

HOMEWORK 3 REPORT

Creating the Filters

I created the filters using the *butter* and *filter* functions which came from the Signal Processing Toolbox. *Butter* function creates the parameters for the filter and *filter* function does the filtering.

Parameters of *butter* function:

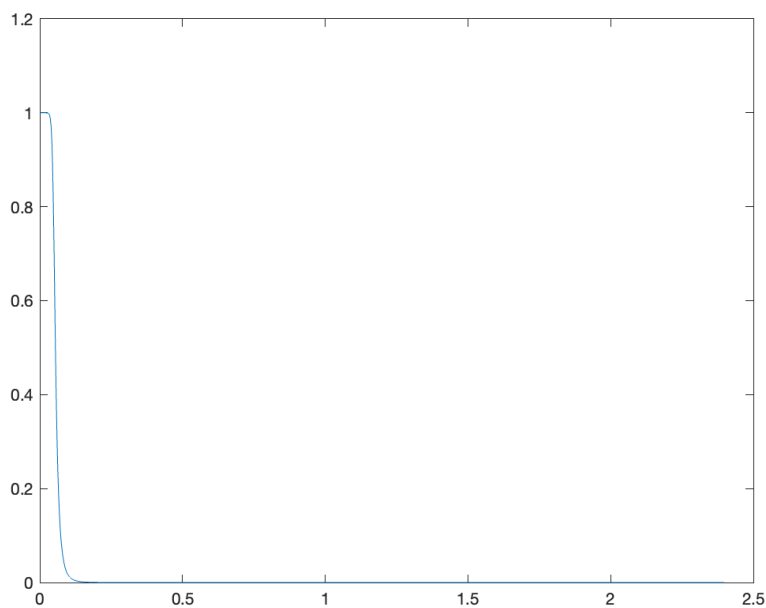
1. *filter_order*: Higher order increases filter success but also increases number of calculations, so I chose a value which I believe is not high or low
2. *normalized_frequency*: The function cannot take frequency values directly, so we have to insert the it as “frequency / (sample_rate / 2)”
3. “low”, “high”, “bandpass”. We have to specify what type of filter are we creating

Parameters of *filter* function:

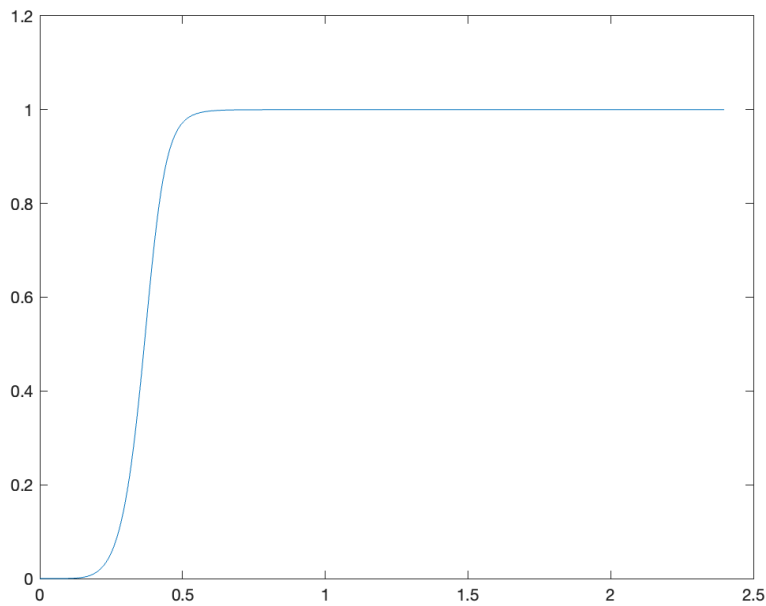
1. *a*: denominator part of the filter, returned by *butter*
2. *b*: nominator part of the filter, returned by *butter*
3. *input_audio*: returned by *audioread* function, represents the waveform of audio.wav

Magnitude Plots of Frequency Responses

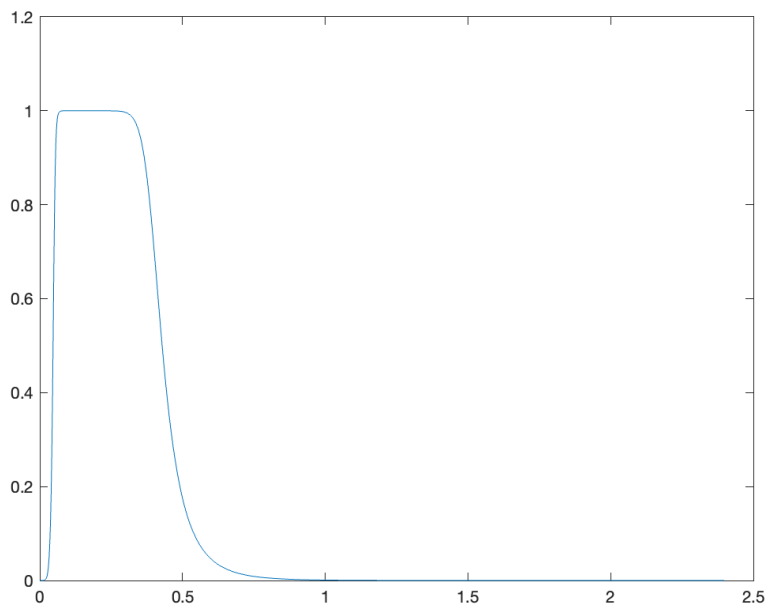
1. Lowpass Filter (Kick)



2. Highpass Filter (Cymbal)



3. Bandpass Filter (Piano)



We can easily understand why the filters are working using the formula $\text{cutoff frequency} * \pi / \text{sample rate}$ to convert the frequency from Hertz to radian. When we make this conversion we will see the following results

$$500 * \pi / 48000 = 0.033$$

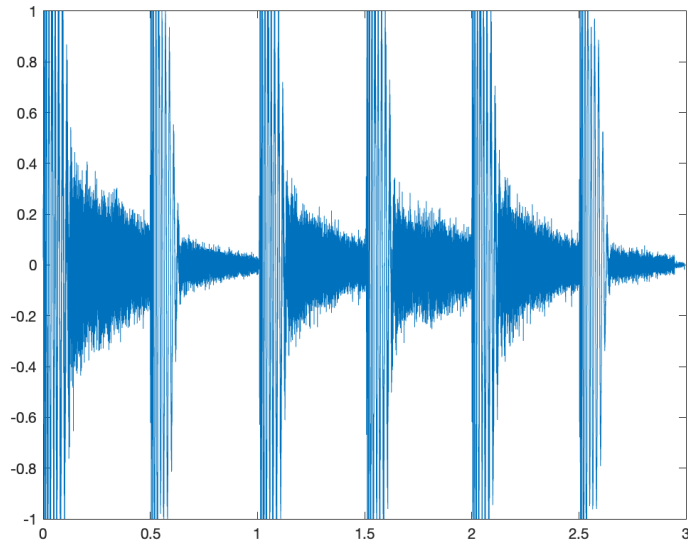
$$4000 * \pi / 48000 = 0.262$$

If we look at the graphs, we will see that in the lowpass filter, magnitudes goes to 0 after some value very close to 0 and in the highpass filter magnitude reaches 1 after 0.2. In the case of bandpass filter we can see that magnitude is at 1 when the normalized frequency is between the same values.

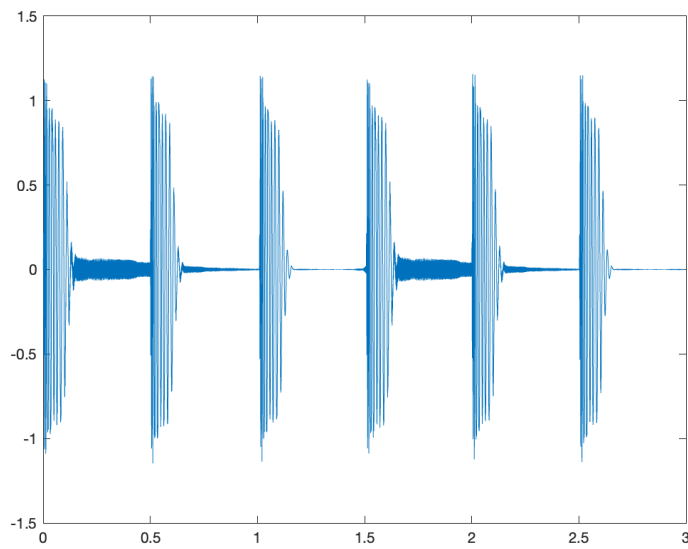
Therefore, we can interpret that when the magnitude equals 1 filters let the wave pass and when the magnitude is 0, filters does not let the wave pass.

Waveform Plots

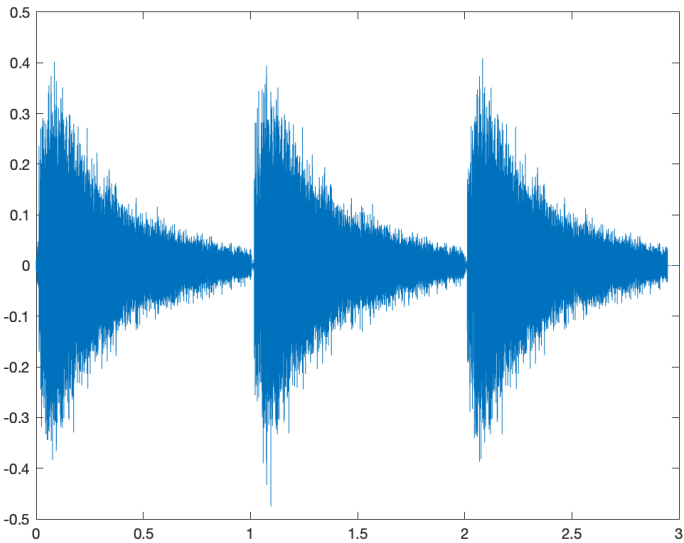
1. Input audio



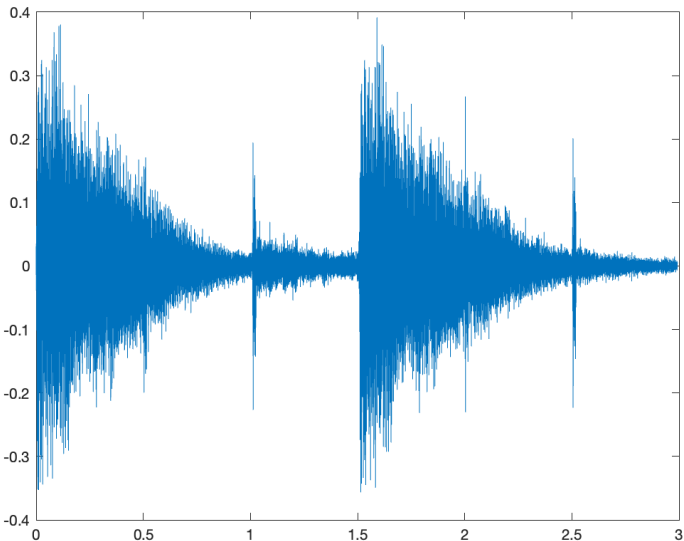
2. Lowpass (Kick)



3. Highpass (Cymbal)

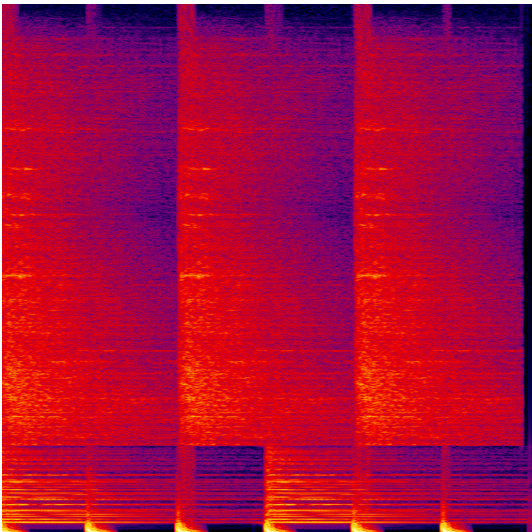


4. Bandpass (Piano)

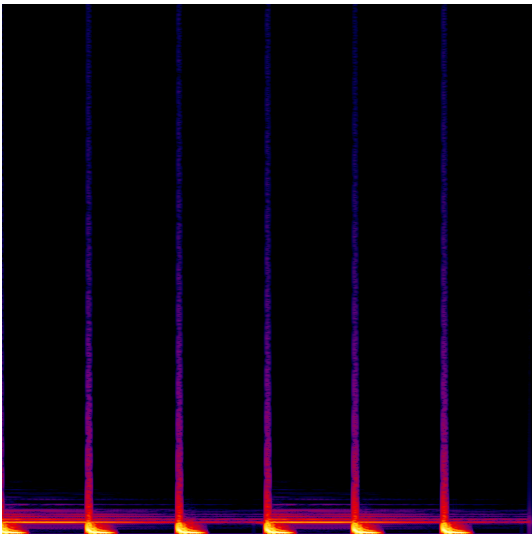


Spectrograms

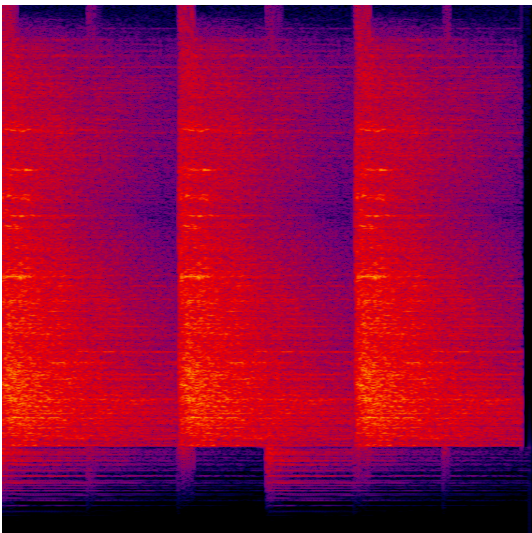
1. Input audio



2. Lowpass (Kick)



3. Highpass (Cymbal)



4. Bandpass (Piano)

