EEL 6504

Hmw # 4

Due October 13, 2015

Problem I

An "unknown" plant has transfer function $H(z) = \frac{1 - z^{-10}}{1 - z^{-1}}$ and its output is added with white Gaussian noise of power N=0.1. The input to the plant is alpha stable noise. To generate this noise use the characteristic function $\varphi(t) = \exp(-\gamma |t|^{\alpha})$ with α=1.8 and choose γ=1. Generate 10,000 samples of the alpha stable noise as well as the white Gaussian noise.

The user has only access to the noisy output of the plant and to its input. The goal of this problem is to design a linear filter **adapted with the RLS algorithm** to identify the unknown plant transfer function. You can NOT use the fact that you know the plant to design the adaptive filter, but you can use this knowledge to validate the solution obtained. Use the normalized MSE as the quality of the identification (normalize by the power of the input). I suggest that you use filters of order 5, 15 and 30. Compare the accuracy of the system identification by computing the weighted error power. $WSNR = 10\log\left(\frac{\mathbf{w}^{*T}\mathbf{w}^{*}}{(\mathbf{w}^{*} - \mathbf{w}(n))^{T}(\mathbf{w}^{*} - \mathbf{w}(n))}\right)$.

Show the effect of increasing the noise N (N=0.3, 0.5) from your experiments. Observe the filter parameters. Explain what you observe. Compare both with the LMS and the Wiener solution.

Problem II

In the class website (http://cnel.ufl.edu under classes) you will find a time series called speech 1. This file contains a spoken sentence "We were away a year ago" sampled at 10 KHz, 12 bits A/D. The purpose here is also to compare the quality of **RLS predictors** in this time series. The difficulty is that speech is nonstationary!

Normalize the error power by the input signal power and use this measure to compare the different predictors and windows. I suggest that you use filters of order 6 and 15. Examine also the filter parameters and how they change over time. Can you find any similarity in the parameters versus the similarity in the sounds? (listen to pieces of the sound and correlate with parameter values). Compare with both the LMS and Wiener solution.