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Modelling a DC–Motor in Matlab

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Introduction

Simulating provides an easy way to understand and describe the dynamics of a mechatronic machine. Matlab–Simulink is one of the most popular simulation environments available. Using Simulink requires some work but is well worth it.

About the system to be modelled

A permanent magnet DC motor can be thought of as an electrical system that consists of the rotor winding (ideal inductor and ideal resistor) and an electromotive force element. Back emf represents how the motor acts as a generator/voltage source that works against the input voltage [1]. The electrical equation of a DC motor (1) and the torque produced by the electromagnetic force (2) are the following:

$$V_{in} = L\frac{dI}{dt} + RI + K_e\omega \quad (1)$$

$$T = K_t I \quad (2)$$

Building the model

Start Matlab and choose the Simulink Library button. Create a new Simulink model by choosing file -> new model in the Simulink library browser.

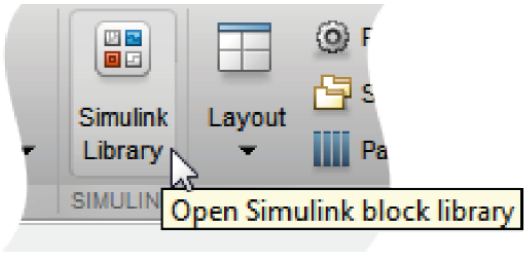


Figure 1: start Simulink

Add all the necessary blocks by drag-and-drop from the block library.

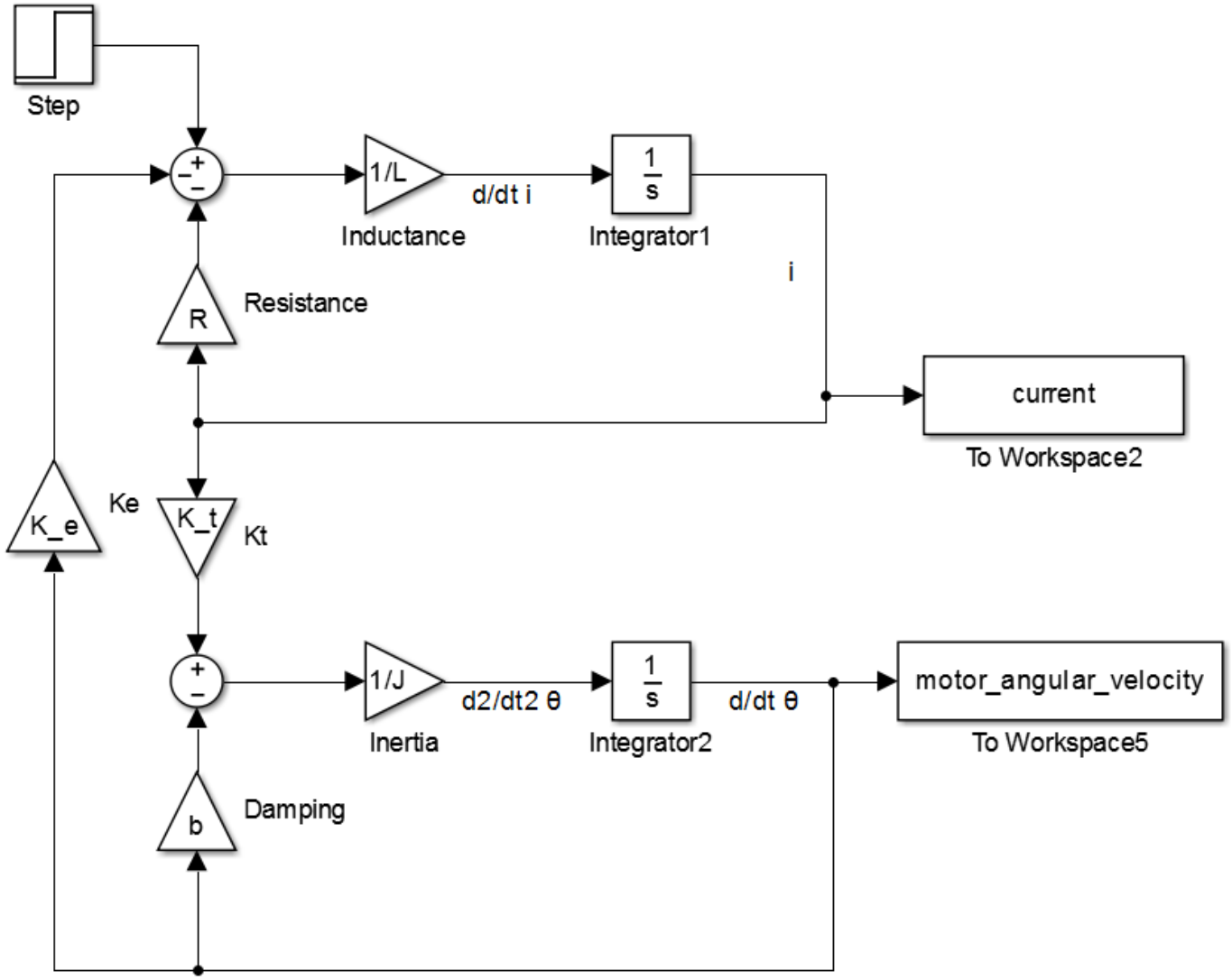
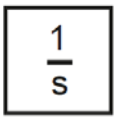
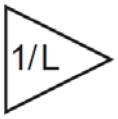


Figure 2: Motor model. Top part represents the electrical system and bottom part represents the mechanics.

Add more To Workspace blocks where necessary. You can find the blocks by name defined according to table 1. You can also follow the instructions in the DC Motor Speed: Simulink Modeling document [2].

Table 1: Brief explanation of used blocks

Step 	Step signal source. Rising edge by default at t=1. Represents the input voltage in this model. Double click to adjust the amplitude of the voltage in the “Final value” field. Found in the Sources library
Sum 	Summing block. Double click to modify inputs. Found in Commonly used blocks.
Integrator 	Integrator blocks integrate the signal. Found in Commonly used blocks.
Gain 	By double clinking you can type in the formulation inside the gain block. Formula visible in labels. Found in Commonly used blocks.
Scope 	Scope block is used to visualize the result. Once you have run the simulation double click on this to get a graph. Found in Commonly used blocks.
	To Workspace block. Found in Sinks library. Exports simulation results to Matlab workspace. Double click to edit the name of the variable created to Matlab workspace.

References

[1] Richardson, M. Back Emf of a DC Motor.[Referenced 5.10.2014]. Available at: http://www.youtube.com/watch?v=qwtiX3pFCIE

[2] Control Tutorials for MATLAB and Simulink, 2012. DC Motor Speed: Simulink Modeling. [Referenced 4.10.2014]. Available at: http://ctms.engin.umich.edu/CTMS/index.php?example=MotorSpeed&section=SimulinkModeling