

MAS160: Signals, Systems & Information for Media Technology

Problem Set 6

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Problem 1: Frequency response of FIR filters (*DSP First 6.4*)

Problem 2: Simple sound filtering

Using our old friend the `sumcos` function, create a sound with a fundamental frequency of 440 Hz, with 12 harmonics of equal amplitude and zero phase, and using the following parameters:

```
fs = 11025;           % Sets sampling rate to 11025 Hz
f = 440*[1:12];      % Creates frequency vector of 12 harmonics of 440 Hz
X = ones(1,12);      % Creates amplitudes of 1
dur = 1;             % Sets duration to be 1 sec
```

Use MATLAB to perform the following tasks:

- (a) Create a three-point averaging FIR filter and plot the frequency response (magnitude and phase) of this filter using `freqz`. What is this filter supposed to do? Filter the sound you created above with this filter. How does it compare to the original sound?
- (b) Create a two-point first difference FIR filter and plot the frequency response (magnitude and phase) of this filter using `freqz`. What is this filter supposed to do? Filter the original sound you created above using this new filter. How does it compare to the original sound?

Problem 3: Return of the Labs: *DSP First Lab 5*

Items to be turned in:

- (a) Plots and answers to questions specified in C.5.2.1.
- (b) Plots and answers to questions specified in C.5.3.2.
- (c) Demonstrate linearity and time-invariance of filter (C.5.3.3 and C.5.3.4).
- (d) Plots and answers to questions specified in C.5.3.5.

Problem 4: Additional Problem (for MAS.510)

The MATLAB function `zplane` is great for plotting the poles and zeros of a system in the z -plane. Use `zplane` as well as `freqz` to answer the following questions.

- (a) Consider the general N -point FIR averaging filter, where each coefficient b_k is simply $\frac{1}{N}$. Plot the zeros of this system in the z -plane as well as the frequency response (magnitude and phase) for $N = 3, 4, 5,$ and 10 . How does the position of the zeros change? Qualitatively, how does the frequency response change, and how does this relate to the location of the zeros? Does N being an even or odd number have any effect?
- (b) Consider the general N -point FIR difference filter, where each coefficient b_k is simply $\frac{(-1)^k}{N}$. Plot the zeros of this system in the z -plane as well as the frequency response (magnitude and phase) for $N = 3, 4, 5,$ and 10 . How does the position of the zeros change? Qualitatively, how does the frequency response change, and how does this relate to the location of the zeros? Does N being an even or odd number have any effect?