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Subject: Mini Project – FIR Notch Filtering

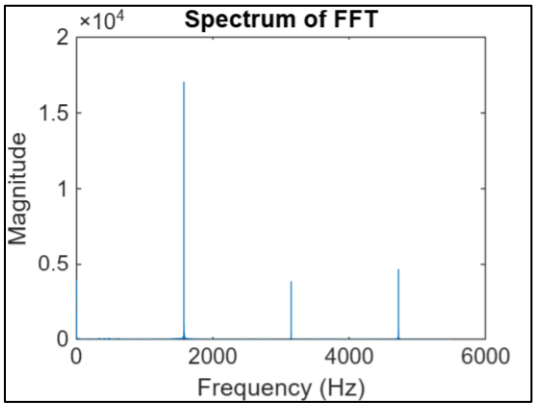
A. Introduction

In this project, I removed three unwanted tones using simple FIR notch filters in MATLAB. The target frequencies were found using ginput on the spectrogram and FFT peak analysis.

B. Summary

(1) I used the ginput function to select approximate noise frequencies from the visualized spectrogram. After clicking on prominent horizontal tone lines, I manually fine-tuned the selected frequencies by observing the filtered spectrogram results.

(2) I also used FFT magnitude spectrum analysis to identify tone frequencies more precisely. I extracted the audio segment from 8 to 10.8 seconds, where the noises were most apparent. Then, I computed the FFT and took its magnitude. The spectrum was divided into three predefined frequency ranges [1000 2000; 2000 4000; 4000 fs/2], and the frequency with the maximum magnitude in each range was selected as a dominant tone.

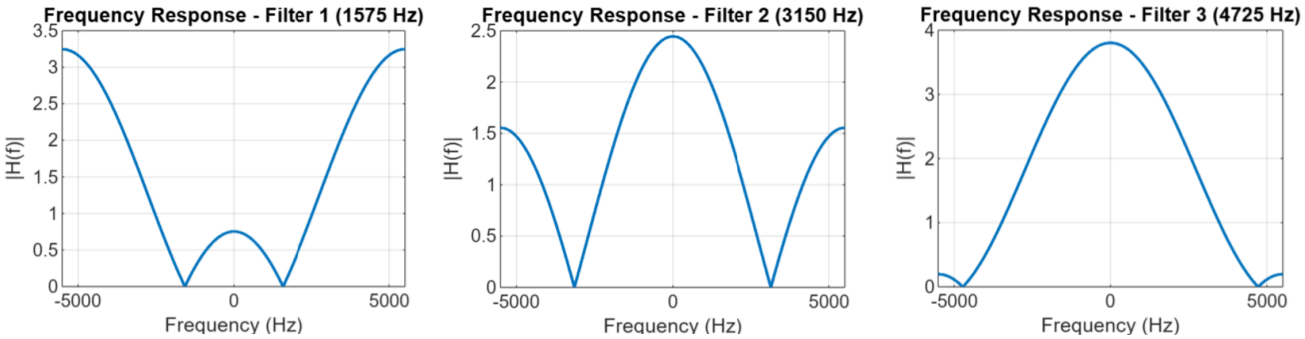


(3) As a result, I identified three noise frequencies: 1575 Hz, 3150 Hz, and 4725 Hz. I then designed 3-tap FIR notch filters to suppress them. To compute the filter coefficients, I ensured the frequency response was zero at each target frequency, leading to the formula $A=-2\cos(\omega)$, where $\omega=2\pi f/fs$.

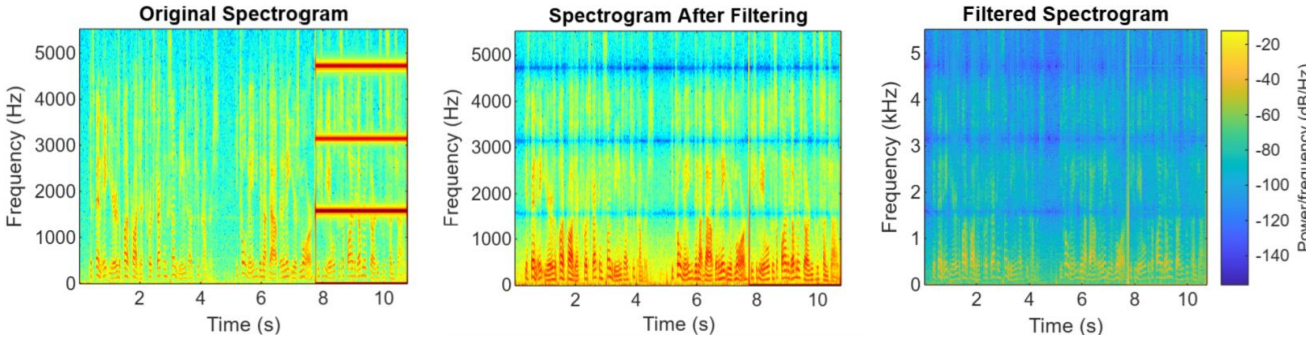
I. FIR Notch Filter Coefficient Calculation for Target Tones

Frequency(Hz)	Digital Frequency(rad/sample)	A(filter coefficient)
1575	$2\pi \times 1575 / 11025 = 0.286\pi$	$-2\times\cos(0.286\pi) = -1.246$
3150	$2\pi \times 3150 / 11025 = 0.571\pi$	$-2\times\cos(0.571\pi) = -0.442$
4725	$2\pi \times 4725 / 11025 = 0.857\pi$	$-2\times\cos(0.857\pi) = 1.802$

II. Frequency response for each noise frequency



III. Spectrogram Comparison



Spectrogram of the original audio

Spectrogram of the filtered audio (using ginput)

Spectrogram of the filtered audio (using FFT)

C. Judgment

This project strengthened my understanding of FIR filter design and its practical use in removing unwanted frequencies.

D. Conclusion

The cleaned audio sounds significantly better after removing the tones. I learned how FIR filters work in practice.