

# Lab 5 - Synthesizer

ECSE 324 - Computer Organization

Winter 2018

## 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  $t$ :

$$\begin{aligned}\text{index} &= (f * t) \bmod 48000, \\ \text{signal}[t] &= \text{amplitude} * \text{table}[\text{index}].\end{aligned}$$

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  $\text{table}[\text{index}]$  by linear interpolation using the two nearest samples. For example,  $\text{table}[10.73] := (1-0.73)*\text{table}[10] + 0.73*\text{table}[11]$ .

You should write a function which takes as input  $f$  and  $t$  and returns  $\text{signal}[t]$ . 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

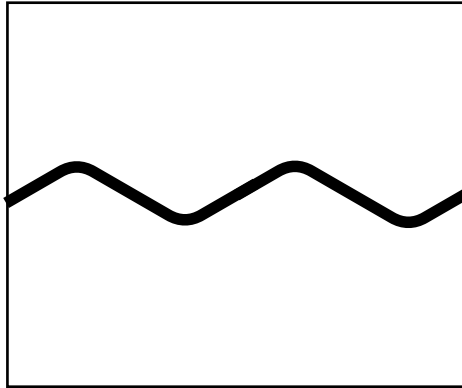


Figure 1: Waveform display for a single note

## 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, **16th April 2018**. A demo timetable and guidelines for submitting the report will be posted on MyCourses.