Modulation and Demodulation

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I. Introduction

In this computer assignment we were instructed to use two different audio clips that we modulated at two different carrier frequencies. We concatenated the two signals and then demodulated and were able to play back the original audio clip. Using these steps, we demodulated Dr. Obeid's frequency modulated data in order to discover the audio clips at separate carrier frequencies.

II. Methods

The method to modulate and demodulate were given on the instructions of the computer assignment. We uploaded our audio signals at the same number of samples and sampling rate. After resampling them to 384,000 samples per second, multiplied by the carrier cosine, and then combined to create a modulated signal. The second part was demodulating the modulated signal and being able to play back the loaded audio clip. This is the method we also used in order to play back the given audio clips. First we had to determine the carrier frequencies by taking the Fourier Transform and seeing which frequencies had energy. Multiplying the modulated signal with the carrier cosine of the exact sampling rate creates a frequency shift away from zero. It is then filtered with a low pass filter at a cut off frequency of 20,000 Hz to be able to hear the signal using the butter function, transfer function, and lsim. Finally, after filtering, we down sampled the signal and then played the audio revealing three different songs at three different frequencies.

III. Results

When taking the Fourier Transform of the modulated signal, it displays energy at the given frequencies.

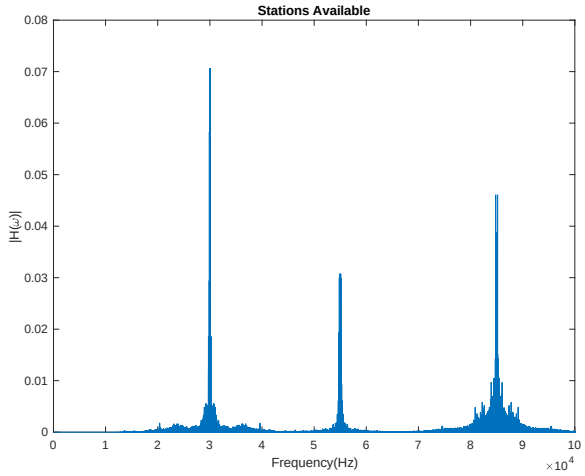

Figure 1: Fourier Transform of Modulated Signal

At 30,000, 55,000, 85,000 Hz there are spikes of energy occurring. We then understood that the carrier cosine would contain frequencies at these values. Using these cosines, we multiplied it by the modulated signal to receive a frequency shifted signal, but not before creating the time vector to be the exact value of our modulated signal. After applying the filter with the butter function we then plotted the filtered signal. This plot shows the filtered signals in orange against the original signal in blue.

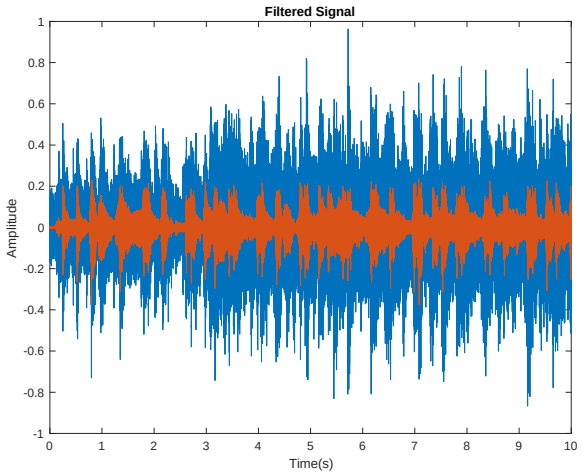

Figure 2: Filtered Signal

This signal was then resampled to be able to be played and heard which we discovered audio clips at each of the carrier frequencies.

IV. Discussion

This computer assignment was another way of taking our basic understanding of the Fourier Transform and looking at its applications. The second part of the assignment we made our code dynamic enough that one should be able to take any signal with a series of carrier frequencies and view the plot of where there are available carrier frequencies or "stations" if you will, and then input the desired station via the command line. Once a desired station is selected the code will then demodulate that carrier frequency and play the audio.