Homework 3

ELEN0071 University of Liège, Spring 2020

Due: Wednesday 13/05/2019 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[n] consists of 3 sinusoidal components

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

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 $x_{\text{ns}}[n]$. single-sided magnitude spectrum of xnS

(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 $x[n]$).

(c) When you plot single-sided magnitude spectrum, you can clearly see the noise and you can identify the frequency range of the noise because we have 3 sinusoidal components so anything else is the noise.
There a 3 sinusoidal components in the original signal so anything else is the noise
(d) You should choose btwn IIR and FIR filter.
(e) Plot that to show that the noise is remvoed
(f) Original signal and filtered signal to see if you really preserve the shape of the signal.