Simulation of speed control DC motor by using DSP board for Electrical Engineering Education

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1. Introduction

A DC motor is a direct current (DC) electric motor that used to run machinery. DC motors are found in many applications as small as toys and disk drives, or in large sizes to operate steel rolling mills and paper machines. The speed of the D.C. motor is dependent and directly proportional is to this variable voltage. The speed encoder or tachometer senses the actual speed of motor in rpm and converts it to a feedback signal proportional to shaft speed. This signal closes the speed-control loop. The feedback is compared with reference setpoint and fed to the differential error amplifier, ad infinitum. Motor speed will remain constant until the speed setpoint changes. In this research, DC motor 24 volt, 48 watt, and base speed 400 -1600 rpm is used for control its speed. Matlab / Simulink software, the interface card dSPACE DS1104 DSP board, PI controller method are used for communication signal and made the controller. The unload and load conditions are considered for performance of speed control in this work.

2. Experimental setup

Block diagram and DC motor circuit can be shown in Fig.1 and Fig.2 respectively.

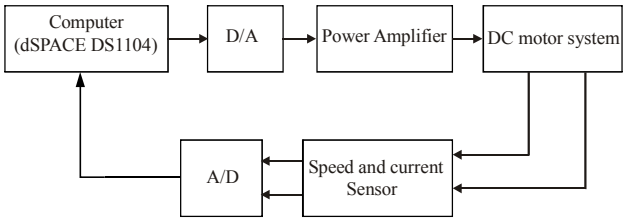


Fig. 1. Block diagram of DC motor speed control.

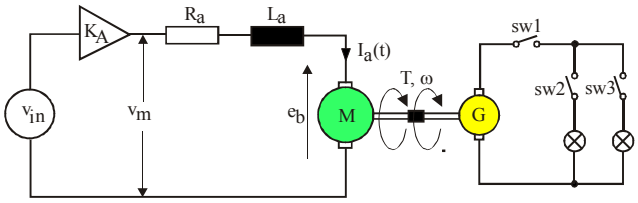


Fig. 2. DC motor and load on its circuit.

The equations are set, institute parameters on its, and get transfer function model as

$$\frac{\omega(s)}{V_m(s)} = \frac{2.97}{s^2 + 400s + 127.87} \qquad (1)$$

3. Experimental results

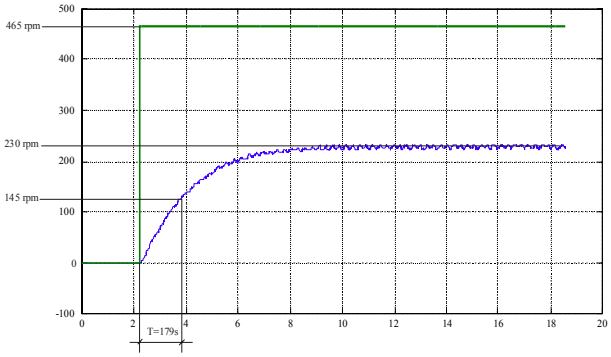


Fig. 3. Example of open loop test at step setpoint from 0-465 rpm.

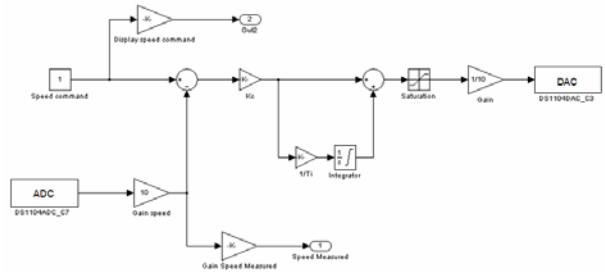
Open loop test at various step setpoint from 0-465 rpm to 0-1163 rpm are used for find average gain (Kp) and Time constant (T) as shown in Fig. 3 and found that the average Kp and T are 0.767 and 1.58 respectively. Pole displacement method is used for set the parameters Kc and Ti where we assumed the damping value(ζ)equal 0.707 and various the frequency (ω), the results as shown in table 1. The simulink and Controldesk of matlab are used for test the simulation and made the display for set the parameters on its as shown in Fig.4. At condition testing, speed step 800 to 1200 rpm, Kc=3.06 s, Ti=0.661, no load and full load are considered. The result of its can be shown as Fig.5 and table 2.

Table 1. The results of Kc and Ti when various ω

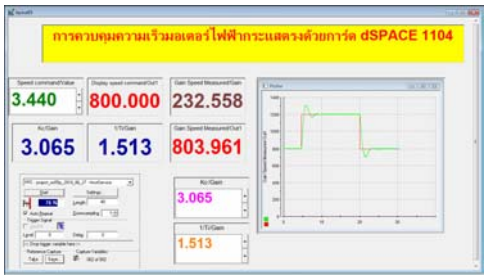
ϕ	Kp	T	ϕ	Kc	Ti
0.707	0.767	1.58	0.559	0.324	0.504
0.707	0.767	1.58	1	1.609	0.781
0.707	0.767	1.58	1.5	3.065	0.661

Table 2. Performance of control motor when various load at speed step 800-1200rpm and speed setpoint 1200 rpm

overshoot speed (rpm)	overshoot speed (%)	rise time (sec)	steady state error (%)	speed decrease (rpm)	speed decrease (%)	Time to setpoint (sec)	load (status)
1262	5.17	0.771	0	-	-	-	no load
1255	4.58	0.788	0	-	-	-	half load
1247	3.92	0.819	0	1076	10.33	5.05	full load

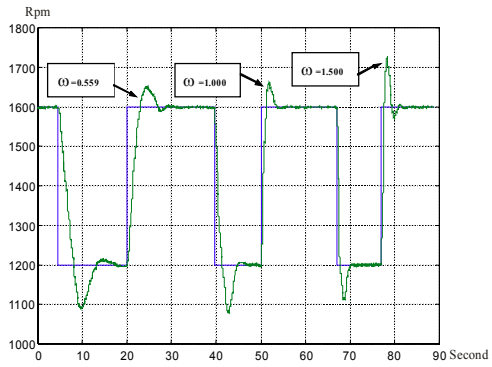


a.)

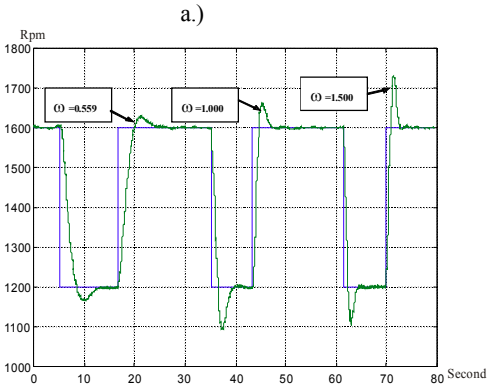


b.)

Fig. 4. PI controller by Matlab/Simulink and for set parameters.



a.)



b.)

Fig. 5. Step response results when various the ω at conditions step setpoint 1200 to 1600 rpm, Kc=3.065, Ti=0.661, and a.)no load b.) full load.

4. Conclusion

DC motor speed control system with interface card dSPACE DS1104 series is designed to control the speed of the motor by considering the effect of ,ω load, (Load) and speed (Speed) can be summarized and recommendations are as follows.

1) DC motor speed control system with the interface card dSPACE DS1104 can be controlled by the speed at around 100 - 2000 rpm.
2) Influence of ω at the high load, the value of rising time(Tr) is high but not more than 2 seconds.
3) When the system load increases, the rising time is increasing too but the over shoot speed will decline.
4) When the motor run at a constant speed and interrupt load, the motor speed decreases and adjust their speed to the target in less than 2 seconds.

Acknowledgements

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