Control of PMDC

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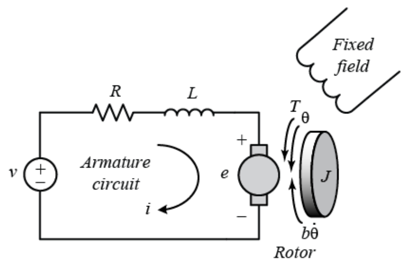

Figura 1. Permanent magnet DC motor generalized figure

J	0.01 $Kg.m^2$
b	0.1 $N.m.S$
K_e	0,01$V/rad/sec$
K_t	0,01$N.m/Amp$
R	1 ohm
L	0.5 Henry

Tabla I
MOTOR CONSTRAINTS

I. MATHEMATICAL MODELING OF PMDC

I-A. Problem Setup:

Let us consider a Permanent Magnet DC motor whose field is fixed. The motor is subject to operate with providing the speed according to the input voltage.

$$Torque(T) = K_t * i \tag{1}$$

(i = armature current and field is constant)

$$e = K_e * \dot{\theta} \tag{2}$$

Since , numerically

$$K_e = K_t = K(say)$$

Now the equation of motor becomes,

$$J \cdot \ddot{\theta} + b \cdot \dot{\theta} = K \cdot i \tag{3}$$

$$L\frac{di}{dt} + Ri = V - e \tag{4}$$

from equation (ii),

$$L\frac{di}{dt} + Ri = V - K\dot{\theta} \tag{5}$$

Now L.T of equation iii and iv,

$$S(J \cdot s + b) \cdot \theta(s) = K \cdot I(s) \tag{6}$$

$$(S \cdot L + R) \cdot I(s) = V(s) - K \cdot S \cdot \theta(s) \tag{7}$$

on solving further ,

$$(L \cdot S + R) \cdot \frac{S \cdot (J \cdot S + b)}{K}\theta(S) = V(s) - K \cdot S \cdot \theta(s)$$

$$S \cdot \theta(s)\frac{(L \cdot S + R) \cdot (J \cdot S + b) + K^2}{K} = V(s)$$

$$\frac{\ddot{\theta}(s)}{V(s)} = \frac{K}{(J \cdot S + b) \cdot (L \cdot S + R) + K^2} \tag{8}$$

II. OPEN LOOP RESPONSE

Now let us open the Matlab and construct the Transfer function. for analyzing , we will be using

$linearSystemAnalyzer('step', T.FofMotor, Timespan[0 : 0{,}01 : 5]$

This will open the linear system analyzer used in control system. we will be visualizing the response. the term Step response means the speed when applying unit step input i.e. 1Volt.

II-A. Graphical analysis

The transfer function response is second order with poles at -2 and -10. the dynamics of motor is dominated by pole -2.

The requirement can be like :

$$SettlingTime(Ts) < 2sec$$

$$Overshoot < 5\,\%$$

$$SSEr < 1\,\%$$

II-B. Closed loop response

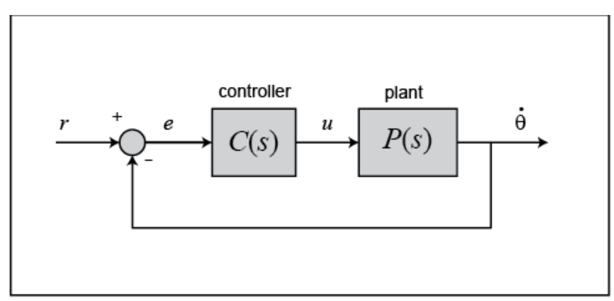

Figura 2. Closed loop design

For controller , We will be visualizing PID controller. lets recall its formula

$$C(s) = K_p + \frac{K_i}{s} + K_d s = \frac{K_d s^2 + K_p s + K_i}{s}$$

1. At first we will be using unity feedback system and visualize how will it affect . For the feedback , We will be using command

   $$feedback(C(s) * P(s), 1)$$

   similarly , we will be using Step command to see step response of the system.

   $$step(system, Timestamp[start : increment : end])$$

2. we will be using P Controller and observe the change.
3. We will be using PI controller.
4. We will be using PID controller.
5. we will Tune it.
   Note for all PID , we will be using PID command

   $$pid(Kp, ki, kd)$$

II-C. Conclusion

The task is to understand the basic fundamental of controller design and its application. It is specified that one shall be regenerate the closed loop controller design with the controller .

lets try it in Simulink and we will meet in new session

II-D. Thank you