Homework 3

ELEN0071 University of Liège, Spring 2019

Due: Wednesday 29/05/2019 11:59pm

Instructions: Name your homework report `LastName1_LastName2_LastName3_homework3.pdf` (in alphabetical order). Submit your homework report on the Montefiore submission platform (`http://submit.montefiore.ulg.ac.be`).

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1. Noise filtering. Consider the following noisy signal

$$x_{\text{ns}}[n] = x[n] + v[n]$$

where $x[n] = \cos(20\pi t) + 0.5\cos(40\pi t + 1.4) + 0.8\cos(120\pi t + 0.7)$ and $v[n]$ is an arbitrary noise. The file `hw3_noisy_signal.mat` contains $x_{\text{ns}}[n]$ and $x[n]$, which are sampled at 1000 Hz.

The goal is to design a filter to remove the noise from $x_{\text{ns}}[n]$ without distortion, i.e., the filtered signal and the original signal should have the same "shape" ($x_{\text{filt}}[n] = G\,x[n - n_0]$).

(a) Plot $x[n]$ and $x_{\text{ns}}[n]$ in the same axis (range: `[N/2-200, N/2+200]` where `N` is the length of $x[n]$).

(b) Plot the single-sided amplitude spectrum of the noisy signal $x_{\text{ns}}[n]$.

(c) Determine the approximate frequency range of the noise $v[n]$.

(d) Design a filter to remove the noise from $x_{\text{ns}}[n]$ preserving the shape of the signal (i.e., without distortion). Explain clearly your filter design procedure.

(e) Plot the single-sided amplitude spectrum of the filtered signal ($x_{\text{filt}}[n]$).

(f) Plot $x[n]$ and $x_{\text{filt}}[n]$ in the same axis (range: `[N/2-200, N/2+200]` where `N` is the length of $x[n]$).