8.3.1: Fourier Analysis of Microphone Data

This is not a simulation but rather software for an alternative version of the Mini-lab on sound analysis using Audacity in the Video/audio examples of the previous section.

The software records the sound from the microphone of a computer or mobile device and displays its amplitude (bottom graph) and frequency (top graph) as calculated by a Fast Fourier Transform (FFT) algorithm. The recording length can be varied by changing the number of data points. However, the number of data points must be a power of two for the algorithm to work. The total range of frequencies is from $20\ \mathrm{Hz}$ to $20\ \mathrm{kHz}$. The minimum and maximum values displayed on the frequency graph can be adjusted to see a more narrow range of frequencies.

Note

The Microphone Sound Analyzer was developed using the Easy JavaScript Simulations (EjS) version 5.3 and is distributed as a ready-to-run html page and requires only a browser with JavaScript support. This model runs on all platforms, including mobile devices, that support the w3C Media Devices API.

https://developer.mozilla.org/en-US/docs/Web/API/MediaDevices

Simulation Questions:

Instructions: When the web page loads the software will ask for access to the device microphone. Click 'allow'. Make some sound (sing, talk, whistle) and click the play button to see the software at work. A second click on the play button will capture a segment of data.

1. Capture a sound sample while whistling a single note (or use a tuning fork if you have one). Describe the waveform of the amplitude (bottom graph) of this sound.
2. The bottom graph is an amplitude versus time (in milliseconds) graph. Click the 'measure' checkbox. Adjust the bars to measure the period of the wave (it is more accurate to measure the period of several waves and divide by the number of waves to get the period of one wave). What is this whistle's period in seconds?
3. Use the 'peaks' checkbox to find the main frequency of your whistle (upper graph). What is the frequency? (Note: You may notice two peaks in this part. Try taking a sound sample while blowing through your lips without making a whistle. Can you now explain what the lower peak is showing?)
4. Divide the period of the wave into one to get the frequency (change to seconds first). Does the frequency as calculated from the period match the frequency (in Hz) on the top graph?
5. Now capture a sound of your voice or a musical instrument playing the same tone as your whistle. What is different about the two graphs from those of a whistle or tuning fork? What is similar?
6. Use the peak checkbox and the period on the lower graph to compare the highest frequency shown in the top graph. How do they compare?
7. The lower frequency peaks are overtones. Are they harmonic? How do you know?
8. Now have a lab partner sing the same note (or use a different instrument). How does their waveform and frequency spectrum differ from yours?
9. Suppose a clarinet and a trumpet both play the same note (have the same fundamental frequency). What would be different and what would be the same for the set of graphs for each. Why is it that you can still tell them apart, even though they are playing the same note?
10. Write a brief definition of each of the following: Fourier Analysis, Fourier Synthesis, spectrogram, harmonics, overtones, timbre.