

CAB202 Microcontroller Assignment

Mini Piano with preset songs

TinkerCad: <https://www.tinkercad.com/things/fhi08I2Eu17-assignment/editel?sharecode=Ha9uqliN3zWpFb5jJ4hnQdmV9jn-fYQVeHCTZS37V44>

Video Demo: <https://youtu.be/7Ob7DgS5xW8>

1. Introduction

1.1. Application

The project is an electronic keyboard with 7 key notes C4/D4/E4/F4/G4/A4/B4 and an addition button used to select preset songs. There are 2 LCD implemented in the project: one is utilized to display menu of presets song and another one is used to display history of note pressed by users. There is also a potentiometer used as a volume controller and a button to reset the key notes history displayed in second LCD. The application is suitable to help people (especially children) get accustomed to performing music and start learning piano from scratch. Users can also keep track what notes they have played to review and improve their performance.

1.2. Components

Components	Quantity	Functionality
Arduino Uno	2	Note History Controller and Music Controller
16x2 LCD	2	Display menu and key notes history
Switch	9	Play note, control menu, clear notes history
Piezo	1	Create Sound
LED	1	Signify if key notes are disabled or not
Potentiometer	1	Adjust the piezo duty cycle (volume)
220 Ohm Resistor	3	

1.3 Learning Outcomes

a) Digital I/O – switch:

The project uses Digital Input for all nine switches. 7 switches are used to play key notes from C4 to B4. One switch is used to display menu button. The keyboard starts with the LRD turned off and 7 piano keys are active. When the menu button is pushed, the LED will turn on to indicate all piano keys are disabled and user is in “menu mode”.

In “menu mode”, user can cycle through preset songs by pressing menu button and select a song to start playing by pressing any of the piano keys. Now, the title of the song is currently playing is shown in the first LCD screen. Once the song has finished playing, user can replay, select another song or exit “menu mode” to play music.

When user is not in “menu mode”, if they press any piano keys, the first Arduino will transfer data via UART to the second and display key notes in the other LCD screen. User can also clear LCD screen displaying key notes history by pressing reset button

b) Digital I/O – interrupt-based debouncing:

Menu button and reset button are implemented with interrupt-based debouncing with Timer 2 similar to Topic 9 AMS exercise 3.

c) Digital I/O – LED:

The LED uses Digital Output to indicate if user is currently in “menu mode” or not.

d) Analog Input:

The Music Controller reads the analog input from the Potentiometer to adjust the duty cycle (volume) of the piezo.

e) Analog output (PWM):

Piezo: The Music Controller uses Timer 0 (Fast PWN mode) to generate for specific notes for the Piezo.

f) Serial Communication:

The Note History Controller and Music Controller communicate using serial communication. They send note symbols to display on the second LCD.

From Locker to Controller

Note	Note symbol
C4	'C'

D4	'D'
E4	'E'
F4	'F'
G4	'G'
A4	'A'
B4	'B'

g) LCD:

The first LCD used in Music Controller is responsible for display menu and preset songs information.

The second LCD used in **Note History** Controller is responsible for display note history.

i) Timers:

The **Note History** Controller uses Timer 1 to count the amount of time the system is in the Waiting state. For example, when the **Note History** Controller does not receive any data from Music Controller, it will be in the Waiting state until it receives any character. Timer 1 with an overflow period of approximately 1 second will start counting. If the **Note History** Controller is waiting for 5 seconds, it will automatically clear the note history in the second LCD.

2. Wiring Instructions

2.1 The Music Controller

a) Switches

All 7 piano switches are placed next to each other in the breadboard of Music Controller, connect the Terminal 1b of each switch to the ground, connect the Terminal 2b of each switch to the Arduino Uno Music Controller as followed

Terminal 2b of switch	Arduino Pin
C4	2
D4	3
E4	4

F4	5
G4	6
A4	7
B4	8

Menu switch is also placed in the breadboard of Music Controller under 7 piano switches. Connect Terminal 1a of menu switch to the ground, connect Terminal 2b of menu switch to Arduino Music Controller Pin 10.

b) LCD

For both 2 LCD, GND, VD, RW, LED Cathode are connected directly to the ground.

Connect the VCC to 5V power. Connect LED Anode to one end of a 220 Ohm resistor, connect the other end to the 5V Power.

Since we are using 4-bit transmission mode, only 4 data pins are needed: DB4, DB5, DB6, DB7.

LCD1 in Music Controller:

LCD Pins	Arduino Music Controller Pins
RS	11
E	A1
DB4	A2
DB5	A3
DB6	A4
DB7	A5

d) Serial Communication

Connect pin 1 of the Music Controller Arduino to pin 0 of the Note History Controller Arduino.

Connect pin 0 of the Note History Controller Arduino to pin 1 of the Music Controller Arduino.

e) LED

LED is placed on the breadboard. Connect Cathode of the LED to one end of a distinct 220 Ohm resistor, connect the other end to the ground. Connect Anode to the Arduino Music Controller pin 12.

f) Piezo

Place the Piezo on the breadboard, connect the positive pin of the piezo to the Ground. Connect negative to Arduino Music Controller pin 12.

g) Potentiometer

Place the potentiometer on the breadboard, connect Terminal 1 of the Potentiometer to the 5V Power, connect the other Terminal 2 to Ground. Connect the Wiper of the potentiometer to Arduino pin A0.

2.2 The Note History Controller

a) Reset switch

Reset switch is placed in the breadboard of Note History Controller. Connect Terminal 2b of reset switch to the ground, connect Terminal 1b of reset switch to Arduino Note History Controller Pin 3.

b) LCD

For both 2 LCD, GND, VD, RW, LED Cathode are connected directly to the ground.

Connect the VCC to 5V power. Connect LED Anode to one end of a 220 Ohm resistor, connect the other end to the 5V Power.

Since we are using 4-bit transmission mode, only 4 data pins are needed: DB4, DB5, DB6, DB7.

LCD2 in Note History Controller:

LCD Pins	Arduino Note History Controller Pins
RS	A0
E	A1
DB4	A2
DB5	A3

DB6	A4
DB7	A5

3. Schematic diagram

