Introduction to Simulink

by Vinay S. K. Guntu

Simulink Basics Tutorial

- Simulink is a graphical extension to MATLAB for modeling and simulation of systems.
- Advantages
- 1) Ability to model a nonlinear system, which a transfer function is unable to do.
- 2) Simulink can take on initial conditions. When a transfer function is built, the initial conditions are assumed to be zero.
- In Simulink, systems are drawn on screen as block diagrams. Many elements of block diagrams are available, such as transfer functions, summing junctions, etc., as well as virtual input and output devices such as function generators and oscilloscopes.

Starting SIMULINK

Open SIMULINK by typing `simulink` at the Matlab prompt. Two new windows will appear on the screen, as shown in Fig. 1. The first window is the SIMULINK block library. The second one is an empty model window, named untitled, in which you will build the SIMULINK model.

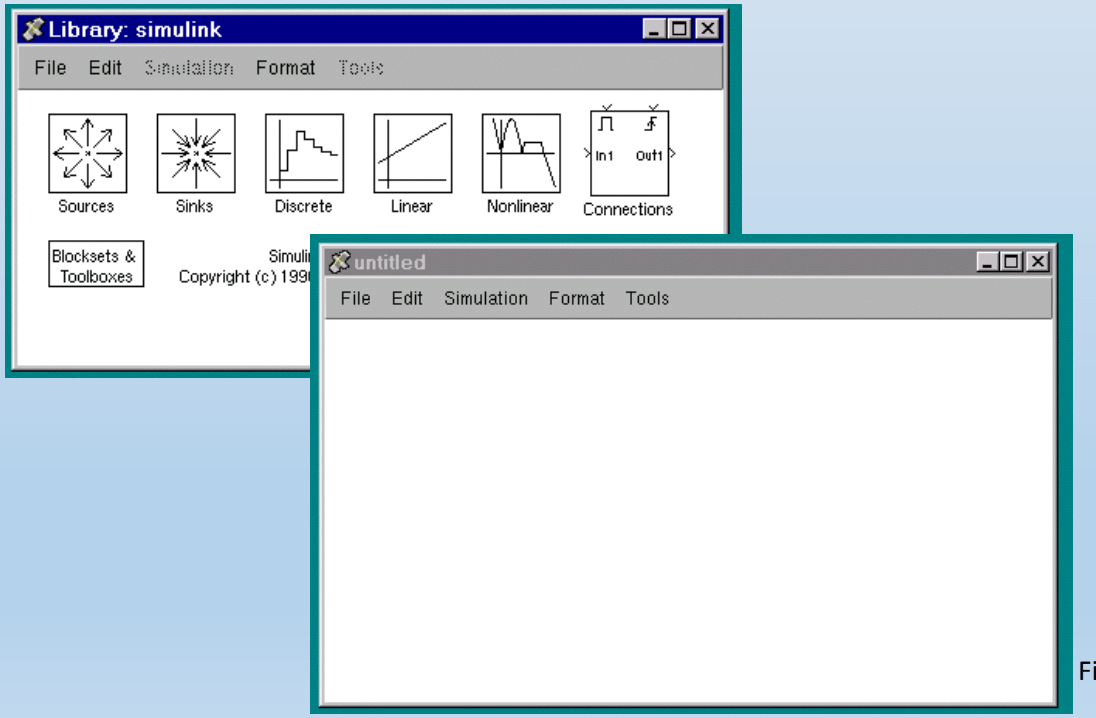

Fig. 1

Please take some time to explore the Block Libraries

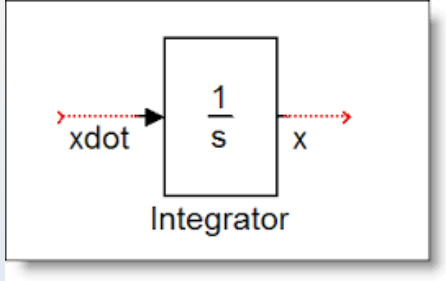

Fig. 2

- The subfolders underneath the "Simulink" folder indicate the general classes of blocks available for us to use:
- **Continuous:** Linear, continuous-time system elements (integrators, transfer functions, statespace models, etc.)
- **Discrete:** Linear, discrete-time system elements (integrators, transfer functions, state-space models, etc.) •
- **Functions & Tables:** User-defined functions and tables for interpolating function values
- **Math:** Mathematical operators (sum, gain, dot product, etc.)
- **Nonlinear:** Nonlinear operators (coulomb/viscous friction, switches, relays, etc.)
- **Signals & Systems:** Blocks for controlling/monitoring signal(s) and for creating subsystems
- **Sinks:** Used to output or display signals (displays, scopes, graphs, etc.)
- **Sources:** Used to generate various signals (step, ramp, sinusoidal, etc.)

- **Lines** transmit signals in the direction indicated by the arrow. Lines must always transmit signals from the output terminal of one block to the input terminal of another block. One exception to this is that a line can tap off of another line. This sends the original signal to each of two (or more) destination blocks, as shown below:

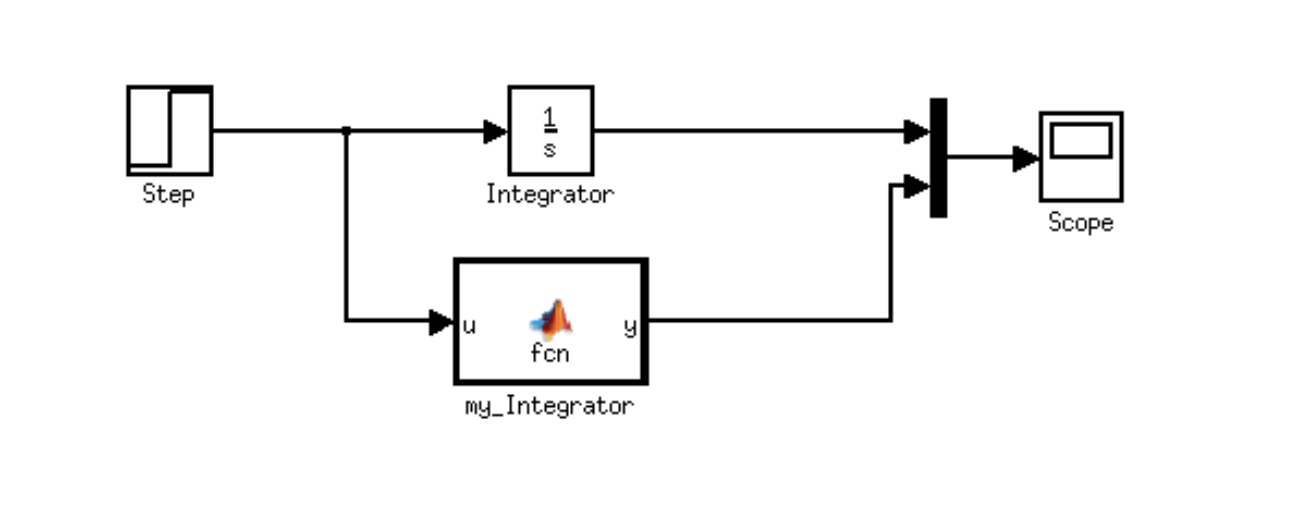

Fig. 3

- Lines can never inject a signal into another line; lines must be combined through the use of a block such as a summing junction.

Lets make an example model (Torque controlled DC motor)

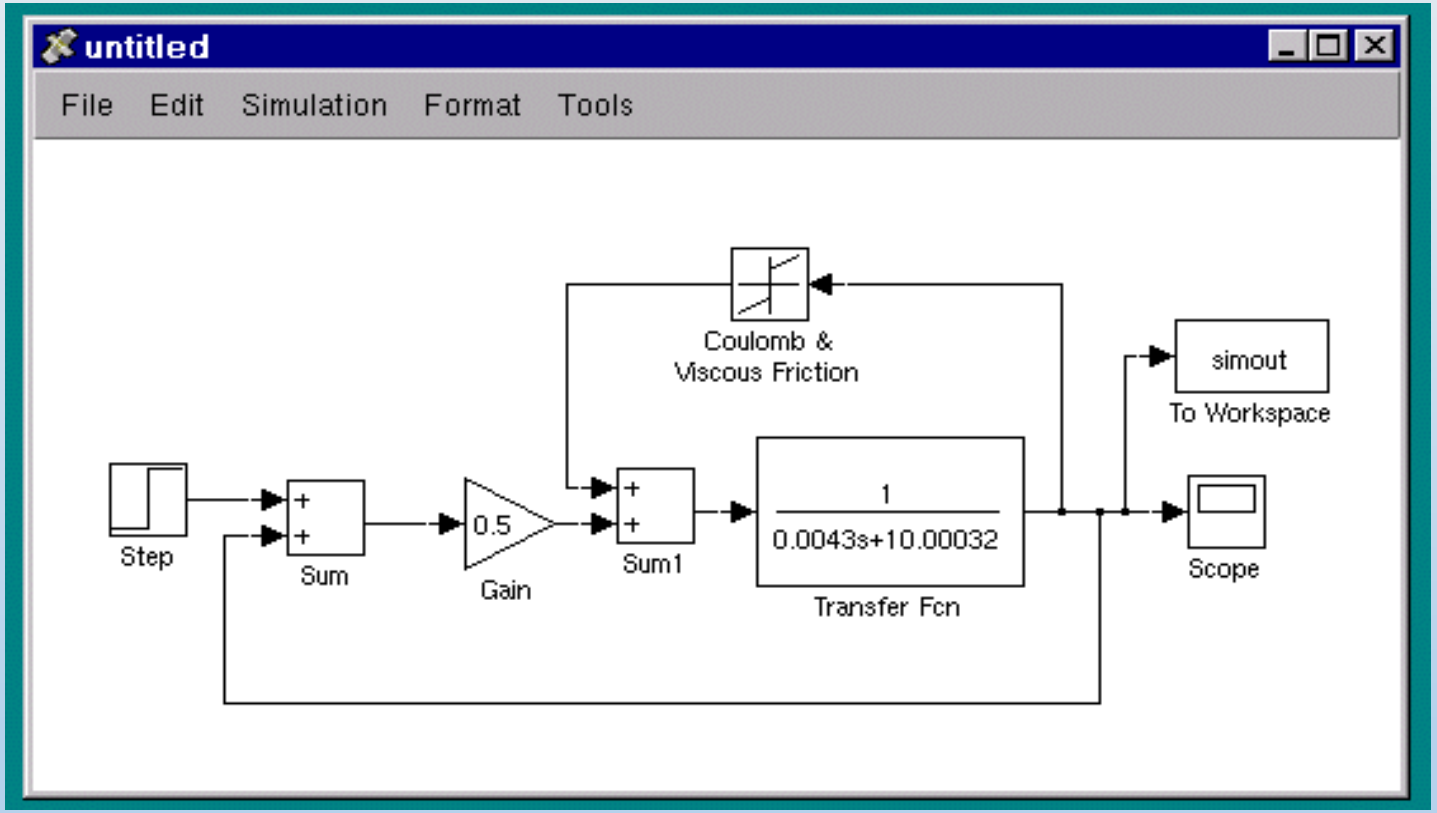

Fig. 4

Your Final SIMULINK model should look like this

- **Step 1:** Assuming Simulink is Open on your computer (Refer to Slide 3)
- **Step 2:** Double click on the Sources icon in the SIMULINK block library, opening the Sources block library, as shown in Fig. 5.
- Drag the Step block from the Sources block library to the model window.
- Double click on the Step block to set up the appropriate parameters (see Figure 6)

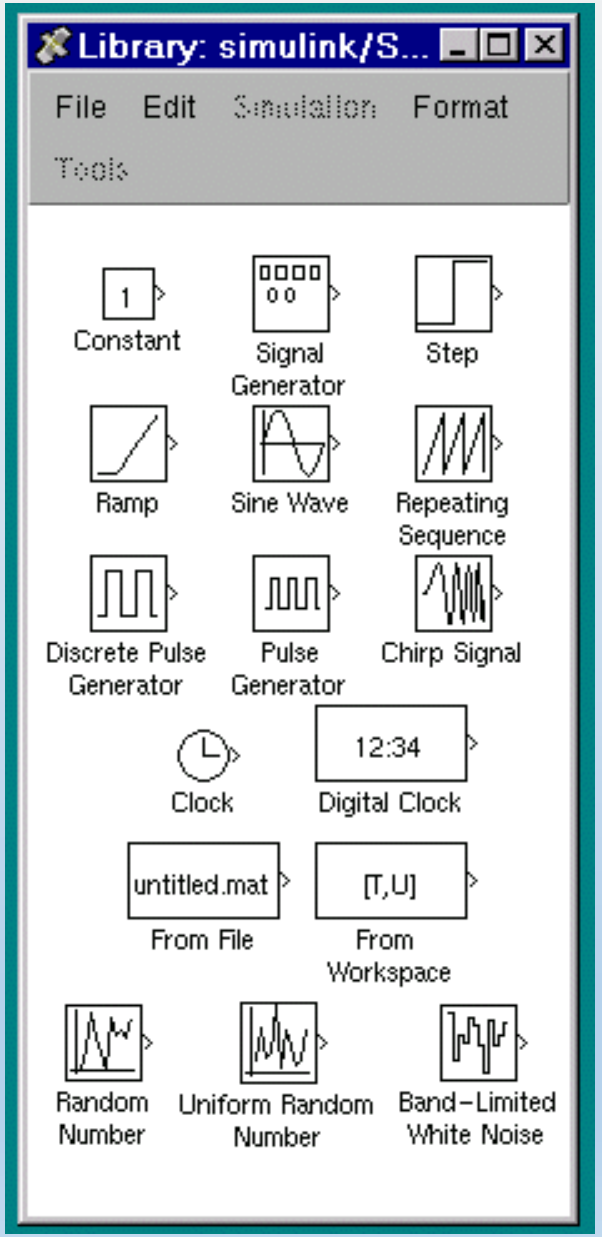

Fig. 5

- **Step 3 :** Open the Linear block library, as shown in Fig. 3, and drag a Transfer Fcn block to the model window. Double click on the Transfer Fcn block to set up the appropriate parameters. Assume zero initial conditions; for non-zero IC transfer fn. blocks, check the Simulink Extras set.
- **Step 4 :** From the Linear block library drag a Gain block to the model window. Double click on the Gain block to set up the appropriate parameter.
- **Step 5 :** From the Linear block library drag a Sum block to the model window. Double click on the Sum block, changing one of the “+” signs to the “–” sign.

- **Step 6:** Open the Nonlinear block library, as shown in Fig. 7, and drag a Coulomb & Viscous Friction block to the model window. Double click on the Coulomb & Viscous Friction block to set up the appropriate parameters. Note: For Coulomb friction, set it to an array with 1 value of 0.032 N-m nad set viscous friction to zero since it has already been considered in the TF.

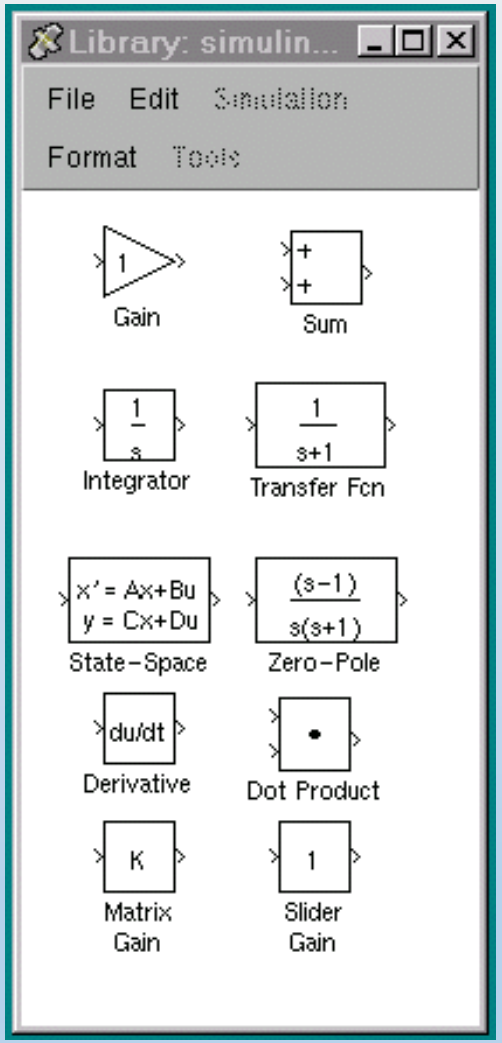

Fig. 6

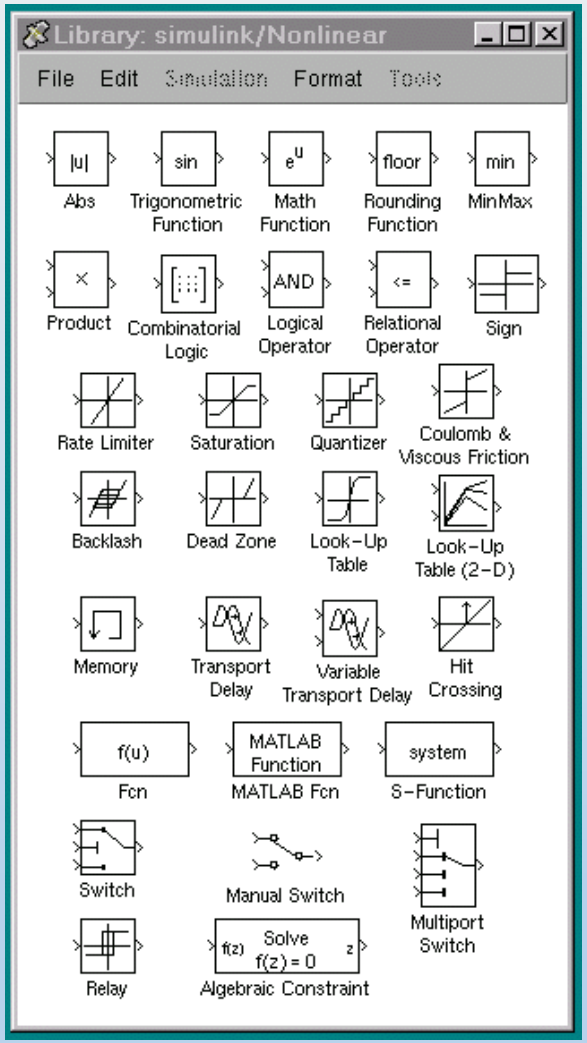

Fig. 7

- **Step 7 :** Open the Sinks block library, as shown in Fig.8, and drag a Scope block to the model window. In the same Sinks window drag a To Workspace block to the model window.

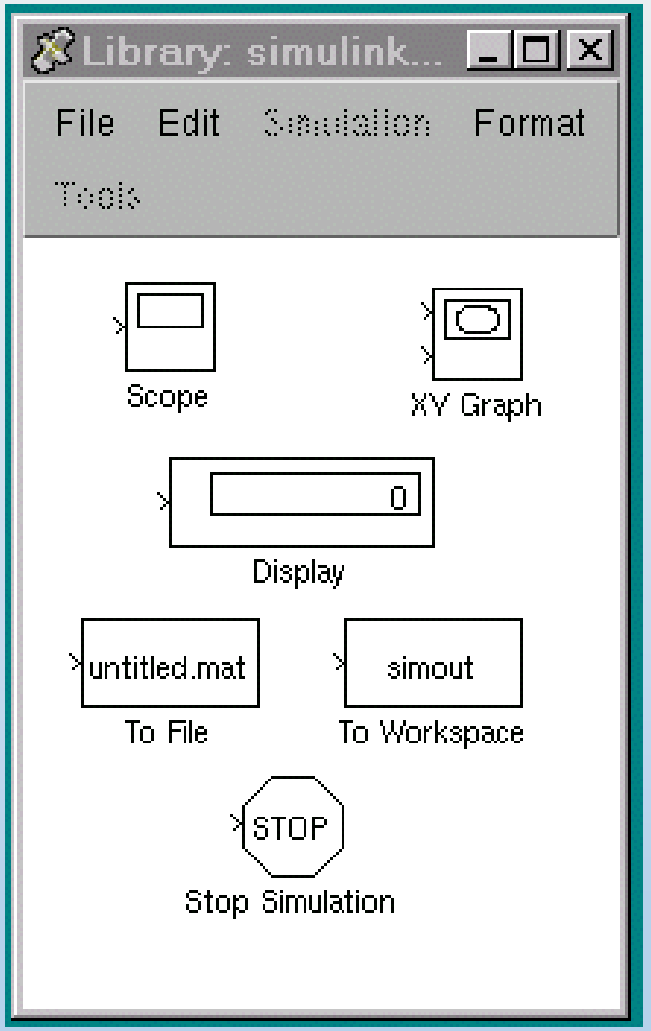

Fig. 8

- **Step 8:** Connect the blocks with signal lines to complete the model:
- Place the cursor on the output port of a block. The output port is the > symbol on the left edge of the block. Note that you can flip a block by pressing symbol on the left edge of the block. Note that you can flip a block by pressing <Ctrl+F>. The signal line has an arrowhead indicating the direction of signal flow.
- If you want to branch from the signal line, click and use the right mouse button.
- The completed SIMULINK model of the torque controlled DC motor should look like what is shown in Fig. 9.

Fig. 6

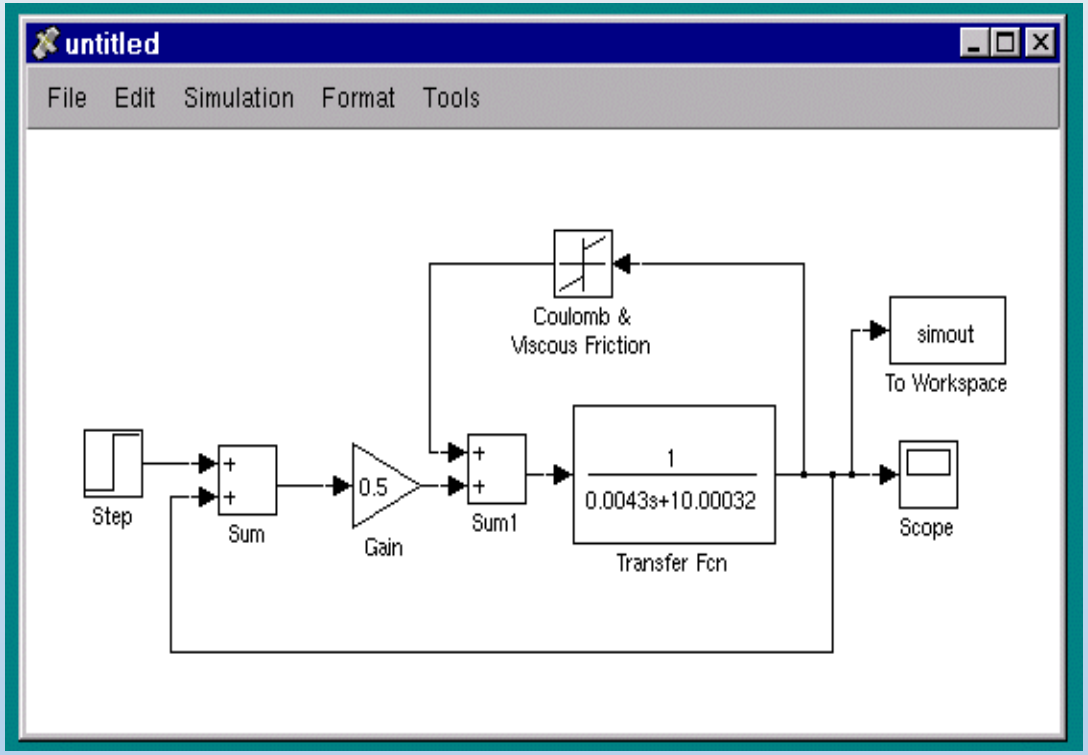

Fig. 9

- After completing the model,
- choose Simulation: Start from the menu bar in the model window (not the SIMULINK block library window).
- The simulation will execute. You will hear a beep indicating the simulation is finished.
- Double click on the Scope block, opening a Scope window.
- If you want to plot the result in a MATLAB figure, use MATLAB command plot(tout,simout).

Interaction With MATLAB

- Block parameters can be defined from MATLAB variables.
- Signals can be exchanged between Simulink and MATLAB.
- Entire systems can be extracted from Simulink into MATLAB.

Questions Time