Skills Class Signal & Image Processing – Wavelet Shrinkage

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In this exercise we concern the task of vinyl audio denoising. The aim of vinyl audio denoising, as you may know, is to remove the clicks, cracks and glitches from audio which is coming from a vinyl record being played on a turntable. Dust, scratches and electrostatic charges are the primary causes for these cracks.

Question 7.1 - Manual denoising

Load the signal `vinyl1.wav` in Matlab with *audioread* and listen if you can hear cracks and a loud click (use the function *sound*). Then plot the vinyl signal. Select a crack and remove it by hand. Plot the result and save the new signal with *audiowrite*. Listen again to the vinyl signal in the media player.

Question 7.2 - Mean filter

Load again the original vinyl signal and apply mean filtering as you have learned in Practical Assignment 3. Try a few different filter lengths, for example 10, 100 and 1000. Save the filtered signals and listen to the result.

Question 7.3 - Wavelet denoising

Load `cd1.wav` into Matlab and listen to it. Denoise the signal by wavelet shrinkage with soft thresholding. Use a 3 level decomposition of a wavelet of your choice. Use Visushrink as described in the book and told in the lectures. Save your denoised signal as `cd3.wav`.

Hint: Apply formula 9.4 (page 321) on all your detail coefficients. Lambda can be obtained using equation 9.9. And sigma of 9.9 can be estimated applying equation 9.10 on your first detail coefficients.

Question 7.4 - Signal-to-noise ratio

`cd2.wav` is the clean version of `cd1.wav`. Determine the SNR (signal-to-noise ratio) in decibels of `cd1.wav`. Use the following formula:

$$\mathrm{SNR} = 10 \log_{10} \frac{\sum_{i=1}^{L} x[i]^2}{\sum_{i=1}^{L} e[i]^2}$$

where $e[i]$ is the error signal between the noisy signal $z[n]$ and the clean signal $x[i]$. So $e[i] = |x[i] - z[i]|$. L is the length of the signals $x[n]$, $z[n]$ and $e[n]$.

Determine also the SNR of your `cd3.wav`. How much did your SNR improved/deteriorated after wavelet denoising?