International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 1 Issue: 9 726 – 729

PID Controller of Speed and Torque of ServoMotor Using MATLAB

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***Abstract*— This paper is to design a controller for servo motor in discrete-time systems. The experimental is used to obtain the transfer function to design the PID controller. The effectiveness of the design is validated using MATLAB/Simulink.This new design method gives us a simple and powerful way to design a speed controller for a servo – motor. In this study DC servo motor's mathematical model and equation were extracted and there were three different motion controller designed for control the velocity It was created simulation model at the MATLAB programme and proportional integral derivative .**

Index Terms — *servo motor PID controller discrete model, MATLAB/Simulink.*

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Introductio

There are many types of dc servo motors use in industries. In dc servomotors, the rotor inertia has been made very small, with the result that motors with very high torque-to-inertia ratios are commercially available. Some dc servomotors have extremely small time constants with relatively small power ratings are used in instruments and computer-related equipments such as disk drives, tape drives, printers, and word processors for the medium and large power ratings are used in robot systems, numerically controlled milling machines, and so on. Servo systems are generally controlled by conventional

Proportional Integral – Derivative (PID) controllers. PID Controller is a feed-back loop unit in the industries control. The controller receives the command, subtracts it with the actual value to create a "difference". This difference is then used to calculate a new input value which allows the data of system to achieve or maintain at the reference value. PID Controller. A PID feedback loop can maintain the system stability, but other control methods may lead to system that have stability errors or repeated process, which can be proved by Math methods. Mathematical models are required in control system design in order to describe the system dynamics, and identification processes. As computers spread, a lot of system identification methods benefiting from the digital processing have been developed, and identification for discrete-time systems has been studied because of facility for analysis and data processing. However, continuous time models tend to be preferred to discrete-time models in control system design, because the relation between pole zeros and time responses of the models is understood easily There are two control aspects of servo motor which are the position and the velocity control. From these both control aspects, two plant models can be identified, one for which the rotor velocity will be the output and another for which the rotor position is the output Position control

Systems are an important component of many industrial products. Examples are found in disc drive, automotive products, robotics, process control and many others. Servo systems are generally controlled by conventional Proportional – Integral – Derivative (PID) controllers, since they designed easily, have low cost, in expensive maintenance and effectiveness. Most of the PID controller was designed using continuous-time system and have been applied widely especially in industrial application.

II. Servo Motor description

Electric motors can be classified by their functions as servomotors, gear motors, and so forth, and by their electrical configurations as DC (direct current) and AC (alternating current motors. An easy way to comply with the conference paper for matting requirements is to use this document as a template and simply type your text into it. Servomotor is a motor used for position or speed control in closed loop control systems. The requirement from a servomotor is to turnover a wide range of speeds and also to perform position and speed. DC servo motors have been used generally at the computers, numeric control machines, industrial equipments, weapon industry, and speed control of alternators, control mechanism of full automatic regulators as the first starter, starting systems quickly and correctly.

Some properties of DC servo motors are the same, like inertia, physical structure, shaft resonance and shaft characteristics, their electrical and physical constants are variable. The velocity and position tolerance of servo motors which are used at the control systems are nearly the same. It has implemented proportional integral, fuzzy logic and adaptive neuro fuzzy inference system respectively at the variable working situations to the simulation model which has prepared at the Matlab programmers for improvement the servo motor performance.

III. Controller Design

The mechanical-electrical model of the servo motor is presented in Fig.1. Commonly, phenomenological models are nonlinear, that means at least one of the states (I current, θ-motor position) is an argument of a nonlinear function. In order to present such a model as a transfer function (a form of linear plant dynamics representation used in control engineering), it has to be linearised .However for the servo motor model, and nonlinearities are small that they can be neglected.

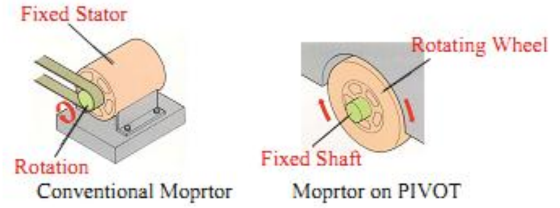


Fig. 1: Servo motor phenomenological model

IV.DC Servo Motor Mathematical Model

The motor used in this experiment is a 24V DC brushed motor with no load speed of 4050 rpm.

Va (t) =Ra.ia(t)La.dia(t)/dt +Eb (t) (1)

T m= j dϖm (t) + Bϖm (t) + T (t) (2)

In order to create the block diagram of system initial conditions are acquiescence zero and laplace transform is implemented to the equations.

Ia(s)= Ea(s) Kb. ϖm(s)/R+L(s) (3)

s.ϖ (s) = KI(S)/Jm – Bϖ(s)- T(s)/JM (4)

ϖ(S)= KI(S)-T(s)/B+SJ (5)

E(s)-K.I(S)-T(S)/B+SJ (6)

E(s)= KW(S) (7)

ω(S)/Ea(s)= K/sjl +SJR + ki.kb (8)

Where:-

i (*t*) *a* =Armature current

R = Armature resistance

E (*t*) *b* =Back emf

T =Load moment

ϖ =Motor angular velocity

J =Motor moment of inertia

B =Friction constant

L = Armature inductance

V (*t*) *a* =Input voltage

K =Voltage constant

T =Motor moment

K =Moment constant

ϕ =Phase margin

g =Gain margin

V (t).R i(t) L di(t)

Kp, *Ti, Td,ω* Proportional gain, Integral Time, Derivative Time constant, Critical frequency.

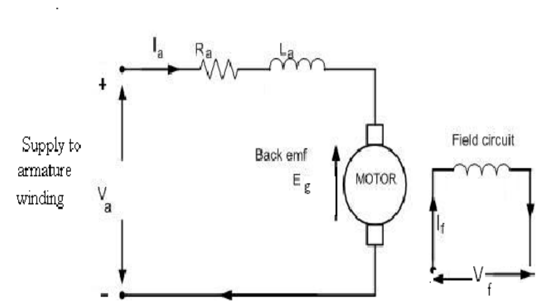


Fig. 2: Servo motor model

V. Servo Motor Parameter

Parameter Value

J-moment of inertia 140.10-17 kg.m2

Kt-torque constant 0.052 NM/A

Kb-electromotive force constant 0.057 Vs/rad

D-linear approximation of viscous friction

1.10-6 Nms/rad

R-resistance 2.6 Ω

L-inductance 2.5 mH

VI. Application

Proportional-integral- Derivative which is controller is created for DC servo motor servo motor according to Åström-Hägglund, phase response. DC servo motor’s current (Ia), angular velocity (ω) is simulated for constant and variable velocity position under the load at the Mat lab programme.

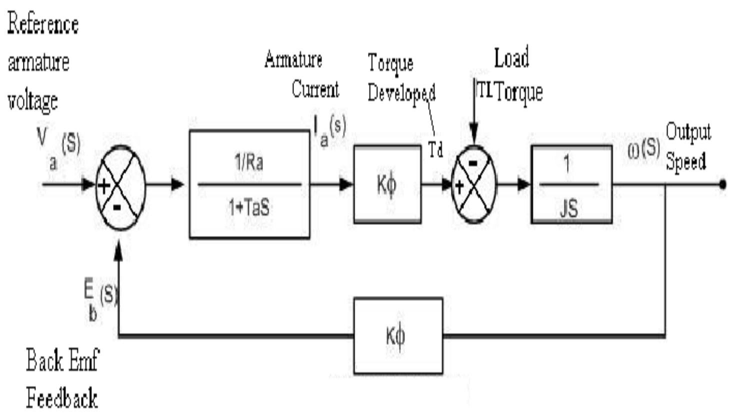


Fig. 3: Block diagrams of the feedback control for DC motor

MATLAB/SIMULINK Model of Speed

Control Methods.

The speed of a DC motor can be varied by control ling the field flux, the armature resistance or the terminal voltage applied to the armature circuit. The three most common speed control methods are field resistance control, armature voltage control, and armature resistance control In the field resistance control method, a series resistance is inserted in the shunt-field circuit of the motor in order to change the flux by controlling the field current. It is theoretically expected that an increase in the field resistance will result in an increase in the no-load speed of the motor and in the slope of the torque-speed curve.

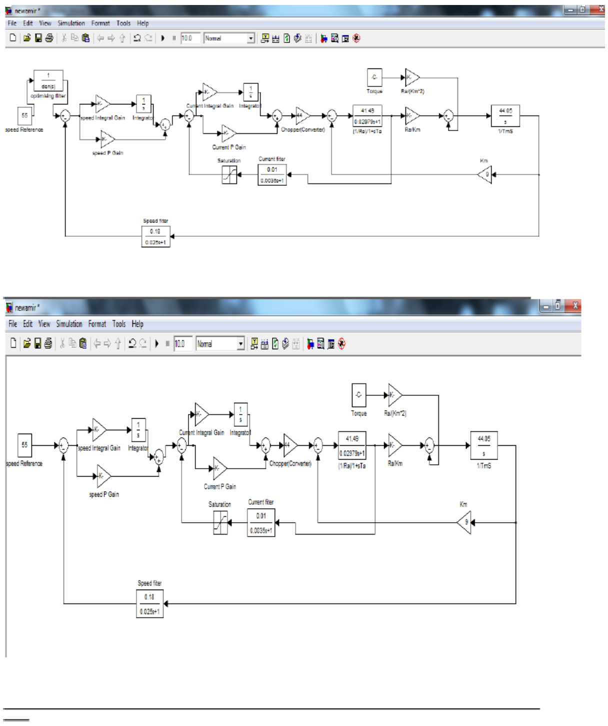


Fig. 4: Simulink model

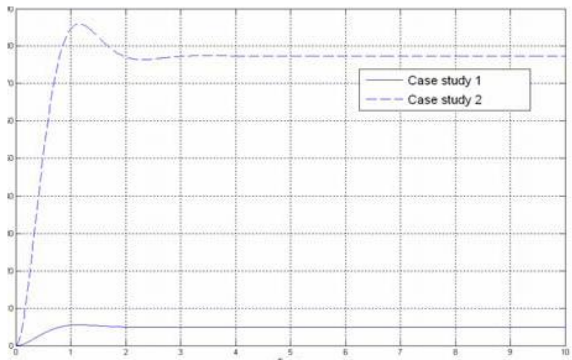
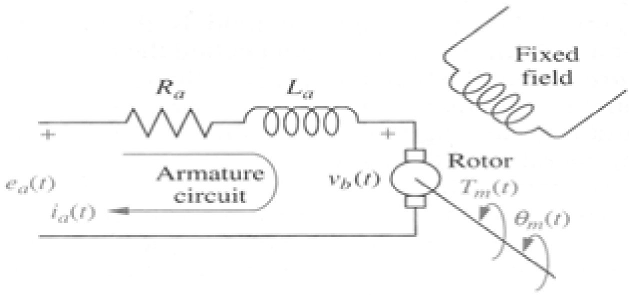


Fig.5: Output response comparison for case study 1 and case study 2.



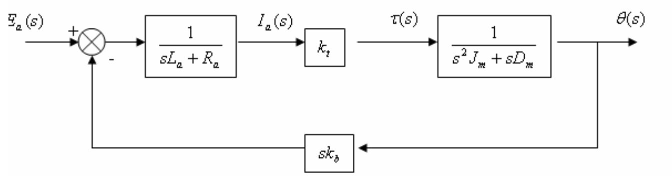


Fig. 6: Block-diagram representation of Servomotor system.

VII.SIMULATION RESULTS

Simulation results for the speed control methods and DC motor feedback control system. The torque-speed curves for the speed control methods are determined using the Simulink models Finally, simulations are performed for three different values of the armature resistance in order to investigate the effect of armature resistance. The validity of the proposed control method is confirmed by computer simulations. The system parameters and simulation conditions The control system allows independent control of the sensitivity and transfer controller and a position controller.

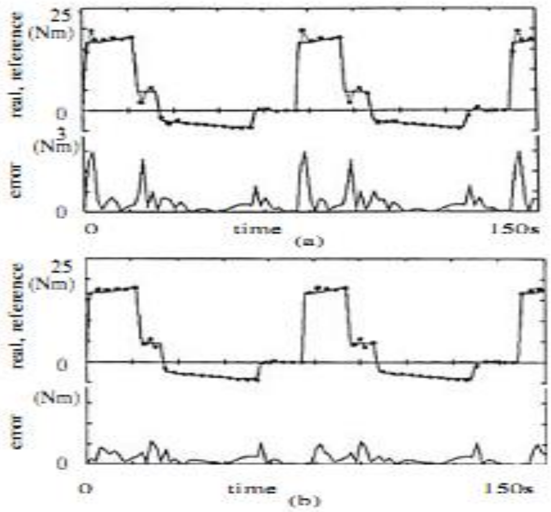


Fig.7: Conventional control result

IX.Conclusion

The basic concepts of **PID** control can be generalized within the same Structure PID controller design method was proposed to deal with both performance and robust stability Specifications for multivariable processes. in order to give the best performance for servo motor in the future. PID controller is designed effectively for the system and applied in both simulation and real-time mode.

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