Lab 5 - Synthesizer

ECSE 324 - Computer Organization

Fall 2017

Introduction

In this lab, you will combine the low-level ARM programming techniques you have acquired in the course by implementing a musical synthesizer (or "synth").

1 Make Waves

We are providing you with drivers for writing to the audio codec, as well as a ".s" file with a wavetable containing one period of a 1 Hz sine wave at a sampling frequency of 48000 Hz.

To play a note with frequency f using the wavetable, generate a signal using the following equations for every sampling instant t:

$$\text{index} = (f * t) \bmod 48000,$$

$$\text{signal}[t] = \text{amplitude} * \text{table}[\text{index}].$$

If more than one note is played at the same time, compute the sample for each note and add them together. If the index is not an integer, you can calculate table[index] by linear interpolation using the two nearest samples. For example, table[10.73] := (1-0.73)*table[10] + 0.73*table[11].

You should write a function which takes as input f and t and returns signal[t]. Use a timer to feed the generated samples to the audio codec periodically.

2 Control Waves

It should be possible for the user to play the synth using a PS/2 keyboard. Table 1 shows the notes your synth should play, the key of the PS/2 keyboard each note should map to, and the frequency of the note in Hz. You should also implement a volume control with the keyboard so that the user can turn the volume (amplitude) up or down. This is the minimum functionality you must implement; you can also implement other notes and features, such as different voices.

3 Display Waves

In addition to playing the waveform, you should display the waveform on the lab computer monitor, as in Figure 1.

Table 1: Note Mapping

Note	Key	Frequency
C	A	130.813 Hz
D	S	146.832 Hz
E	D	164.814 Hz
F	F	174.614 Hz
G	J	195.998 Hz
A	K	220.000 Hz
B	L	246.942 Hz
C	;	261.626 Hz

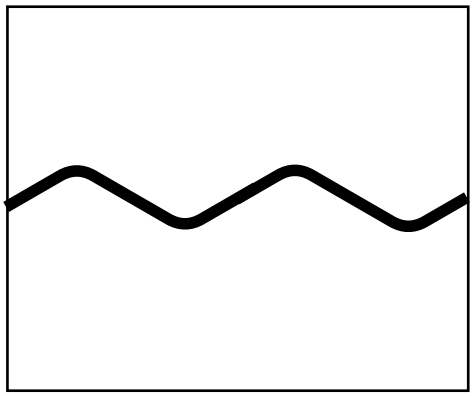

Figure 1: Waveform display for a single note

4 Presentation

Prepare a 10-minute presentation for the TAs and course instructor describing your synth, its software architecture, the problems you encountered during the design process, and the solutions you developed for those problems.

5 Grading

You will be evaluated according to the following criteria:

- Audio sounds correct (12.5%)
- Note control works (12.5%)
- Volume control works (12.5%)
- Display works (12.5%)
- Does the code follow good software development principles (style, efficiency, clear commenting, appropriate use of source files, code reuse, etc.)? (25%)
- Presentation quality (25%)

The final date for demoing and submitting the final report is on the last day of classes, **6th December 2017**. A demo timetable and guidelines for submitting the report will be posted on MyCourses.