Simulink Tutorial

Simulink

model systems as block diagrams and simulate them in this form.

basic block diagram

\[ r \rightarrow e \rightarrow \text{Control} \rightarrow u \rightarrow \text{Plant} \rightarrow y \]

if we specify to Simulink exactly what is in "Control" and "Plant", we can simulate this system in exactly this form.

How to represent the "Plant"

2 ways: State-Space

Transfer Func

\[ \dot{x} = Ax + Bu \]
\[ y = Cx + Du \]

use basic 1st order system:

\[ \dot{x} = x + u \quad A = 1 \]
\[ y = x \quad B = 1 \]
\[ C = 1 \]
\[ D = 0 \]

we can observe the entire state
to represent this in state space directly, use Continuous State Space
the values of A, B, C, D are parameters of the block
change parameters by double-clicking on the block to open the parameter dialog box.

To represent this system as a transfer function:

\[ \dot{x} = x + u \]

\[ 5 \ddot{x} = \ddot{x} + \dddot{u} \]

\[ (s-1) \dddot{x} = \dddot{u} \]

\[ \dddot{x} = \begin{bmatrix} 1 \\ s-1 \end{bmatrix} \dddot{u} \]

Transfer function
in Simulink, use a Transfer Func block
parameters are the coefficient vectors of the num & denom.

if we want the system to track a ref, we must provide it.

step response is a convenient choice

Unit Step block

parameters: step time = 0
final value = 1

implement proportional control
we need an error signal r - y

use a summing junction
default is 1++, but change to 1+- to get a subtraction of second input gain error; scale is parameter

Look at output w/ scope; binoculars autoscale

Now, to demonstrate that SS/TF are the same, insert a switch for the output

Double click on switch to change it.

PID control

Use Continuous/Integrator

\[ \frac{1}{s} \text{ is reference to Laplace Tfm of integral} \]

and Continuous/Derivative
we can't really see good behavior

can't see behavior because $t = 10s$ is too short

Configuration Parameters

change Step Time to vary Length of sim

make it 20

now we can rescale the scope and see more about the stability

Now make the Control a subsystem; this makes the block diagram clearer.

Drag in Ports & Subsystems/Subsystem

Double-click to open the subsystem model

rename In 1 as error

Out 1 as control
Notice that corresponding port names on subsystem block have changed cut/paste the control calculation (PID) into the subsystem model.

insert subsystem block where the control calculation used to be

Done! (first block diagram!)

Simulink style

make diagram to resemble flow of information

would not make a block diagram

must take time to make diagrams flow logically
If necessary, Simulink makes tools available to help me make the diagram pretty:

- Flip Block
- Rotate Block

Can also color blocks w/ options in Format menu and in the context menu.