Comparative Study of Speed Characteristics of DC Motor with and without Controllers

Tireesh[1] | S.Israel Babu[2] | Murali Krishna.N[3]

[1]PG Scholar, Department of EEE, Sri Vani School of Engineering, Chevuturu, Andhra Pradesh, India.
[2]Assistant Professor, Department of EEE, Sri Vani School of Engineering, Chevuturu, Andhra Pradesh, India.
[3]HOD. Department of EEE, Sri Vani School of Engineering, Chevuturu, Andhra Pradesh, India.

ABSTRACT

In this paper a dc motor is modeled using transfer function analysis and the speed characteristics are plotted for dc motor with and without controllers. The difference between load torque and electromagnetic torque is improved using discrete p, I, d controllers for improving the speed characterics.the best speed characteristics is obtained using proportional plus derivative controller. These characteristics are obtained by formulating a relation between speed and torque. The entire simulation is conducted on mat lab/simulink2013 environment.

KEYWORDS: *dc motor, discrete PID controller, speed, simulink*

I. Introduction

The dc motor have been popular in the industry control area for a long time, because they have many good characteristics. Those are having high starting torque and high response and proved to be easier to linear control [1].at present mat lab simulation simplifies the scientific computation, process control, research, and industrial application and measurement applications [2].Fig.1.shows the block diagram of speed control of dc motor using discrete PID controller.

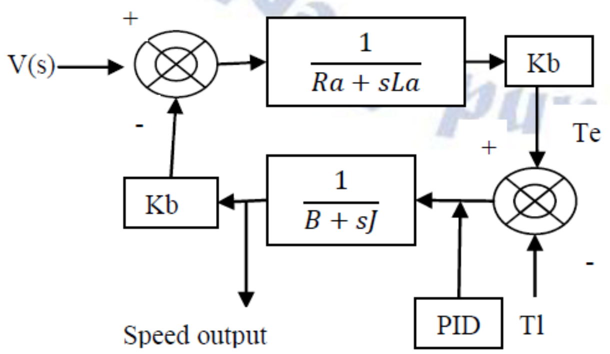

Fig.1. Block diagram of speed control of dc motor using discrete PID controller

II. Block Diagram And Transfer Functions

We know that the differential equation of dc motor in terms of speed and torque is given by

$$J\frac{dwm}{dt} + Bwm = Te - Tl = T \quad (1)$$

Where Tl is the load torque and Te is the electromagnetic torque and Ta is the acceleration torque is the moment of inertia and wm is the speed.
After applying Laplace transform we get the below equations:

$$Ia(s) = \frac{V(s)-Kb*Wms\,(s)}{Ra+sLa} \quad (2)$$

$$Wm(s) = \frac{Kb*Ia(s)-Tl(s)}{B+sJ} \quad (3)$$

By using equations (2) and (3) block diagram shown in Fig.1.is constructed. The difference between Te and Tl is improved using discrete P, I, D controllers and the speed characteristics for different combinations are plotted [3].

III. CIRCUIT DIAGRAM

The simulink diagram of dc motor using transfer function analysis is shown in Fig.2.as shown in figure the simulink includes with and without PID controllers. The PID combinations are with pi controller, PD controller, PID controller and without PID controller.

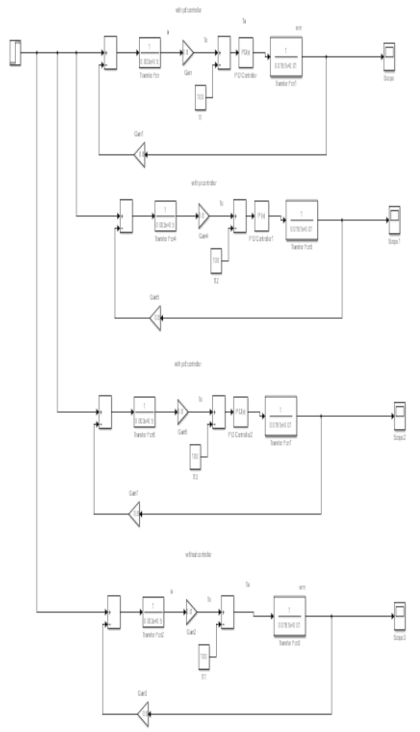

Fig.2.Simulink diagram of dc motor

IV. DISCRETE P, I, D CONTROLLER

The discrete PID controllers are very flexible today. Earlier we used to apply zadeh rules manually for p, I, d values. But, now a days it became very easy so that it is auto tuned in mat lab. In this paper first the load torque and electromagnetic torque is improved using P+I controller and secondly using P+D controller and finally using P+I+D controller. After all the three combinations of PID controller, the best result of speed control is obtained using P+D combination. The input given to the dc motor in simulink diagram shown is step.

V. VALUES

The values used in the speed control of dc motor are shown in Table.1.

Ra	0.003
La	0.5
B	0.01
J	0.0167
Kb	0.8
Tl	100
Vs	220
P	0.0102628039128877
I	0.0103454229667397
D	-0.00357312093128814
Filter coefficient N	2.87222406133

VI. GRAPHS

The graphs for different combinations of pid controllers and without controller are shown from Fig.3. To Fig.6 below

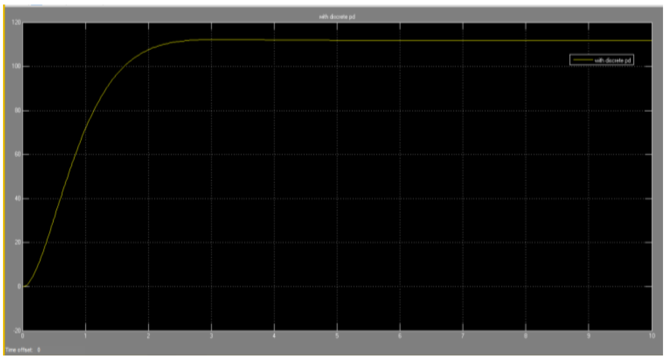

Fig.3.speed characteristics discrete P+D combination

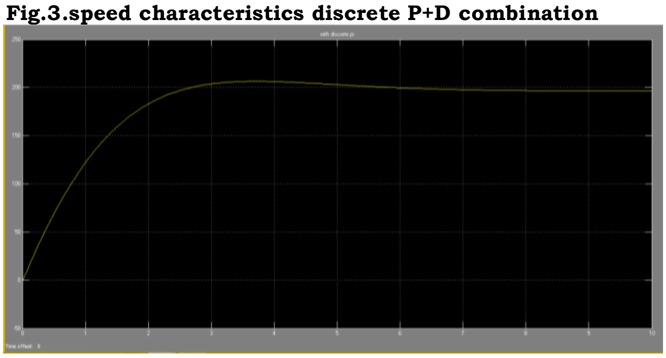

Fig.4.speed characteristics discrete P+I combination

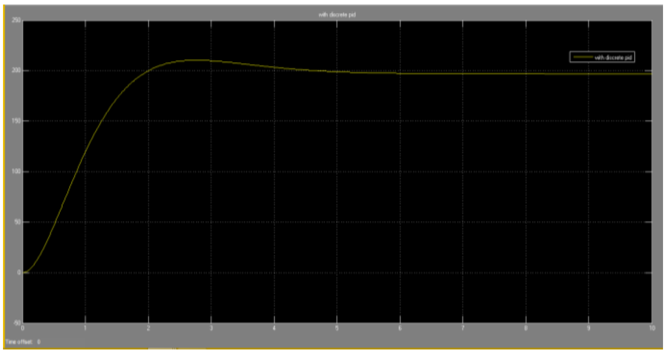

Fig.5.speed characteristics discrete P+I+D combination

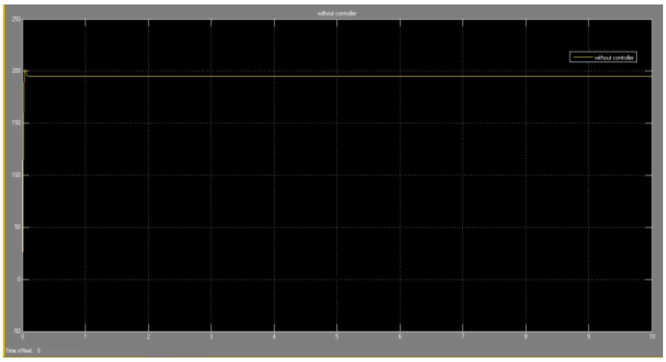

Fig.6.speed characteristics without controllers

As shown in the figures the speed is improved more using discrete P+D combinations compared to other combinations. The data used in this work is shown in table.1.

VII. Conclusion

The characteristics of speed of dc motor control are plotted and compared for different combinations of discrete PID controllers and without controller. The results obtained by using P+D combination are very satisfactory compared to any other type of combinations. The entire simulation is conducted on mat lab/simulink2013 environment.

NOMENCLATURE

$Ra = armature\ resistance$
$La = armature\ inductance$
$B = viscous\ coefficient$
$J = moment\ of\ inertia$
$Tl = load\ torque$
$P = proportional$
$I = integral$
$D = derivative$

EQUATIONS FOR P, I, D CONTROLLERS

The equations for proportional (P), integral (I) and derivative (D) are given in the below equations.

$$u(t) = Kp * e(t) \quad (4)$$

$$u(t) = Ki \int_0^t e(t)dt \quad (5)$$

$$u(t) = Kd * \frac{de(t)}{dt} \quad (6)$$

For P+I+D combination the equation after applying Laplace transform is given below:

$$C(s) = Kp + Kt/s + Kd * s = \frac{U(s)}{E(s)} \quad (7)$$

ACKNOWLEDGEMENT

I sincerely thanks to all my faculty of Sri Vani School of Engineering who helped me in this publishing work. I sincerely thank all my friends who helped me in calculating the values.

References

[1] Salim, Jyothi Ohri, Naveen, "speed control of dc motor using fuzzy logic based on lab view," international journal of scientific and research publications, vol. 3, issue6, june-2013.
[2] Atul Kumar Dewangan,Sashai Shukla,Vinod Yadu,"speed control of a separately excited dc motor using fuzzy logic control based on mat lab simulation program", international journal of scientific and technology research, Volume 1,issue2,march 2012.
[3] Electric motor drives modeling, analysys and control, R.Krishnan, PHI publications.