E E - 2 7 4 *Introduction to Wavelets & Filter Banks* Spring Semester 2007

HOMEWORK 4

SPECTRAL ANALYSIS USING SPTOOL & THE CWT.

In this homework we analyze frequency and scale spectra of the following signals using *sptool* and *cwt*:

(1.) Sine wave

(2.) Singularities

(3.) Frequency breakdown

A.
First generate 100 samples of a 50 hz sine wave, sampled at 1000 hz in Matlab. In Matlab, save the signal as for example, *signal.mat*. Then do the following:

B.

(1.) Bring up sptool in Matlab by typing *sptool* at the command line.

(2.) In the SPTool window (startup.spt), go to File → Import. In the Import window check off From Workspace. Highlight the variable *signal* in the Workspace Contents, press the right arrow and make sure it appears in the rightmost section of the Import window. Press OK.

(3.) In the SPTool window, go to Edit → Sampling Frequency and for your signal, set that to 1000.

(4.) In the SPTool window, press View and look at your signal in the Signal Browser. (You can also hear it by invoking the loudspeaker icon).

(5.) In the SPTool window, with your signal highlighted under Signals, go to the Spectra part on the RHS and press Create. The Spectrum Viewer come up.

(6.) In the Spectrum Viewer use the FFT method, 100 samples for Nfft and press Apply. Look at the spectrum and verify that you get a sharp peak at 50 hz.

(7.) Now do a 1000 sample FFT. (Do you know how this is being done?) Look at the Options for Magnitude Range, Frequency Range and Frequency Scale and exercise all of them.

C.

Now type *wavemenu* in Matlab. In the Wavelet Toolbox Main Menu go to Wavelet Display. Look at all the wavelets and specifically the Haar, db (for various Ns, expecially N=1), symmetric, coiflet (for N=1), biorthogonal for various size input-output size ratios, various gaus wavelets (do you see how the first and then the others are derived?) and shannon. In Matlab, you might want to invoke, for example, $cfreq = centfrq('mexh', 10, 'plot')$ and $scal2frq(5, 'mexh', .001)$ to relate scale to frequency for various wavelets. Note that in the Wavelet Display you will sometimes see a Scaling Function as also a Wavelet Function, when they both exist (as in the DWT). Otherwise you only see a Wavelet Function (as only required for the CWT).

D.

In the Wavelet Toolbox Main Menu, go to the Continuous Wavelet 1-D, and the File $\rightarrow$ *LoadSignal*. Load your sine wave. Set your sampling period on the right-hand side as 0.001. Step by Step Method. Coloration mode as init+by scale+abs and choose a Colormap (I use pink). The step sizes under the Step by Step method is something that you will choose based on what you are looking for. Now do the following:

(1.) Start with the Haar. Look at the $C(a, b)$ coefficients. Look at the New Coefficient Line at some scale and see if you get the 50 hz for the 50 hz signal, for some scale. Observe the graph for the coefficient line corresponding to 50 hz and for other frequencies. Explain why the C(a,b) coefficients are being generated as they are and what is their significance. What should one be looking for to identify the 50 hz sine wave.

(2.) Now do the same as above using the *mexh* wavelet. Comment. Is one better than the other for determining the frequency of the sine wave? You can bring up 2 CWT 1-D windows and compare the two side-by-side.

E.

Now in the CWT 1-D window, go to File$\rightarrow$ Example Analysis and load the Test Singularities example which is set-up with the Haar wavelet and the Symmetric(4) wavelet. Comment on distinguishing the waveform singularity with both the wavelets.