Lab C8: Musical Instruments: harmonics and wave shapes

May 19, 2002

Cutnell & Johnson reading: 17(7)

1) Use the Lab Pro/Logger Pro setup as you did in lab C6, Part 5
[close the window that opens; then select File → Probes and Sensors → Microphone → fft]
(in Setup, Mode = Real Time Collect; for Sampling, select 0.1 second for experiment length and the sampling rate should be as large as possible: use the mouse to drag the bar as far to the right as possible; in Triggering, make sure that the Enable Triggering box is NOT checked).
[for the horizontal scale on the bottom FFT graph, we suggest a frequency range from 0 Hz to 1500 Hz or 2000 Hz, but you may have to modify this, particularly for higher frequency notes.
{for the horizontal scale on the upper FFT graph, we suggest a time range from 0 to 0.5 sec to see the wave shape best]

Remember that the Lab Pro will likely produce 60 Hz frequencies (and a higher harmonic or 2; continue to ignore these). In this part, you will want your note to be fairly loud to drown out the 60 Hz stuff.

2)) a) The flute sound generally produces the sound closest to a pure fundamental tone; however, it is likely that some higher harmonics (but of much lower amplitude) are included. Play a flute note (let's say A) from the Casio.

b) The bottom part of the screen will display a graph of relative amplitude vs. frequency analogous to Cutnell and Johnson's figure 17.30, far left, except your graph plots frequency horizontally instead of harmonic number; however, given the fundamental frequency of your flute note, you should be able to determine the higher harmonic numbers easily.

c) use the Examine icon to easily read amplitude and frequency values on the bottom fft graph

d) What did the flute sound produce? Mostly fundamental and just a bit of the higher harmonics or ??? You can record your observations in the form of the fft graph at bottom.

e) the top graph shows the actual wave shape of the sound; if the sound were a pure tone (i.e., a single frequency) than the top graph would display a perfect sine wave. Is the shape a pure sine wave for flute notes?

f) Now play the same note using the trumpet sound. How does the amplitude-vs-harmonic number compare to the flute note?
Did the fundamental still produce the greatest amplitude? If not, which harmonic did?
How does the wave shape compare to the nearly pure sine wave shape of the flute?

3) Exploring Real instruments (aka Music Appreciation):
Try various other sound devices (the Casio keyboard instruments, tuning forks, pop bottles, the human voice, instruments brought be other students, etc.). Use the following questions as a guide in your exploration.

a) Does the relative percentage of various harmonics from your instrument change with loudness? with the note played? How does a real flute (or trumpet) note compare to the synthetic note?

b) Are the harmonics always integral multiples of the fundamental? exceptions?

c) What instruments have pure or nearly pure tones (i.e., that of a single frequency)? Which have complex (many harmonics) tones? What properties of the instrument might determine simplicity or complexity in wave shape/tone?