INSTANTANEOUS SPEEDCONTROL OF BLDC MOTOR USING PI, PID CONTROLLER

M.Saichetana[1] , Ch.Govinda[2]

[1]*Assiantant Professor, Department of EEE, SVECT, (India)*

[2]*Assiantant Professor, Department of EEE,AEC, (India)*

ABSTRACT

Brushless DC Motor (BLDC) features high efficiency, reliability, good dynamic response and very low maintenance that prove it as one of the best electrical drives that is gaining more and more popularity.
Brushless DC Motor has been widely used in industries because of its properties such as high efficiency, reliability, high starting torque, less electrical noise and high weight to torque ratio.
We are using PI controller to control speed of BLDC MOTOR instantaneously, Here PI controller regulates the speed of BLDC motor, And the PI controllers output is summed and is fed as the input to the boost controller. The BLDC motor is supplied from the inverter.

Keywords: ***DC motor, PI, PID controller***

I. INTRODUCTION

DC motors have been widely used in many industrial applications such as electric vehicles steel rolling mills, electric cranes, robotic manipulators, and home appliances due to precise, wide, simple, and continuous control characteristics.
The purpose of a speed controller is to drive the motor at desired speed. DC motors are generally controlled by conventional Proportional plus Integral controllers, since they can be designed easily. However the performance of PID controller for speed controldegrades under external disturbances and machine parameter variations. This makes the use of PID controller a poor choice for variable speed driveapplications.
In the past three decades, nonlinear and adaptive control methods have been used extensively to control DC drives . In these methods, the state estimation and parameter identification are based on and limited to linear models. Performance comparison of PI control and PID controller for speed control of separately excited DC motors

II. ANALYSIS OF BLDC MOTOR DRIVE SYSTEM

Figure 1 shows the overall system configuration of the three-phase BLDC motor drive. The three phase inverter topology is a six-switch voltage-source configuration with constant dc-link voltage (Vdc), which is identical with the induction motor drives and the permanentmagnet ac motor drives. The analysis is based on the following assumption for simplification:

1. The motor is not saturated.
2. Stator resistances of all the windings are equal, and
Self and mutual inductances are constant.
3. Power semiconductor devices in the inverter are ideal.
4. Iron losses are negligible.

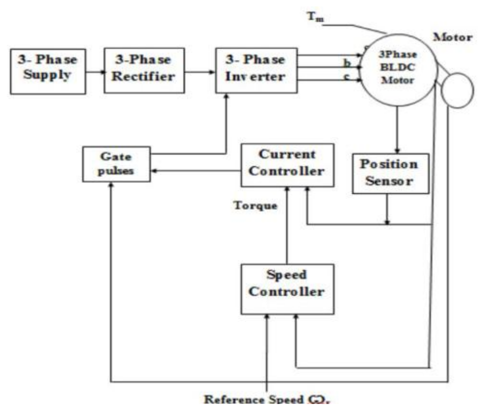


Fig.1: BLDC Motor Drive System

III. DYNAMIC MODELING OF BLDC MOTOR

BLDC motor can be modeled in the 3-phase ABC variables which consist of two parts. One is an electrical Part which calculates electromagnetic torque and current of the motor. The other is a mechanical part, which Generates revolution of the motor. Fig 3 shows the mathematical model of BLDC motor

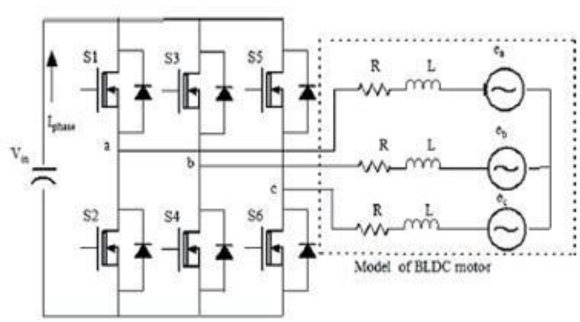


Fig. 2: Mathematical model of BLDC motor

Using KVL the voltage equation from Fig. 3 can be expressed as follows:

$V_a = R_a i_a(t) + L_a \frac{di_a}{dt} + e_a(t)$ (1)

$V_b = R_b i_b(t) + L_b \frac{di_b}{dt} + e_b(t)$ (2)

$V_c = R_c i_c(t) + L_c \frac{di_c}{dt} + e_c(t)$ (3)

Where, L represents per phase armature self-inductance [H], R represents per phase armature resistance [Ω], indicates per phase terminal voltage V_a, V_b, V_c[V],i_a ,i_b andi_c represents the motor input current [A],$e_a e_b, e_c$indicates the motor back-EMF developed [V].M represents the armature mutual-inductance [H].In case of three phase BLDC motor, we can represent the back emf as a function of rotor position and it is clear thatback-EMF of each phase has 1200 shift in phase angle. Hence the equation for each phase of back emf can bewritten as:

$e_a = k_b w(t)(\theta_e)\ \omega$ (4)

$e_b = k_b w(t)(\ (\theta_e - 2\Pi/3)\ \omega$ (5)

$e_c = k_b w(t)\ (\theta_e + 2\Pi/3)\ \omega$ (6)

Where,$k_b w(t)$ denotes per phase back EMF constant [V/rad.s-1], θe represents electrical rotor angle [rad],

w represents rotor speed [rad.s-1].The expression for electrical rotor angle cab be represented by multiplying the mechanical rotor angle with the number of pole pair's P:

$\theta_e = \frac{P}{2}\theta_m$ (7)

Where,θm denotes mechanical rotor angle[rad].The summation of torque produced in each phase gives

The total torque produced, and that is given by:

$T_e = \frac{e_a i_a + e_b i_b + e_c i_c}{w}$ (8)

Where, $T_e$denotes total torque output [Nm].Mechanical part of BLDC motor is represented as follows:

$T_e - T_1 = j * \frac{dw(t)}{dt} + B*w$ (9)

Where,

T_1 denotes load torque [Nm],

J denotes of rotor and coupled shaft [kgm2],

B represents the Friction constant [Nms.rad-1]

 ISBN: 978-93-87793-01-9

IV. SPEED CONTROLLER

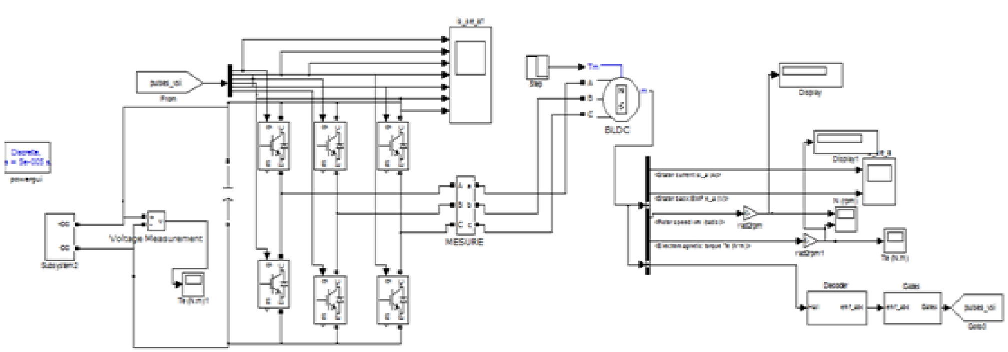
Proportional, integral and derivative are the basic modes of PID controller. Proportional mode provides a rapid adjustment of the manipulating variable reduces error and speeds up dynamic response Integral mode achieves zero offset. Derivative mode provides rapid correction based on the rate of change of controlled variable. The controller transfer function is given by C_{PID} (S) $=K_P(1+\frac{1}{T_S(s)}+T_d s)$ where,K_p,T_c and $T_d$proportional, integral and derivative constants of PID controller respectively.PIDcontroller tuning algorithm is based on Ziegler-Nichols open loop method. And the preference is given to the load disturbance rejection

V. PARAMETERS AND SPECIFICATIONS

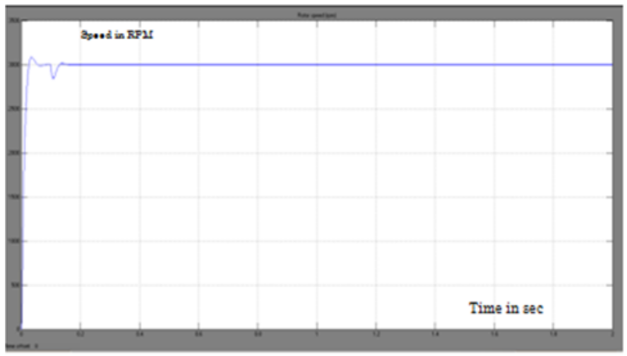
PARAMETERS	SPECIFICATIONS
Number of Pole Pairs, P	4
Supply voltage (V)	12V
Armature Resistance (R)	R 1Ω
Self Inductance (L)	20 mH
Motor Inertia (J)	0.005 kgm^2
EMF constant (	0.763 (V/rad)
Torque Constant)	0.345Nm/A

VI. SIMULATION AND RESULTS:

(a) SPEEED CONTROL OF BLDC MOTOR BY PI CONTROLLER

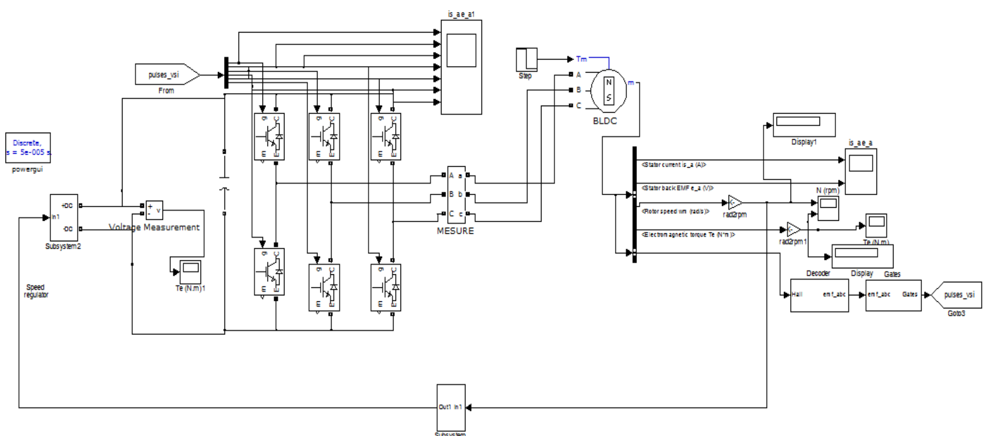


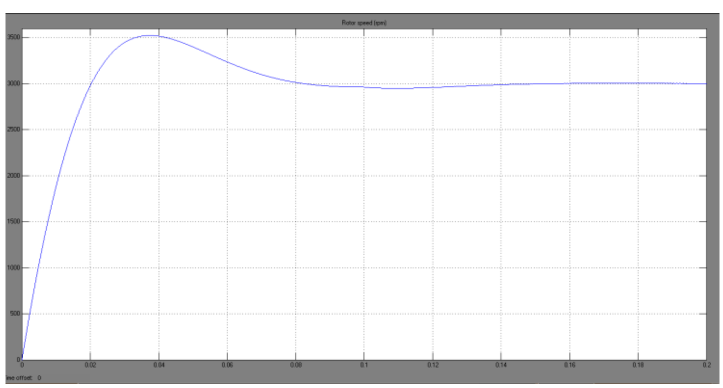
17th February 2018 www.conferenceworld.in ISBN: 978-93-87793-01-9



Speed vs Time

(b) SPEED CONTROL OF BLDC MOTOR PID CONTROLLER:





VII. TABLES

Controller	Rise time(T_r) (sec)	Settling time(T_s) (sec)	Controller usage
PI	0.05	0.18	Proportional value
PID	0.03	0.16	Decreases exceed value

VIII.CONCLUSION

The performance of three phase BLDC motor with Fuzzy and PID controllers are analyzed. The performance of the two controllers are compared on the basis of various control system parameters such as steady state error, rise time, peak overshoot, recovery time and settling time

IX. ACKNOWLEDGEMENTS

I express my deep gratitude to my guide Mr.Ch Govinda**.,** Assistant Professor, Department of Electrical & Electronics Engineering, Aditya engineering college.

REFERENCES

[1.] Krishnan R, “Permanent magnet synchronous and brushless DC motor drives”, Boca Raton: CRC Press, 2010

[2.] T. Gopalaratnam and H.A.Holiya, 2003. “A new topology for unipolar brushless dc motor drives”. IEEE Trans. Power Electronics. 18(6): 1397-1404.

[3.] Pragsen Pillay and R. Krishnan, “Modeling, simulation and analysis of permanent-magnet motor drives. The brushless DC motor drive”, IEEE Transactions on Industrial Electronics, vol.25,no. 2, pp. 274 – 279,Mar/Apr 1989

[4.] P. Pillay, R. Krishnan, “Modelling, Simulation and Analysis of Permanent-Magnet Motor Drives Part

[5.] The Brushless DC Motor Drive”, *IEEE Transaction on Industry Applications*, pp. 274-279, September

[6.] A.K.Singh and K.Kumar, *Modelling and Simulation of PID Controller Type PMBLDC Motor*, Proceedings

[7.] National Seminar on Infrastructure Development Retrospect and prospects, Vol. I, pp. 137-146.

[8.] Tan C.S., Baharuddin I. "Study of Fuzzy and PI controller for permanent magnet brushless dc motor
[9.] drive". *Proceedings of International Power Engineering and Optimization Conference*, June 23-24,
[10.] 2010, pp.517- 521
[11.] Muhammad Firdaus Zainal Abidin, Dahaman Ishak and Anwar Hasni Abu Hassan, 2011, ― "A
[12.] comparative study of PI, fuzzy and hybrid PI fuzzy controller for speed control of brushless DC motor
[13.] drive‖ ", *International Conference on Computer Application and Industrial Electronics*, 978-1-4577-
[14.] pp.189-