Math 320 Programming Project V - Fall 2018

Plucked String Filter

Please submit all project parts on the Moodle page for MAT220. You should include all necessary files to recompile, and a working executable, all in a zipped folder (one file for upload). Time-stamp determines the submit time, due by midnight on the due-date.

Due: Monday, Dec 3

Programs should compile under g++, so no Windows specific code is allowed.

1. Implement the plucked string filter in Chapter 6, which consists of the three filters combined in figure 8.1 on page 119. Call the program pluck.cpp. The output should be a wave file which plays a major scale starting on an input frequency that is entered at the command line. Each note should start on one second intervals, for a total length of eight seconds.
2. Notes:
   (a) Generate a mono wave file at sample rate 44100 Hz. The header can be borrowed from another wave file and can be modified with Hanson's struct given on the web site. The main modification to the header is to assign the correct data size before writing the output to file.
   (b) Test output uses constant $R = 0.99985$, and 100 random samples at the start of each note in the range from -15000 to 15000. With these intial inputs it should not be necessary to normalize the data.
   (c) Other test data: For frequency 440 we get $D = 100.23$, $L = 99$, $\delta = .727$, and $a = .158$.
   (d) For the delay loop of length L in the filter, you should use a queue. Simplest to use the standard queue from STL. Start by pushing L zeros into the queue and then push each output back into the queue while the filter is running. These are multiplied by R^L and added to the input before going into the first lowpass filter.
   (e) The allpass filter coefficient a is calculated before each second of data is produced.
   (f) After each second of data is written, the frequency should be advanced by a semitone, so multiplied by $2^{1/12}$. In two cases, between the third and fourth frequencies and between the seventh and eighth frequencies, the semitone step is all that is needed. In the other steps of the scale you need a whole step (two semitones), so multiply by $2^{1/12}$ once more. This gives the pattern of the major scale with starting frequency F Hz:

$$F \longrightarrow 2^{\frac{2}{12}}F \longrightarrow 2^{\frac{4}{12}}F \longrightarrow 2^{\frac{5}{12}}F \longrightarrow 2^{\frac{7}{12}}F \longrightarrow 2^{\frac{9}{12}}F \longrightarrow 2^{\frac{11}{12}}F \longrightarrow 2^{\frac{12}{12}}F = 2F.$$