Assignment - 5
Z-Transform

March 3, 2018

Task 1

Let

$$H(z) = \frac{1 - 2\cos(\omega_0)z^{-1} + z^{-2}}{1 + 0.5z^{-1}},$$

where $\omega_0 = 2000\pi/F_s$. F_s is the sampling rate of the input (and of course the output) of the system. You can assume $F_s = 11025$ samples per second where you need it.

Questions

1. Find inverse Z-transform of $H(z)$ on paper. Find all poles and zeros and draw them in z-plane.

2. Find inverse Z-transform of $H(z)$ using MATLAB. Plot all poles and zeros in z-plane using MATLAB. Read the help topics on the following functions:

   (a) `roots`

   (b) `residuez`

   (c) `zplane`

   You can ask questions about above-mentioned functions on piazza. However, your question should be specific.

3. Substitute $z = e^{j\omega}$ in the expression above and calculate its Fourier transform $H(e^{j\omega})$ on paper. Plot the response using MATLAB. What kind of a system do you think it is?

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Task 2

Write a function like you have written in previous lab to compute output of the system $H(z)$. (Hint: Take Z-transform of both sides of a constant-coefficient difference equation. You have already written a function that implements a constant-coefficient difference equation in a previous lab). Assume the system is initially at rest. Plot the impulse response of the system.

Task 3

Download the file almostcaught.wav from piazza. The file has the voice of the great Captain Jack Sparrow but perturbed by a tone of 1 kHz.

1. Play the file in MATLAB using `sound` command and listen to the legend speaking with a tone. You can read a wave file in MATLAB using `audioread` command. The output of `audioread` is the sampled data and the sampling rate at which this sound was sampled.

2. Pass the sampled sound data from the wave file through your system. Plot the DTFT of the sound data before and after passing through the system.

Questions

1. Can you identify the tone in the sound spectrum before passing through the system?

2. Can you identify the tone in the sound spectrum after passing through the system?

3. Do you hear the tone in the output of your system? Can you relate the output of your system to its Fourier transform.

4. Can you figure out why the system is suppressing or enforcing the tone? Give your answer based on its z-plot.

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