) = (Va - E_b) / (R_a + L_a S) \quad \text{..... (5)}$$

Put Eb in equation (4) now equation become

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

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

(Armature time constant) Ta = La / Ra

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

$$\omega(s) / Va(s) = [K\Phi / Ra] / J_m S(1+T_a S) / [1+(K^2\Phi^2 / R_a) / J_m S(1+T_a S)] \quad \text{...(7)}$$

III. Speed Control of Dc Motor

3.1. PI Controller

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

$$Gc(s) = (sKP+KI) \text{……..} \quad (8)$$

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].

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:

$$Gc(s) = (Kp+KI / s + KD.s)$$
$$Gc(s) = (KD.s2 + KP.s + KI) / s \text{…..} \quad (9)$$

3.3 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. Figure 1 indicates the basic configuration of FLC.

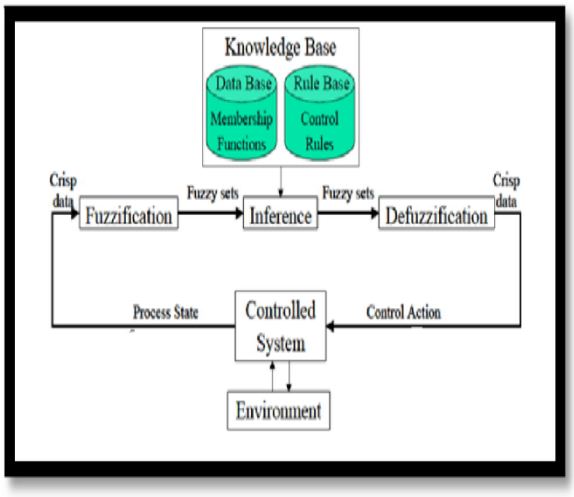

Figure 1. Block diagram of fuzzy logic system

Table 1: Parameter used for Simulation of DC motor.

Voltage	220v
Rpm	550 rpm
Moment of inertia (J)	0.068 kg m^2
Armature resistance (R_a)	7.56 ohms
L_a	0.055 H
D	0.03475 Nms
Torque	40 ms
B_m	0.003 Nm/rad/sec

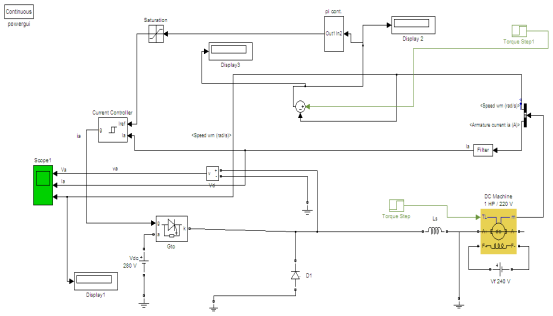

Figure 2: The Simulink model of FUZZY-PID Controller.

In present work, Mamdani based totally fuzzy machine has been used. to control the speed of DC motor, error in speed and rate of exchange pace area unit taken because the input variables and also the profits (Kp, Ki, Kd) area unit taken because the output variables. thus in gift paintings a fuzzy convenience with input and 3 outputs area unit simulated [5]. The triangular club has been used for its simplicity and intensely sensible overall performance. each universe of discourse has been advanced into seven fuzzy units as well as unhealthy Brobdingnagian (NB), unhealthy medium (NM), unhealthy tiny (NS), high-quality tiny (ps), fine medium (PM), nice massive (PB). A rule base that embrace forty 9 rule has been advanced supported the predefined membership capabilities of the 2 inputs (e is that the mistake, metal is that the exchange in errors) and also the 3 outputs (Kp, okay, and Kd) [9].

The structure of the rule base used will be visualised from table (2) given below

Table 2: Structure of a Rule Base

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. Simulation Results and Discussion

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

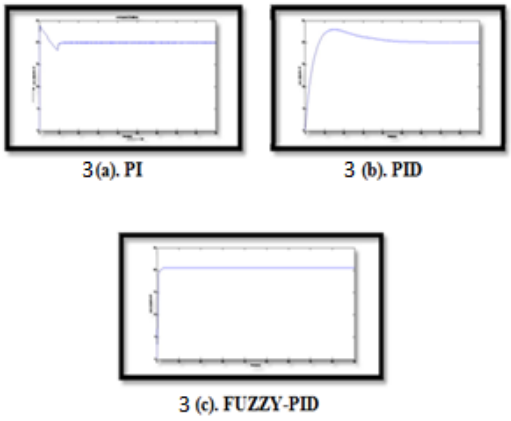

Figure 3: Simulation results

The speed time characteristics non-inheritable with the assist of various controllers with a reference speed of twenty rad / sec is proved in figure 3(a), 3(b), 3(c).

In an endeavor to enhance the response, once Ziegler-Nichols tuned inflammatory disease controller is employed, undershoot and overshoots are decreased. Use of adaptive self tuned FLC facilitates to lower subsiding time but consistent nation error will increase with no overshoots and undershoots. Hybrid techniques which incorporates GA tuned fuzzy inflammatory disease controller additionally improve the responses. More over, there aren't any overshoots and undershoots.

Table 3: Summarizes the Results Obtained with Different Controllers

Parameters ↓ / Controllers →	PI	Pid	self tuned FLC	GA TUNED fuzzy PID
Settling Time (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
Steady state error (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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