Homework 3: Filtering Audio

In this homework, you are given an audio file with the name “audio.wav”. This audio is composed of three instruments: A piano, a drum kick and a cymbal. The sound of the kick is between 0 and 500 Hz. The sound of the piano is between 500 and 4000 Hz. The sound of the cymbal is bigger than 4000 Hz. The audio.wav is sampled at 48000 Hz.

Your task is to apply three FIR(or IIR) filters using MATLAB to separate this audio into three audio tracks that contain each instrument separately.

- Your first filter should be a low pass with a cutoff frequency 500 Hz. This filter is going to separate the drum kick sound.
- Your second filter should be a band pass filter which allows only the frequencies between 500 Hz and 4000 Hz. This filter is going to separate the piano chords.
- Your third filter should be a high pass filter with cutoff frequency 4000 Hz. This filter is going to separate the cymbals.

You are allowed to find these filters online, from course materials, from inbuilt MATLAB functions (Signal Processing Toolkit will be helpful), or from other external resources.

Note: You are not supposed to apply these filters all at once. You need to apply them to the “audio.wav” separately for each separate instrument, meaning that you will generate three separate files.

Note: If your filter does not separate the audio perfectly, it’s okay. You can try applying it more than once. It’s still possible that artifacts would remain so it is not a problem that it is not perfect.

Submission:

- Submit every relevant MATLAB code file.
- Provide a pdf report where you explain your work. Your report should contain:
    - Your name and your student id
    - Explanation of how you came up with each filter (is it inbuilt MATLAB functions? or an external resource? or course materials?) . You don’t have to be in depth, a brief explanation would suffice. In the case you use MATLAB functions, try to explain parameters that you’ve given to the function and why you selected those.
    - Plots of magnitude of the frequency response of each filter (similar to those in course slides).
    - An explanation why each filter does what it *should do* by *only* referring to the plots.
    - A picture of waveform plots of the “audio.wav” and also of the three separate audio tracks you generated after filtering.
    - A picture of spectrograms of the “audio.wav” and also of the three separate audio tracks you generated after filtering. (You don’t have to use MATLAB to generate spectrograms.)

- Provide three wave files kick.wav, piano.wav, cymbal.wav that contains three audio tracks you separated.

If your submission file size exceeds the Moodle limit, please provide a download link to your submission in a text file.