CMPE 422/Spring 07/Project III: Window based filter design

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Abstract

In class we have studied window based methods for filter design. This project asks students to design a band–stop filter using the Hanning window.

In this project students will write a function in MATLAB to enable them to create different filters.

Keywords: Filter design, windowing methods, Hanning window, band–stop filter.

Contents

1 Window Methods and filter design

Page 465–478 of OSB presents the basic principles of window based filter design. The essential equation is

$$h[n] = h_d[n]w[n]. \tag{1}$$

For this project will use the Hanning window:

$$w[n] = \begin{cases} 0.5 - 0.5\cos(2\pi n/M) & 0 \leq n \leq M \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

Characteristics of this window are also in OSB.

2 The design problem

Pages 43 and 44 of OSB show ideal filters. We have also discussed that ideal filters are not realizable. The windows design method permits non–ideal filters to be designed.

Problem 1: Design an band–pass filter using the Hanning window. Specifications for this filter are:

- Lower stopband edge (ω_{s_1}): 0.4π
- Upper stopband edge (ω_{s_2}): 0.6π
- Lower passband edge (ω_{p_1}): 0.3π
- Upper passband edge (ω_{p_2}): 0.7π
- Stopband attenuation $A_s = 40$dB
- passband ripple $R_p = 0.5$dB

3 What to do?

Write a MATLAB script (call it HanningMain) that obtains the coefficients of a band–pass filter and prints it to the screen. Input parameters will be as described in Problem 1. In additional to standard programming constructs in MATLAB, here is a list of other intrinsic functions that you are allowed to use: hanning, min, floor, freqz, subplot, stem and plot.

Use subplot to create a four panel (2×2) graphical output. Here is the order from left–to–right, top–to–bottom:

1. UL: Ideal impulse response
2. UR: Hanning window
3. LL: Actual impulse response
4. LR: Magnitude response (dB) (y–axis) versus frequency in π units (x–axis).

Due date II: 11:59pm on 16 May 2007 by email (HanningMain program that solves problem 1) only to Haleh Safavi.
Start immediately. Plan for the inevitable rush that occurs at the end of the semester. Projects will not be accepted late.