Digital Signal Processing/Processamento Digital de Sinais

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Tutorial Questions/Lista de Exercícios - 5

1. Consider the design of IIR filters using the bilinear transformation.

a) Determine the analogue transfer function from $G\left[z\right]=\frac{4(z^{2}+z-2)}{10z^{2}+4z+6}$ using T=0.4.

b) Design Butterworth and Chebyshev filters that meet the following specifications: $f\_{sb}=700Hz$, $f\_{p}=500Hz$, ripples in the passband $α\_{p}=1 dB$, ripples in the stopband $α\_{s}=32 dB$ and sampling frequency $f\_{s}=2kHz$.

c) Sketch the frequency response of these filters using Matlab and explain the differences

2. A 2nd order lowpass IIR filter with 3dB cutoff frequency ωC = 0.55π has transfer function given by

$$G\left[z\right]=\frac{0.3404(1+z^{-1})^{2}}{1+0.1842z^{-1}+0.1776z^{-2}}$$

a) Design a 2nd order lowpass IIR filter with 3dB cutoff frequency ωC = 0.27π by modifying the transfer function above through a spectral transformation.

b) Show the frequency response of the two filters with Matlab and explain the differences.

3. Design a lowpass FIR filter that satisfies the following specifications:

$$0.95<H\left(e^{jω}\right)<1.05, 0\leq \left|ω\right|\leq 0.25π,$$

$$-0.1<H\left(e^{jω}\right)<0.1, 0.35π\leq \left|ω\right|\leq π,$$

by applying a window $w[n]$ to the ideal impulse response $h\_{d}[n]$ for a lowpass filter with cutoff frequency ωC = 0.3π.

a) Which windows satisfy the above specifications?

b) What is the lowest filter order for each window that satisfies the above specifications?

c) Design filters with the windowing techniques that meet the requirements above.

d) Show the magnitude and phase responses of the filters designed in item c).

4. Design a lowpass FIR filter with generalized linear phase using the Kaiser window tbat satisfies the following specifications:

$$\left|H\left(e^{jω}\right)\right|<0.01, 0\leq \left|ω\right|\leq 0.25π,$$

$$0.95<\left|H\left(e^{jω}\right)\right|<1.05, 0.35π\leq \left|ω\right|\leq 0.6π,$$

$$\left|H\left(e^{jω}\right)\right|<0.01, 0.65π\leq \left|ω\right|\leq π,$$

a) Determine the filter order and the values of the parameter $β$ for a filter that satisfies the above specifications.

b) What is filter delay?

c) Determine the ideal response of the filter.

d) Design the filter using the Kaiser window and show the magnitude and phase responses using Matlab.