EE462 Spring 2016
Project 0

DC Motor Drive and Analysis

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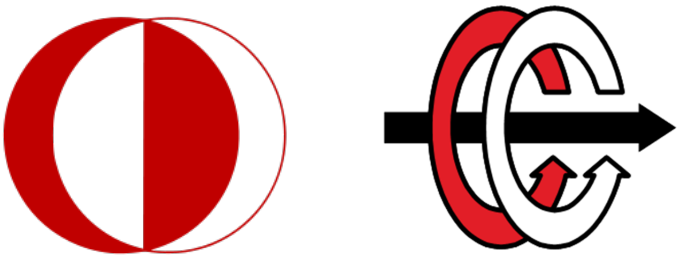

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1 Brief Explanation

These report will try to explain and give information about DC Motor drive and analysis . The wanted specific details are,

- A short info about the motor (voltage, current, power ratings etc.)
- Short info about the power source and control system
- Graphs showing acceleration curve from stationary to rated speed
- Start-up current graphs
- Produced torque during start-up

2 Results

In that project,Firstly I used Chopper-Fed DC Motor Drive Example,and after thinking about Project-0 ,I decided,I will use H-bridge topology due to it is Project 0 and I can test which drive I want.

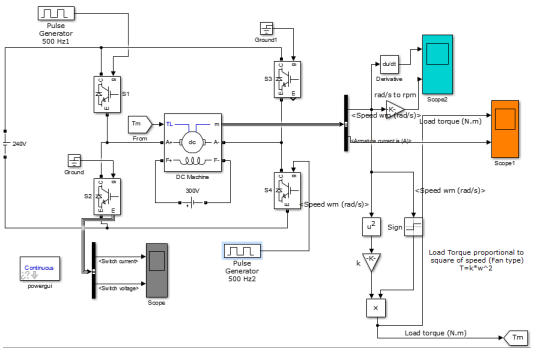

Figure 1: Simulink Diagram of H-Bridge Controlled DC Motor

DC Motor Properties

I looked motor properties from Simulink DC Motor block,and properties are,

-240V
-Nominal 15A(Maximum 30A)
-$\approx 240 * 15 = 3.6kW$
-300V field voltage
-5 HP

-While looking and testing different motor selection, I realised that when I decreased the voltage of the field, field current was weakening .So,

- Induced Voltage(Ea) $\downarrow \rightarrow RotorCurrent(Ia) \uparrow \rightarrow MotorTorque(Tm) \uparrow$

Finally,when motor torque increased our acceleration will increase,so our speed will increase . Then our induced voltage will increase and hopefully our system will be again in steady-state .[2]

-About HP calculation,

$$HP = (\text{Speed(Rpm)} * \text{Torque})/5252 \quad (1)$$

$$T = 15 \text{ Nm}$$

or

$$HP = (\text{Voltage} * \text{Current} * \text{Efficiency})/746 \quad (2)$$

$$I = 15.5 \text{ A (If we assume efficiency is 100}$$

Power Source and Control Explanation

The system consist of ,
-Power Source Part
-Motor Drive Part
-Control Part(To obtain closed-loop control),

240 V DC power supply used to feed the motor,and to control the DC motor I used H-Bridge topology. H-Bridge topology has four switching element and sometimes called as "Full Bridge". In contrast to MatLab SimScape Power System (power Hbridge) example I used IGBT switches instead of BJT.

As a machine I used Wound winding DC machine,and it is torque loaded. The torque value calculated via,

$$\text{Torque} = k * (\text{speed}^2) \quad (3)$$

H-Bridge or Full bridge topology used often in Robotics area to drive DC motor forward or backward. If we look the circuit diagram, we see IGBTs used as switches. IGBT(Insulated Gate Bipolar Transistor) is widely used power semiconductor and its major advantages are high efficiency and fast switching,and its shaped is similar to BJT with anti-parallel diode. To drive IGBTs ,I used the topology which was shown in [1]. I only changed motor operating periods and directions. They was driving from forward direction to backward, but in my DC machine drive analysis if I only drive in forward direction it will be sufficient.

In Control part, feedback loop constructed via the DC motor block, mechanical input property.I used the property as torque loaded so by using (3) we can calculate instantaneous torque from speed and we can have closed-loop controlled DC motor.

There used Pulse Generator to trigger the gate of IGBTs.I gave the pulse to S1 and S4 so the current flow is like in the Fig 2,

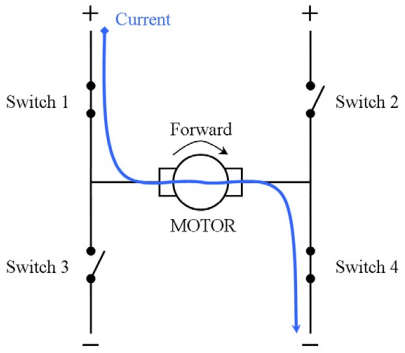

Figure 2: Torque and Current Graphs of DC Motor Drive

Graphs

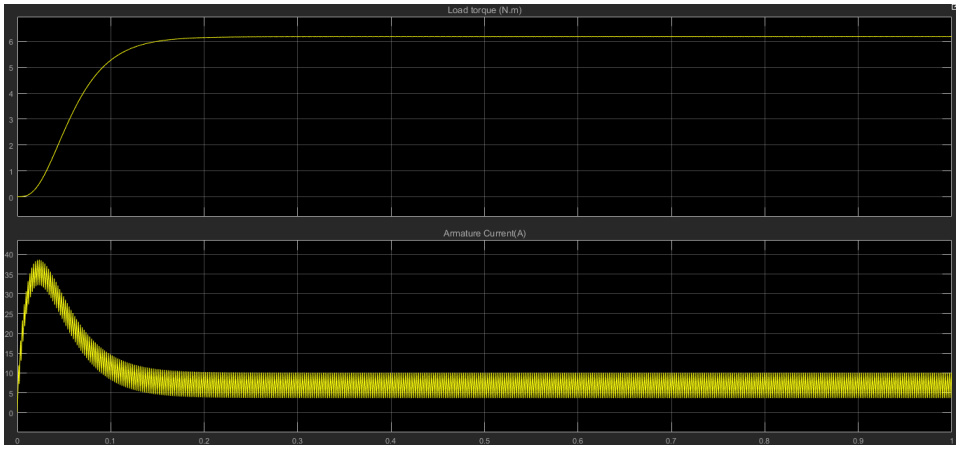

Figure 3: Torque and Current Graphs of DC Motor Drive

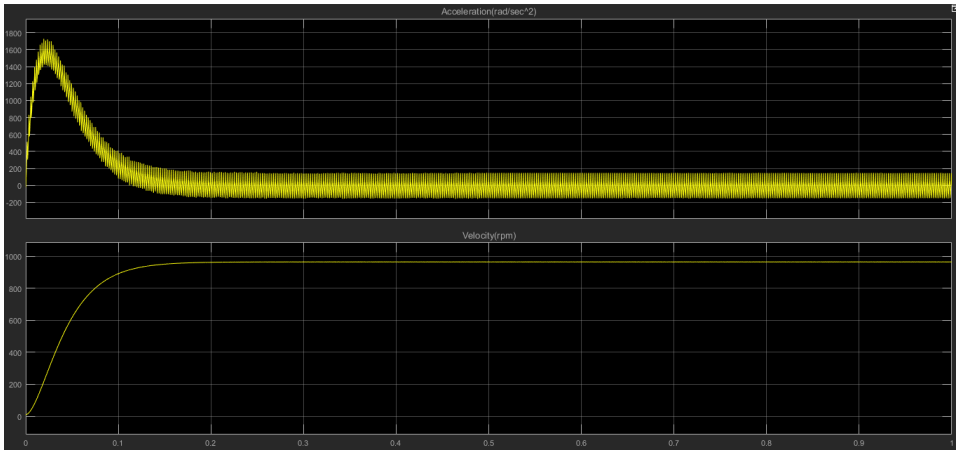

Figure 4: Acceleration and Velocity Graphs of DC Motor Drive

References

[1] Gilbert Sybille *Hydro-Quebec Transmission Company*. SimScape Power Systems Examples, MathWorks

[2] https://www.quora.com/Why-do-we-decrease-the-field-current-in-a-DC-shunt-motor-by-to-increase-the-speed-and-mechanical-output-power *Quora*. (Loren Rademacher answer..)

[3] http://electrical-engineering-portal.com/5-most-common-motor-load-types *Portal*. (Edward answer..)