CPX 2 Report

ECE 434: Digital Signal Processing

November 20, 2024

C1C Ben Cometto

Contents

List of Figures

List of Tables

Abstract

Computer Exercise 2 (CPX 2) required processing 5 signals in a variety of manners to produce certain objectives. Digital signal processing using various FIR and IIR filters enabled these objectives to be met with low order filters. The signals, including test tones, ECG data, and jammed audio, provided a wide range of applications for digital signal processing. Overall, CPX2 was a great exercise in solving real-world problems using digital filter techniques.

1 Introduction

Computer Exercise 2 (CPX 2) for ECE 434, Digital Signal Processing, involved processing 5 signals. The five signals are:

- Signal x_1: Two tones, one louder and one softer
- Signal x_8: A message containing the secrets of sunshine extraction from cucumbers, but important information is jammed
- Signal x_3: An electrocardiogram (ECG) that is contaminated with a power line artifact
- Signal x_4: An unknown audio signal that is jammed
- Signal x_7: A series of 10 test tones that must be modified

The processing goals for each signal are:

- Signal x_1: Make the louder tone softer and the softer tone louder
- Signal x_8: Reveal the jammed information
- Signal x_3: Remove the power line artifact
- Signal x_4: Reveal the unknown audio
- Signal x_7: Correctly modify the 10 test tones

I filtered each signal to enact the signal's processing goal. All aspects of the filter, including using an infinite impulse response (IIR) versus a finite impulse response (FIR) design method, order, and other parameters, have been carefully considered, and are reported in each signal's respective section. For access to the Matlab `.mlx` files, source signal data, filter designer session `.fda` file, filter taps `.bin` files, and output `.wav` sound files, see the project's GitHub repository at `https://github.com/dbcometto/ece434_cpx2`.

2 Signal

3 Signal

4 Signal

5 Signal

6 Signal

7 Conclusion

For each of the five signals provided for Computer Exercise 2 (CPX 2), the processing goal was met with a filter of minimum order. In summary, in Signal x_1, the louder tone was attenuated so that the quieter tone was more than 30 dB greater in magnitude. In Signal x_8, the secrets of extracting sunshine from cucumbers was revelaed after an attempted jamming. In Signal x_3, interference from a power line in an electrocardiogram (ECG) was removed. In Signal x_4, the secret to a good life according to Conan the Barbarian was revealed after another attempted jamming. In Signal x_7, ten test tones were modified to be within 1 dB of a specified magnitude.

For the filters for Signals x_1 and x_8, preserving linear phase was not important, and thus infinite impulse response (IIR) filters were used because they have a better magnitude response for a given order. For Signals x_3 and x_4, preserving linear phase was important, and thus finite impulse response (FIR) filters were used. For details on each filter, see the signal's respective section.

Throughout this experience, I gained experience working with digital filters, in both design and application. Additionally, I built upon my ”signal hunting” skills that had been built in CPX 1 in order to understand the content of the signals, a necessary prerequisite to processing them appropriately. I also gained more experience with audio processing in Matlab, and learned how to export to `.wav` files. Additionally, I gained more experience in LaTeX, which is always helpful.

For access to the Matlab `.mlx` files, source signal data, filter designer session `.fda` file, filter taps `.bin` files, and output `.wav` sound files, see the project's GitHub repository at `https://github.com/dbcometto/ece434_cpx2`.

Documentation

I did all my own work. I had various conversations with classmates, including C1C Csicsila and C1C Chen. However, no changes were made based on those conversations. Additionally, I used Google (`https://brainly.com/question/2233369`) to find the cucumber quote and YouTube (`https://www.youtube.com/watch?v=V30tyaXv6EI`) to find the Conan the Barbarian quote. I used various resources, including overleaf.com, for Latex help. I also used various ECG interpretation resources, including this article, several YouTube videos, and several Google images of atrial fibrillation. I also used the Mathworks website for Matlab help, for various syntax issues, and additionally for the `upsample` function, in an attempt to play the ECG data (until I learned that real ECGs use sonification to play the data, which makes way more sense). I also used my notes from Math 342 Numerical Analysis and the Remez algorithm Wikipedia page. Additionally, C1C Csicsila asked me a question regarding why it is worth finding the period in both the time domain and frequency domain, and that led me to realize I had forgot to answer several questions.