PRINCIPLES AND APPLICATION OF MICROCONTROLLERS
Arduino Lab1: Electronic Piano

Introduction

In this lab, you are required to design and build a digital piano using an Arduino MCU. The piano you are required to build will only use a small subset of keys. Each key is associated with a frequency corresponding to a unique musical tone. The musical tones are digitally produced using the Arduino and a buzzer. The piano should play a tone as long as the corresponding key is pressed. After completing this lab you should be able to:

- Master in simple circuit interfacing
- Implement buzzers

Parts List

- A breadboard
- An Arduino Uno MCU
- Resistors
- A buzzer
- Buttons

Musical Note

A musical note, or a pitch, is a waveform at a certain frequency. The waveforms are at different frequencies. This gives each note a distinctive sound. Tone waveforms are sinusoidal and sound smooth and clear. However, sinusoidal waveforms are complex to generate. In this project, we will use square waveforms, which are much easier to implement even though their sound is not as good as sinusoidal waveforms.

The piano you are asked to build will have 7 keys (Fig. 1). Each key is associated with a musical note listed in Table 1. The piano generates a square wave at the specific frequency when the corresponding key is pressed. For example, the piano generates a square wave at a frequency of 261.63 Hz when the key C is pressed. Since period is the inverse of frequency, the cycle duration of the signal is 3.816 ms. In a cycle, the signal connected to the buzzer system is ON for 1.908 ms then is OFF for 1.908 ms and so on. This applies to all piano keys, only the frequencies change.

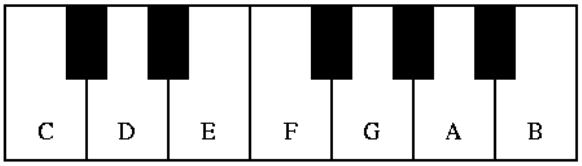

Figure 1: Piano keys

Table 1: Musical note frequency

Note	Frequency (Hz)
C	261.63
D	293.66
E	329.63
F	349.23
G	392
A	440
B	493.88

Procedure

We will use pin 3 as the output to the buzzer. Connect pin 3 to a buzzer as shown in Fig. 2. Pin 2 and pins Analog0 to Analog5 are used as the inputs from the keyboard. The keyboard is composed of several keys (switches). Connect the switches as shown in Fig. 2. Write an Arduino program that plays a musical tone through the buzzer when a key is pressed.

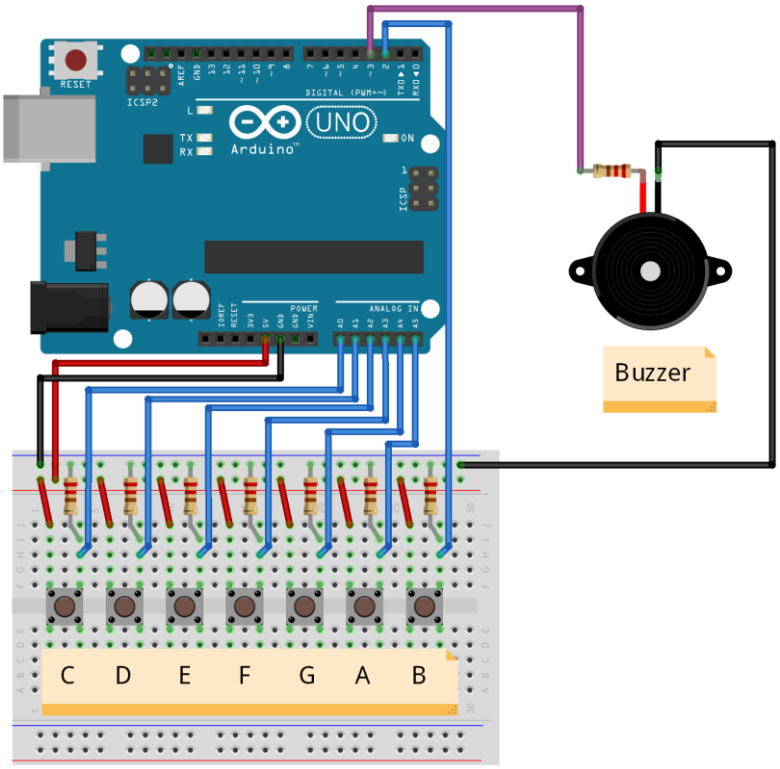

Figure 2: Circuit of the electronic piano

Deliverables

Basic points (80%):

Use your piano to play the song “twinkle twinkle little star”. Demo the result to the TAs, or record it in a video. Upload the followings to ceiba: 1) your Arduino scratch, 2) a photo of your physical circuit, and 3) contributions from each teammate to the lab. The contributions must include the information of the tasks each teammate has done and the contributions in percentage. The total percentage should be 100%. All the teammates have to agree with the contributions before they are uploaded.

Advanced points (20%):

Write a program that plays the song “twinkle twinkle little star” automatically.