DEPARTMENT OF ELECTRONICS AND INFORMATION TECHNOLOGY SYSTEMS
ELECTRIC CIRCUIT ANALYSIS LABORATORY
COURSE: DIGITAL SIGNAL PROCESSING - 8th SEMESTER

Optional Assignment

(Due date: 30/6/2023 @ 23:59)

Wiener Filter for Denoising

a) Load the audio file "guit1.wav" in MATLAB. Generate a Gaussian noise signal with zero mean and a standard deviation of $\sigma = 0.01$ and add it to the input signal. Implement a Wiener filter with orders p = 10, 20, and 30 that will denoise the input signal. Note that you have access to the true noise variance and can compute the Wiener filter coefficients. Calculate the SNR of the noisy signal and the SNR of the denoised signal for each Wiener filter order. Finally, listen to the denoised signals and analyze the results.

b) Use the function "frame_wind.m" and apply it to the input signal with a frame length of 256 samples and an overlap of 0.5. Calculate and apply the Wiener filter to each frame of the signal with orders p = 10, 20, and 30. Note the true noise variance and compute the SNR of the denoised frames. Reconstruct the denoised signal using the function "frame_recon.m".

(For the calculation of the Wiener filter matrix, use the function pinv(A, 0.0001) instead of inv(A) to account for possible ill-conditioning of the matrix A.)

Calculate the SNR of the noisy signal and the SNR of the denoised signal for each Wiener filter order. Finally, listen to the denoised signals and analyze the results.

c) Calculate the average power of the noisy signal and verify that the power is approximately constant.

d) Repeat step a) assuming that the true noise variance is unknown. Instead, select a segment of the signal that contains only the noise and calculate the noise variance from there. Use this estimated noise variance to denoise the input signal. Repeat the analysis and evaluate all the results.

e) Repeat step b) without knowing the autocorrelation of the original signal. Here, use your own mechanism to determine whether each window contains speech or noise. If it contains noise, then use it to calculate the autocorrelation of the noise. Use this estimation as a constant noise autocorrelation template for all subsequent windows until another noise window appears, at which point the noise autocorrelation template is updated.

Comment on the results and compare them with the previous values.

f) Use the structure from b) without noise to predict the next 2, 10, 15 values of the input signal using the Wiener filter.
Taking into account the time shift, calculate the SNR again for each case and comment on the results.

Xanthi, 2/6/2023