EEE 506 - Spring 2015
Digital Spectral Analysis

Semester Project
Power Spectral Estimation

Due Date: 5-5-15 (Day of Final Exam)

You will be working with the following data sets:

Data Set #1: Create a 128-point real data sequence consisting of unit-amplitude sinusoids at 5 Hz, 15 Hz, and 16 Hz. Let the sampling frequency f_s = 64 samples/second.

Data Set #2: Create a data record identical to Data Set #1, but add white noise such that the signal-to-noise ratio (SNR) is 0 dB.

For each data set:

(a) Form Blackman-Tukey PSD estimates with lags of 10 and 20. Use a Hamming window and unbiased correlation estimates.

(b) Form Welch Periodogram PSD estimates. If N samples are divided into P segments of D samples each, with a shift of S samples between adjacent segments, let S = 10 and 20, and let D = 32. Use a Hamming window.

(c) Form Yule-Walker PSD estimates. Use model orders of 5, 15, and 30. Use both biased and unbiased autorcorrelation estimates.

(d) Form Burg (Harmonic) PSD estimates. Use model orders of 5, 15, and 30.

(e) Form Covariance PSD estimates. Use model orders of 5, 15, and 30.

(f) Form Modified Covariance PSD estimates. Use model orders of 5, 15, and 30.

(g) Form adaptive least mean squares (LMS) PSD estimates. Use model orders of 5, 15, and 30. Try three different adaptive step sizes.

(h) Form MUSIC PSD estimates. Use model orders of 5, 15, and 30. Try three different values for the number of signal space vectors.

For each of the PSD estimation algorithms discussed above, calculate 4096 PSD points in the interval $-f_s/2$ to $f_s/2$. Plot all PSD estimates as Power (dB) vs. frequency (Hz).

Submit a typed report in WORD format with a separate chapter corresponding to each algorithm (i.e., (a) - (h)) as discussed above. In each chapter, discuss the theory behind the algorithm and clearly identify your observations with respect to variables such as model order, biased vs. unbiased, different weighting factors, etc. Include an introduction chapter that describes the overall experiments, how you created the test signals, and any implementation details. Include a final chapter that compares and contrasts all of the algorithms, and draws conclusions based upon the observed results.

In addition, submit eight MATLAB programs (.m files) that I can run to verify your findings-one for each algorithm. Each program should be completely automatic and display the appropriate figures simultaneously. For example, for part (c), the program should display 12 figures, appropriately labeled. Securely attach a CD-ROM with your programs to the inside of the front cover of your report. All programs must run on MATLAB 2012b.