UNIVERSITY OF HAMBURG, DEPARTMENT OF INFORMATICS, SIGNAL PROCESSING GROUP

Digital Media Signal Processing — Assignment VII

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June 6, 2017

1 DIFFERENTIATOR

Consider the system with the impulse response $h(n) = \frac{1}{2}\delta(n+2) - \frac{1}{2}\delta(n-2)$.

1. Is this a FIR or IIR filter?
2. Derive the transfer function $H(z)$ of the system
3. Draw a pole zero plot for the system
4. Depict the systems block diagram
5. Sketch the magnitude and phase response of the filter
6. Label the above axis with frequencies, assuming a sampling rate of Fs = 10kHz

2 EXPONENTIAL MOVING AVERAGE FILTER (EMAF)

A popular and very frequently used filter is the EMA-Filter. It is described by the difference equation $y(n) = \alpha x(n) + (1-\alpha)y(n-1)$ with $\alpha \in [0,1]$.

1. Is this a FIR or IIR filter?
2. Derive the transfer function $H(z)$ for the system
3. Draw a pole zero plot for the system
4. Depict the systems block diagram

5. Find a description for the impulse response of the system. Hint: Use a z-transform table.

6. Plot the transfer functions for $\alpha = .05, .1, .2, .5, .7, .9, .95$, using Python.

3 Python

In the given IPyton notebook we will look at the relationship between FIR, windowed FIR, and IIR systems. We will explore this experimentally on a low pass filter example. The functions for computing those coefficients are given and so are the functions to plot the magnitude responses.

1. Play around with the parameters Fc and NSAMPLES (the FIR filter length) and describe what the differences are in the magnitude response. Especially interesting are the number of filter taps (NSAMPLES) needed to achieve a somewhat comparable performance to the IIR version of the filter. I.e., suppression of frequencies beyond the pass band and gain in the pass band.

2. Write a function, which plots all three filters's poles and zeros into the complex plane. Use different colors for the different filters. Discuss what you see.