MECE-743 Digital Control Systems

Lab #2: *Stability Analysis*

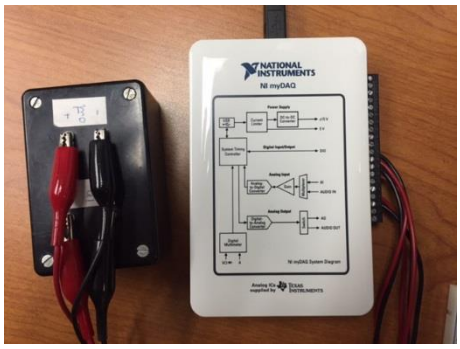

Figure 1: NI myDAQ driving an unknown plant

Objective: The goal of this lab is twofold:

1. Use system identification concepts to experimentally determine the discrete time model of an unknown system.
2. Determine the stability bounds theoretically and prove via experiment.

Experiment:

The unknown plant is truly a black box. (FIG 1) Inside is a combination of LCR passive circuit elements.

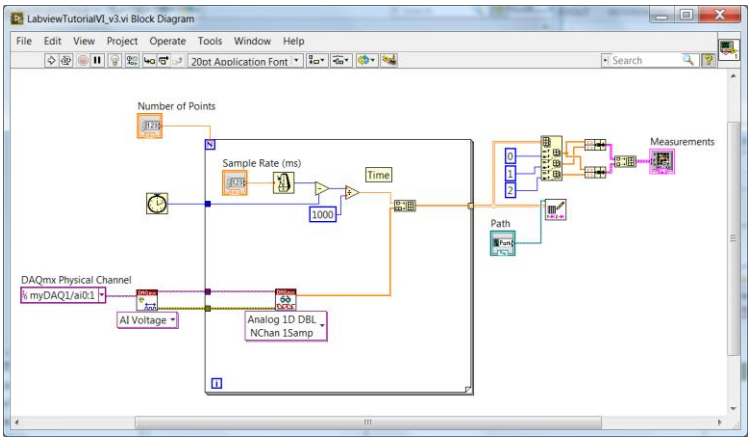

Figure 2: Example LabVIEW Code for sampled-time control

First, using a function generator create a 0 to 5 volt square wave as the driving input to the black box. Using LabVIEW Signal Express measure on analog channel 0 (AI0) the input square wave and on analog channel 1 (AI1) measure the output voltage of the black box on one plot. Obtain enough cycles to demonstrate the response (2-3) and save the results to a text file. Using system identification principles identify a 1st and 2nd order discrete-time ARX model to fit the data. Verify your result with the Matlab System Identification Toolbox (*arx.m*). For the 1st order model select a sample rate to get 10 samples per visible time constant. (*Hint*: settling time = 4τ) For the 2nd order model choose a sampling time fast enough to "see" all the dynamics.

Next, using both models theoretically determine the stability bounds for a single gain feedback control system when the sampling time is chosen to be 10 times the dominant time constant.

Finally, demonstrate the control bounds by creating a sampled time control system in LabVIEW. (Figure 2) Use the function generator to provide the desired set-point between 0-5 volts with a frequency such that the output reaches a steady-state (~5τ) Use AI0 to measure this set-point into the code and use AI1 to measure the output of the black box. Determine the error signal and controller gain to then calculate the control output that is sent to the analog out 0 (AO0) which is then connected to the black box input. Use LabVIEW to record the set-point, control signal, and black box output in one text file. Collect two data sets. One that shows the stability boundary determined from theory and a second set that uses a gain half as large. Does the controller saturate?

Simulation:

- Simulate your ARX models versus your collected data for the system identification step.
- Simulate your feedback control system and compare versus the experiment for both control gains.

Deliverable: A concise report on the simulation approaches with a description of the results. The number of plots should be kept to a minimum but be of high quality and description (legends, captions). Always combine results when appropriate. Please submit all of your Matlab/Simulink code separately as well and consolidate it to as few pages as possible.

Due Date: Two weeks after the assigned date.