Perceptual Frequency Response: Musical Illusion and Hearing Test

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Shared Concepts:

Both projects are focused on testing the perceptual acuity of human hearing. They show the limitations of human hearing and through them we were able to demonstrate how manipulating frequency response through DSP can affect our perception of the world.

Musical Illusion: Shepard Scale

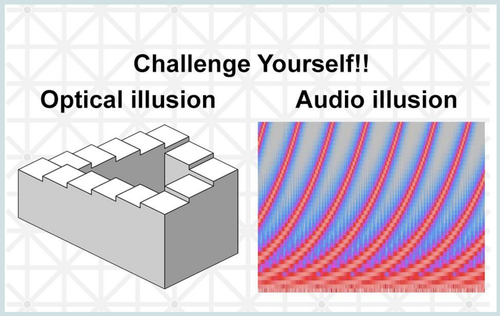
Background:

The Shepard Tone is an audio illusion that creates the perception of an infinitely rising tone.

The goal of this project was to adapt this idea to a musical scale, creating an illusion of an infinitely rising sequence of musical notes.

This project demonstrates how the perception of pitch is based on context rather than fundamental frequency.

Analogy: Penrose Stairs



Methodology:

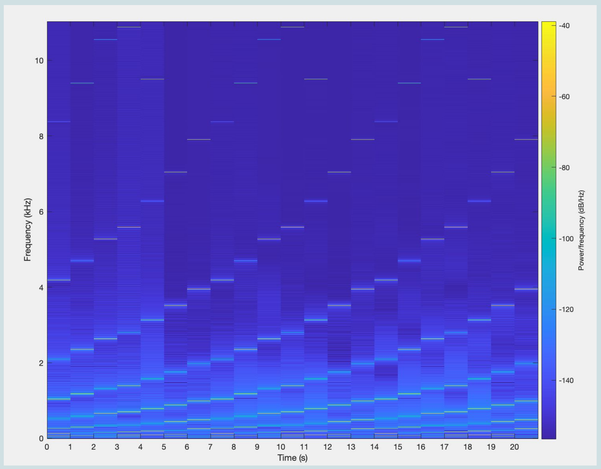
- Gaussian Frequency Weighting: Using a Gaussian function as a band-pass filter to weight the frequencies of the sequence (Gaussian as Fourier Transform of a filter)

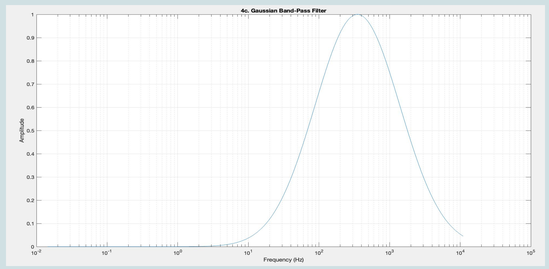
- Gaussian Amplitude Modeling: Using a Gaussian function as an amplitude window to modulate the volume of each note in the sequence

- Equal-Temperament Octave Chords: Generating sinusoidal waveforms for all notes from A0 to A*b*9, organizing them into octave spaced chords

- Fourier Domain Multiplication:

Results:





Demo Audio Files:

"Cs.wav"
"sequence.wav"
"filtered_sequence.wav"
"chromatic.wav"
"filtered_chrom.wav"

Frequency Response: Hearing Test

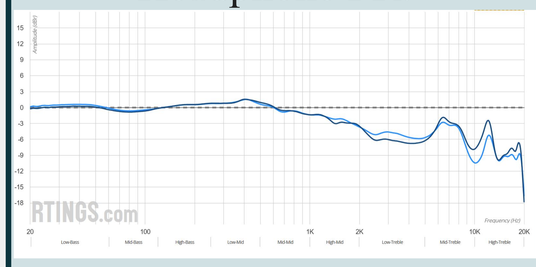
Background:

The goal of the hearing test was to represent a person's hearing as a frequency response plot.

To do this, we vary the amplitude for a set frequency signal until the user indicates that the hearing threshold has been reached. Then we plot the hearing threshold amplitude vs frequency.

```
tt = 0:1/samplingRate:duration;
xx = amplitude * cos(2 * pi * frequency * tt);
```

Headphone FR:



Apple Airpods Pro 2nd Gen.

https://www.rtings.com/headphones/1-8/graph/25486/sound-profile/apple-airpods-pro-2nd-generation-truly-wireless/29490

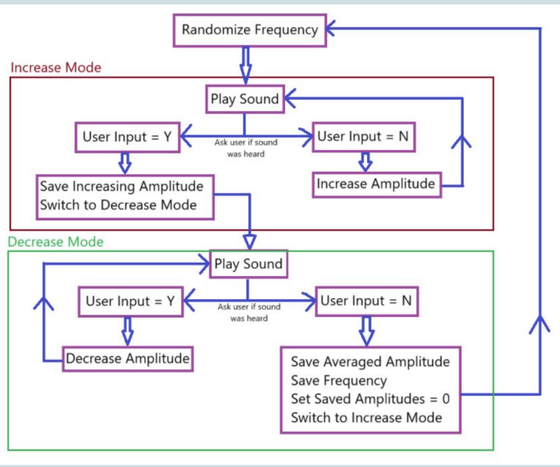
Methodology:

- Determine sample rate, duration, frequency range, and initial amplitude

- Design Hearing Test

- Convert the amplitudes to dB

- Determine offset threshold



Results: