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Digital Signals Processing

Lab 8 Perfect Pitch

Code

import numpy as np

import matplotlib.pyplot as plt

from scipy.fftpack import fft

from scipy.io import wavfile

def analyzeWave(wave):

# Read in the input audio file.

# fs = Frequency Sample in samples per second.

# data = The data from the wave.

fs, data = wavfile.read(wave)

# Find the total time of the wave file.

# t = nT

total\_time = len(data)/fs

print(total\_time)

# Take the Fast Fourier Transform of the data.

fftOut = fft(data)

# Make a list of sample indices.

n = np.arange(len(data))

# T = the duration of time between samples.

T = 1/total\_time

# Multiplying the sample frequency by every data sample.

freqLabel = T \* n

# Plot the data.

plt.plot(freqLabel, abs(fftOut))

# Format the title and axis.

title = 'Piano Note Analysis ' + wave

plt.title(title)

plt.xlabel('Frequency (Hz)')

plt.ylabel('Amlpitude')

# Highest note on a piano

highestNote = 4186.01

min = 0

max = highestNote

# Set the limits of the x axis to be from 0 to the highest possible piano note in Hz.

plt.xlim((min, max))

# Show the plot.

plt.show()

if \_\_name\_\_ == "\_\_main\_\_":

analyzeWave('hkp.wav')

analyzeWave('kpt.wav')

Question 1

Let’s establish a function.

We want to find t which is the total time of the system

We are given n which is the number of samples in the system, just a number.

We are given the sample frequency is the inverse of the sample time between each sample.

The variable T is defined in units of Hz

1/Hz = 1 second.

The variable total time is therefore in units of Hz.

Question 2

I zoomed in the plot to get a real close look at the first three largest amplitudes.

A screenshot of a social media post

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I estimate the first three notes for ‘hkp.wav’ to be:

G4 at 392.00 Hz

A4# at 466.16 Hz

D5# at 622.25 Hz

I zoomed in the plot to get a real close look at thre first thee largest aplitudes.

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I estimate the first three notes for ‘kpt.wav’ to be:

A3# at 233.08 Hz

D4# at 311.13 Hz

G4 at 392.00 Hz

Question 3

From this video for hkp.wav: <https://www.youtube.com/watch?v=AcFOKiHaNm4>

You press keys:

G4 at 392.00 Hz

A4# at 466.16 Hz

D5# at 622.25 Hz

And those frequencies match up with the frequencies I chose for part one of question 2.

From this video for kpt.wav: <https://www.youtube.com/watch?v=D2AfkmCnqgY>

You press keys:

A3# at 233.08 Hz

D4# at 311.13 Hz

G4 at 392.00 Hz

This checks out because the first note A3# is pressed with your thumb, and the human thumb is one of the strongest hand appendages. Being that the thumb is strong, it allows for more control and force to be applied to the key; this makes sense that a piano key pressed with a thumb will exhibit a larger amplitude than the other keys.

The next key pressed is D4# with the middle finger, there is decent control and power exhorted with the middle finger. Allowing for a high amplitude to emit from the piano key.

Lastly, the key G4 is pressed with the pinky finger. The pinky finger is the least used finger and has a diminished range of motion. It only makes sense that the pinky finger will not be able to exhort the same amount of force on a piano key in opposition to a thumb. Therefore, with less force, the amplitude of the piano key pressed will be much smaller than the other two keys.

Full Plots

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