Audio Pitch Shifting and Transmission through Optical Fiber

Project Proposal

6.101 - April 10, 2019

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1. Overview

Motivation

For this project, we are focusing on pitch shifting. First, this will create an interesting audio effect, and second, it will provide anonymity to the audio's source. The perception of an audio signal can convey information about its source, and by transforming the signal, the source can be anonymized. One reason to do that would be to create audible effect, or just for anonymity.

We both also took an optics class (6.161), and therefore, we want to incorporate a little bit of optics to our project. And therefore, we plan on transmitting audio signals over optical fiber.

Basic Goals

- Create perception of a pitch shift for single tone sounds
- Transmit audio over a optical channel
- Modules working independently

Expected Goals

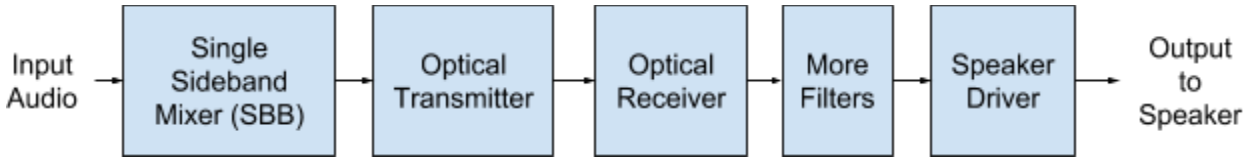
- Create perception of pitch shift for monotone voice or audio
- Modules connected and working

Stretch Goals

- System built on a PCB board
- Additional filters for band pass selection and amplification

2. Modules

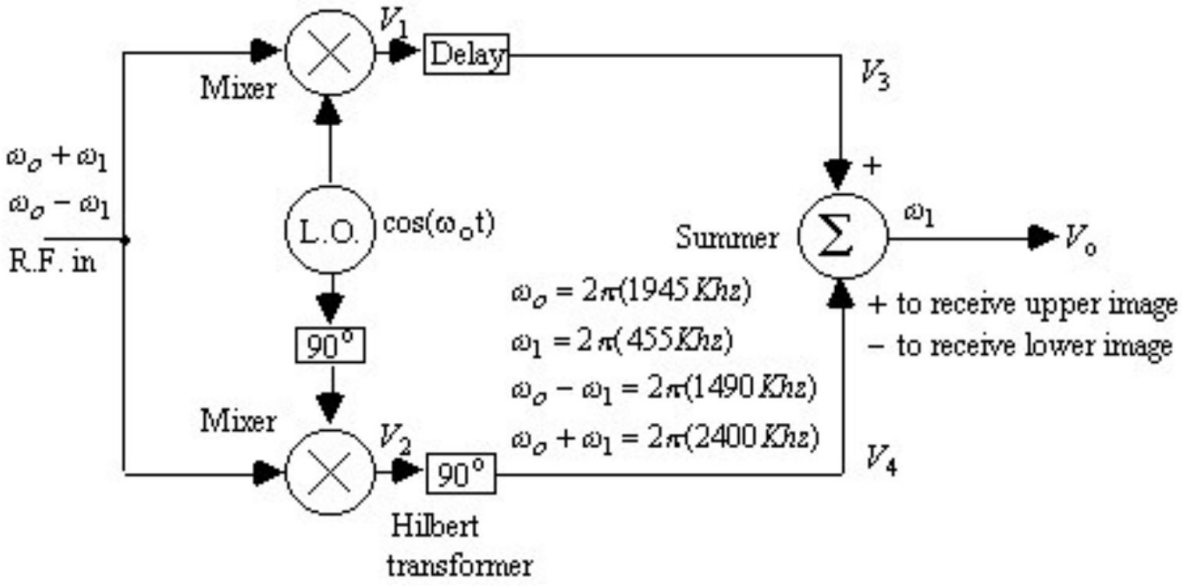
High level block diagram



Single Sideband Mixer (SBB) Module

To give the perception of pitch shifting, we will mix our incoming audio signal with another signal. For example, if both signals are pure tones, by mixing the signals, we would get a higher and a lower tone. So, we will focus on mixing a signal with itself and then filtering for the desired signal. To both mix and filter, we will implement a single sideband (SSB) mixer.

A single sideband mixer can be implemented the following way:



https://www.linkedin.com/pulse/hilbert-transforms-ssb-circuits-michael-ellis/

The main structures in the SBB mixer are a local oscillator to create a cosine signal, a 90 degrees phase shifter, a mixer, and a summer.

Emmanuel will focus on creating the adder and mixer, while Wings will work on creating the local oscillator and phase shifter.

Optical Transmitter and Receiver Module

To transmit the audio, we plan to send a baseband audio (but may switch to a modulation scheme if audio fidelity is poor) over an optical fiber. An optical transmitter module and receiver module must be implemented.

The optical transmitter can be modeled as a LED, where the output light intensity changes based on the incoming signal's amplitude modulation. In order for effective output light intensity changes, the amplitude and biasing of the incoming signal needs to be adjusted.

The optical receiver can be modeled as a photodiode, and the current through the photodiode will change as the receiving light intensity changes. High pass filters and low pass

filters might need to be implemented to eliminate the noise that comes with transmitting a signal through an optical fiber.

We will both work on the optical transmitter and receiver together with Emmanuel focusing on the receiver module and Wings focusing on the transmitter module.

Filter Module

This filter module is used to further eliminate the noise in the signal to produce a better output to the speaker. In addition, there is flexibility for us to add an adjusting band pass filter so that the user can amplify a certain part of the audio signal. A variable band pass filter can be created. We will implement a variable bandpass filter cascading HPF and LPF, which allows us to change lower frequency and high frequency independently by swapping capacitors for different bands(Like Lab 5 experiment 1, but variable band).

Speaker Driver Module

In order to properly drive the speaker, we need to amplify the signal appropriately. We aim to use a modified version of the Class AB speaker amplifier created in Lab 5, Exercise 1.

3. Potential Issues

For making the system on the PCB we will have to finish the project almost a week presentation date for PCB manufacturing lead time. One way to mitigate that would be to modularize the system and have some modules tested and worked independently and may put on the pcb ones that are working by time we can get a pcb back.

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4. Equipment Needed

For transmitting the audio, we will need an optical fiber, AV02 fiber receiver, and AV02 fiber transmitter. In addition, we will need a speaker.

5. Timeline

Week of April 15:

- Build and test optical transmitter and receiver
- Build and test speaker driver module
- Start building the SBB mixer components

Week of April 22:

- Finish building and testing the SBB

- Start the PCB design

Week of April 29:

- Finish PCB design and send it in (beginning of the week)
- Build additional filters

Week of May 6:

- May 7, 9 - Project Demo
- Write final project report

Week of May 13:

- Write final project report
- May 16: Final Project Report Due