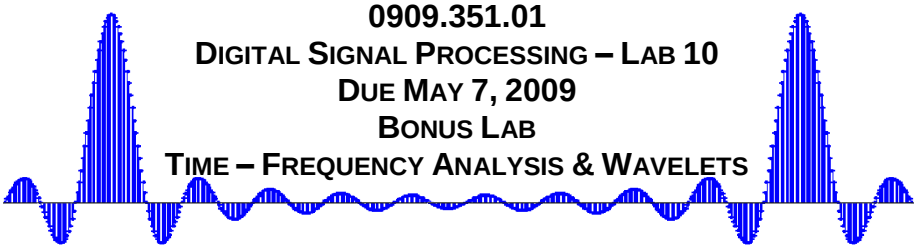

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DIGITAL SIGNAL PROCESSING – LAB 10
DUE MAY 7, 2009
BONUS LAB
TIME – FREQUENCY ANALYSIS & WAVELETS

This is an extra credit lab. If you submit this, I will replace your worst lab grade with this one. If you go above and beyond what is asked here, and demonstrate your understanding of wavelets and/or its applications beyond what is provided in lecture notes, I will add a percentage of your grade to your final exam.

1. Implement the short time Fourier transform in Matlab using your own code, that is systematically windowing a signal and taking its Fourier transform for each window. Evaluate your code on a test signal that concatenates the following signals. Plot the surface plots showing time vs. frequency vs. magnitude. Try different window widths and observe (and plot) the effects. Explain your observations.

$$x_1(t) = \cos(2\pi \cdot 10t) + \cos(2\pi \cdot 40t)$$
$$x_2(t) = \cos(2\pi \cdot 20t) + \cos(2\pi \cdot 30t)$$
$$x_3(t) = \cos(2\pi \cdot 5t) + \cos(2\pi \cdot 50t)$$

2. Implement continuous wavelet transform using your code. You may use built in functions of the wavelet toolbox. However, you should plot the output as shown in the lecture notes, that is, as a 3-D surface plot. Plot both scale – translation – amplitude as well as frequency – translation – amplitude plots. Find in Matlab how to convert a given scale value to a frequency value. Note that this depends on the mother wavelet you choose (Matlab has a function for this, find out what it is). Evaluate your code on the above given test signal. Interpret the outcome and compare it to that of STFT. Explain the time-frequency resolution on the transformed signal.

3. Implement the DWT using your code. You may use built in functions of the wavelet toolbox. Analyze and interpret the DWT of the above signal. Can you also plot the DWT as a 3-D surface plot (extra extra credit)? Explain the time-frequency resolution on the transformed signal. How is this transform different than the continuous wavelet transform?

4. Add noise to this signal and then clean it using wavelet shrinkage denoising. You may use the wavelet toolbox GUI for this purpose. Explain how the wavelet shrinkage denoising works.