

TAKE HOME FINAL EXAM

Due: By Monday May 7, 2007, 12 noon

Problem 1.**Stationary Wavelet Transform & Denoising**

This example involves doing a stationary wavelet transform on a noisy test signal and then doing simple denoising using a global threshold. The threshold is calculated using an estimate of the noise. The example is taken from MATLAB Help, Wavelet Toolbox, Getting Started, Using Wavelets, One-Dimensional Discrete Stationary Wavelet Analysis, One-Dimensional Analysis Using the Command Line. Do the following:

- (1.) Go to the above section in MATLAB Help.
- (2.) Do Steps 1 → 11.
- (3.) Now we look at Step. 12. Here we do very simple denoising. We will use

$$[thr, sorh] = ddencomp(IN1, IN2, X)$$

where the input parameters IN1, IN2 are respectively 'den' for denoising (as opposed to 'cmp' for compression) and 'wv' for wavelets (as opposed to 'wp' for wavelet packets) and X is the input signal. Output parameters are *thr* (global threshold) and *sorh*.

thr is calculated using $thr = \sqrt{2 \cdot \log(n)} * s$, where *s* is an estimate of noise level and *n* is the size of the signal X. (The specific procedure for doing the estimation for the noise level is not described here). In variable *sorh*, you find out if it has been assigned soft thresholding or hard thresholding. You use the *wthresh* function to apply the global threshold and the inverse *swt* transform to reconstruct the signal from the thresholded coefficients.

Now do Step 12 Remove noise by thresholding.

Hand in the following:

- (1.) Submit the figure generated in Step 11.
- (2.) In class we used Noble's identity to commute the downsampling operations with the filters, to obtain stationary wavelet coefficients. Assume that these coefficients are now processed in some way depending on the application. Now we wish to reconstruct the signal from the processed coefficients. Does the synthesis part need to change in any way? Draw a 2-channel stationary PRFB, say 2-levels, showing the analysis (decomposition) filters with the "holes". Also show the corresponding synthesis (reconstruction) part.

Problem 2.

Two-Dimensional Discrete Wavelet Transform

Here we do a simple image decomposition using 2-D wavelets. This problem is the same as the example that you will find in MATLAB Help, Wavelet Toolbox, Using Wavelets, Two Dimensional Discrete Wavelet Analysis, Two Dimensional Analysis Using the Command Line. Do the following:

- (1.) Go to the above section in MATLAB Help.
- (1.) Go through steps 1 \rightarrow 11.
- (2.) You are working with a 256×256 image and the biorthogonal 3.7 wavelet. Explain why, in step 4, the size of the the first level coefficients cA1, cH1, cD1, cV1 is 135×135 .
- (3.) Submit the 2×4 plot that you get in step 10. Comment on what you are observing

Problem 3.

2-D Directional Filtering

- (1.) In the above example, you saw the limitations of directionality in the “separable transform” for 2-D wavelet analysis. To rectify this situation, multi-directional or so-called “steerable” filters have been generated. Obtain the 4 files stored under Steerable Filters Demo and run ‘runDemo’. Comment.