ECE-520 Lab 4
System Identification For Two Degree of Freedom Systems Using Matlab's System Identification Toolbox

Overview

*In this lab you will be utilizing Matlab's system identification toolbox to try and determine a model for both of your two degree of freedom systems (torsional and rectilinear) You will compare these models with a your continuous time model that after it has been discretized assuming a zero order hold. You will be storing these models for later comparison. You should look again at **Lab 3**.*

Part A: Modification of Programs

You need to modify the program **compare_sys_id.m** to work with two degree of freedom systems, since those are the type we will be using in this lab.

The vector *get_desired_states* in the program **DT_openloop_driver.m** is currently set so the output of this block will only be the position and velocity of the first cart/disk.The state variables are in the vector $\begin{bmatrix} x_1 & \dot{x}_1 & x_2 & \dot{x}_2 & x_3 & \dot{x}_3 & \theta_1 & \dot{\theta}_1 \end{bmatrix}^T$. Hence the get_desired states vector must be modified to be

```
get_desired_states = [1 0 0 0 0 0 0 0;
                      0 1 0 0 0 0 0 0;
                      0 0 1 0 0 0 0 0;
                      0 0 0 1 0 0 0 0];
```

Part B: Changes Needed In System Identification Toolbox Usage

The only thing you should have to change from the procedure outlined in Lab 3, is that when you make a state model now it should have five (5) states: four(4) ''real'' states and one (1) output state, as shown on the next page.

Four states and an extra delay
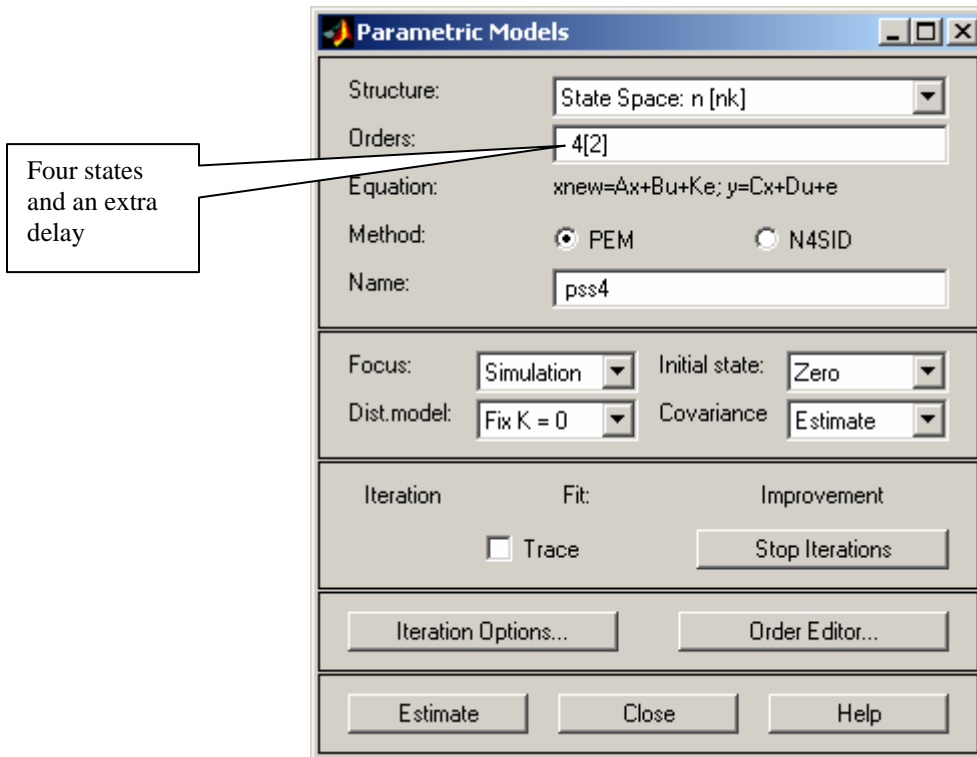
Part C: Some Possible Inputs/Guidlines

Below I have listed some of the things that I have tried. You do not need to try these, but they may be a good starting point. I also found for my systems that it was more difficult to get a good model for the rectilinear system than for the torsional system.

Generally Good Inputs are: *Pulses, Chirp, Bandlimited White Noise, Multiple Sine Waves*

Combinations of these are also good (use a summation block to add the inputs). Keep the frequencies at a maximum of 4-5 Hz, usually lower. The power in the white noise sources should be very small (start with 0.00001 and then increase it) I found that using pulses with a period of 5 seconds and a duty cycle of 50% in parallel with another input often worked fairly well. For many of the sources, such as noise or chirp sources, the system identification toolbox tends to produce a better model the more data it has to work with (i.e., the longer the system is allowed to run).

Part D: Models Needed

For each of your systems, you need to try and find _three_ treasonably good models, in addition to _one_ model using only a step input to create the model. (A total of four models.) For _each_ of these models you need to include the following:

1) A description of the input source (or sources if you merged data). This needs to be sufficiently detailed that I, or future students, could exactly duplicate your input.

2) The corresponding name of the state variable model. What I mean is that at the end of the program **compare_sys_id.m** a state variable model is stored in the file _sys_id_1dof_model210.mat_.This file needs to be renamed and you need to tell me the name and relate it to the inputs used to create the model (from requirement 1 above). Be sure to use a naming convention so you can tell the torsional models from the rectilinear models! In lab 5 you will be comparing the different models when we try and use state variable feedback to control the system, and you need to know which file goes with which source.

3) A plot comparing the response of your model created by the system identification toolbox and the response of the discretized version of your continuous time model, for a step input. This is the output of the **compare_sys_id.m** program.

4) The name of the underlined_discretized state variable model for both the rectilinear and torisional systems. Again, at the end of the program **compare_sys_id.m** the discretized state variable model is stored in the file _c2d_1dof_model210.mat_ .You need to change the name, or at least be sure the model file for the 205 system is named differently.

The body of your memo should contain the information from parts 1,2, and 4 above. You should try and see if you can put the information in a table. You should also indicate which of your input sources, other than the step, seemed to work best for creating a model that matched a step input.