18.327/1.130: Wavelets, Filter Banks and Applications
Problem Set 1

Issued: Wednesday, Feb. 11, 2004 **Due:** Monday, Feb. 23, 2004

Matlab Exercises

Please submit your Matlab code and plots.

1. Consider a two channel perfect reconstruction filter bank (see pp. 103 in the text) with the analysis filters $h_0[n] = \{1/\sqrt{2}, 1/\sqrt{2}\}$ and $h_1[n] = \{1/\sqrt{2}, -1/\sqrt{2}\}$. Consider also a signal $x[n] = \{0, 7, 12, 15, 16, 15, 12, 7, 0\}$.
   (a) Find the corresponding synthesis filters $f_0[n]$ and $f_1[n]$.
   (b) Compute (and plot) the signals $v_0[n], v_1[n]$ and $\hat{x}[n]$. Verify the perfect reconstruction property.
   (c) Plot the zeros of the filters $h_0[n], h_1[n], f_0[n]$ and $f_1[n]$ (use `zplane`).
   (d) Plot the frequency spectra of $v_0[n]$ and $v_1[n]$.
2. Repeat the previous problem for the filters $h_0[n] = \{-1, 2, 6, 2, -1\}/(4\sqrt{2})\}$ and $h_1[n] = \{1, -2, 1\}/(2\sqrt{2})$.
3. Construct a signal that will produce non-zero high-pass coefficients when passed through the first filter-bank, but will result in zero high-pass coefficients when passed through the second one.

Textbook Problems

1. Problem Set 1.1, pp. 6–7. Problems 5 and 11.
2. Problem Set 1.2, pp. 11. Problems 9 and 13.
3. Problem Set 1.3, pp. 15. Problem 5.
4. Problem Set 2.1, pp. 44–45. Problems 7 and 13.
5. Problem Set 3.1, pp. 90–91. Problem 2 (Give both time and frequency domain descriptions).
6. Problem Set 3.2, pp. 95–96. Problems 3 and 7.
7. Problem Set 4.1, pp. 113-114. Problems 9 and 12.