Bonus exercise 2 MM 2019/2020

February 28, 2020

Instructions

Use the `bonus2_2019_2020.m` file as a template. Do not use a livescript. Implement the tasks below in Matlab/Octave. Give comments where needed. This is an individual assignment. The assignments should be uploaded as .m and not be compressed to facilitate automatic plagiarism checks. You have to upload your solution before 10am on March 13, 2020 through the student portal. This is an individual graded assignment. What you submit should be your work alone and by submitting it you testify that this is indeed the case. Obviously, what is already in the template can be used. You are not allowed to use any toolboxes (even not the control systems toolbox) unless it is explicitly mentioned in that specific question that you may.

Task 1

Implement the Fadeev algorithm to find the coefficients a of the denominator polynomial and the coefficients a of the numerator polynomial of a LTI state-space model. In the template `bonus2_2019_2020.m` there is a model given on which this bonus exercise is based, but your implementation of the Fadeev algorithm should work for any LTI state-space system of any order.

Task 2

Given the outcome of the Fadeev algorithm, compute the poles p and the zeros z.

Next, make a pole-zero plot. Part of the code is already in the template. If you are unsure about what a pole-zero plot is, have a look here `https://iowegian.com/scopeiir/pole-zero-plots/`

Task 3

Next, compute and plot the frequency response of the system. The sampling frequency is $f_s = 100$Hz. In discrete-time the frequencies "live" along the unit circle in the Z-plane, where 0 radians correspond to 0Hz and 2π radians to f_sHz. Traversing the circle in the opposite direction gives you the negative frequencies, yielding symmetry in not only 0 radians, but also in π radians. Again, part of the code can be found in the template `bonus2_2019_2020.m`. Using functions to work with polynomials helps here.

Task 4

You will now use the system on data. To this end in the template a signal is created with a harmonic of 25Hz, a harmonic of 37Hz and Additive White Gaussian Noise. The latters appears in all frequencies.

Simulate what effect the system has on this signal. For this specific task, you are allowed to use the `ss` and the `lsim` functions from the control systems toolbox. Everything should be visualized in the frequency domain. Once again, fins already some code in the template `bonus2_2019_2020.m`.

Relate what you are seeing here with the frequency response and the pole-zero plot and explain what you are seeing from a perspective of the poles, zeros, frequency response and the magnitude spectrum of the original signal. Put this in the comments of the submitted .m file.