

Music Box

project documentation & overview

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Summer 2017

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1 Introduction

This document provides an overview for a proof of concept/rough prototype of a music box. It describes both hardware and software aspects of the project.

Functionality can definitely be optimized through future iterations as the current project is still very basic – as of writing, only the audio playback capability can be accessed. Part of this is owing to the limited programming knowledge of the author, and the other part to the ever developing library being used. Suggestions and resources are provided for more advanced software development.

If available, supplementary information – such as component part numbers, vendors, and links – are provided and can be found by following the in-document numeric links.

2 Hardware

2.1 Description of Parts Used

- (x1) 3D printed enclosure[1]

A 65x65x65mm cube with four circular cut-outs for the speaker, the microphone, the indicator LED, and the play/stop/record button. For prototyping and testing purposes, the back face of the enclosure is missing. This facilitates access to the electronic components inside. The enclosure was designed in Sketchup and printed on a Maker-Bot 3D printer. Select dimensions can be found in the Sketchup (.spk) file, but may not precisely correspond with actual measurements, as plastic shrinks when it solidifies.

- (x1) Arduino Pro Mini microcontroller - 3.3V | 8MHz model[2]

Acts as the brains of the project. I/O is controlled here.

- (multiple) 0.100-inch pitch, straight breakaway male connector headers[3]

Row of pins that can be soldered on to help with connecting adapter boards to solderless breadboards or prototyping boards.

- (x1) FTDI USB-TTL serial cable - 3.3V option[4]

Cable is required to upload program from computer to Pro Mini. Acts as a virtual serial port, which is needed to program the microcontroller. Driver installation may be necessary. **NOTE:** When connecting to program the Pro Mini, make sure that the voltage from the cable (red wire) is connected to the RAW pin on the board. The reason for this is because the voltage from the cable is the same as is supplied from the PC (5V DC), it cannot be used to directly power the Pro Mini on the VCC pin. Doing so may cause damage. Connecting the 5V to the RAW pin ensures that the voltage is regulated and stepped down to 3.3V.

- (x1) SD card

Used to store recorded audio files and shoulder some of the program weight using the SD FAT library. The one provided is a 4GB, Class 4 SD card operating on a FAT32 file system.

- (x1) Sparkfun SD card breakout board[5]

Provides access to SD card pins and interfaces Pro Mini and SD card.

- (x1) tactile switch[6]

Sole control point for user. Accesses play and stop functions. (Will also trigger recording function in later development.)

- (x1) 5mm green LED

Lights up as an indication to the user that audio is playing.

- (x2) 220Ω resistor

Through-hole resistor for switch circuitry and LED.

- (x1) 8Ω , 5W speaker

Audio output from SD card files.

- (x1) LiPo rechargeable battery[7]

3.7V rechargeable lithium polymer battery. Connects to setup via wires leading to RAW and GND pins on the Arduino Pro Mini.

- (x1) LiPo charger[8]

Charging circuit for battery. Micro-USB cable for charging phones can be used to power board from computer.

- wire

Used to make connections between components.

2.2 Connections

The connections between components are described below.

- Battery

positive (red wire).....Arduino Pro Mini – **RAW pin**

negative (black wire).....Arduino Pro Mini – **a GND pin**

- LED

anode + a 220Ω resistor.....Arduino Pro Mini – **pin 7**

cathode (side with flat edge).....Arduino Pro Mini – **a GND pin**

- Microphone

positive (red wire).....Arduino Pro Mini – **pin A0**

negative (black wire).....Arduino Pro Mini – **a GND pin**

- SD Card Breakout

D3.....Arduino Pro Mini – **pin 8**

CMD.....Arduino Pro Mini – **pin 11**

CLK.....Arduino Pro Mini – **pin 13**

VCC.....Arduino Pro Mini – **VCC pin**

GND.....Arduino Pro Mini – **a GND pin**

D0.....Arduino Pro Mini – **pin 12**

- Speaker

positive (red wire).....Arduino Pro Mini – **pin 9**

negative (black wire).....Arduino Pro Mini – **a GND pin**

- Switch

Pin numbering: Orient the switch so that the legs are protruding from the top and bottom sides. Disregard there being a "right-side up". The top-left leg is pin 1 and the subsequent legs are numbered in the anticlockwise direction.

pin 1.....no connections

pin 2.....Arduino Pro Mini – **VCC pin**

pin 3.....remaining 220Ω resistor + Arduino Pro Mini – **a GND pin**

pin 4....Arduino Pro Mini – **pin2**

3 Software

3.1 Libraries Used

Two libraries need to be downloaded and installed. Below are links to the relevant GitHub repositories.

TMRpcm (handles audio): <https://github.com/TMRh20/TMRpcm/wiki>

advanced features wiki for TMRpcm: <https://github.com/TMRh20/TMRpcm/wiki/Advanced-Features>

SdFat (helps handle memory and speed): <https://github.com/greiman/SdFat>

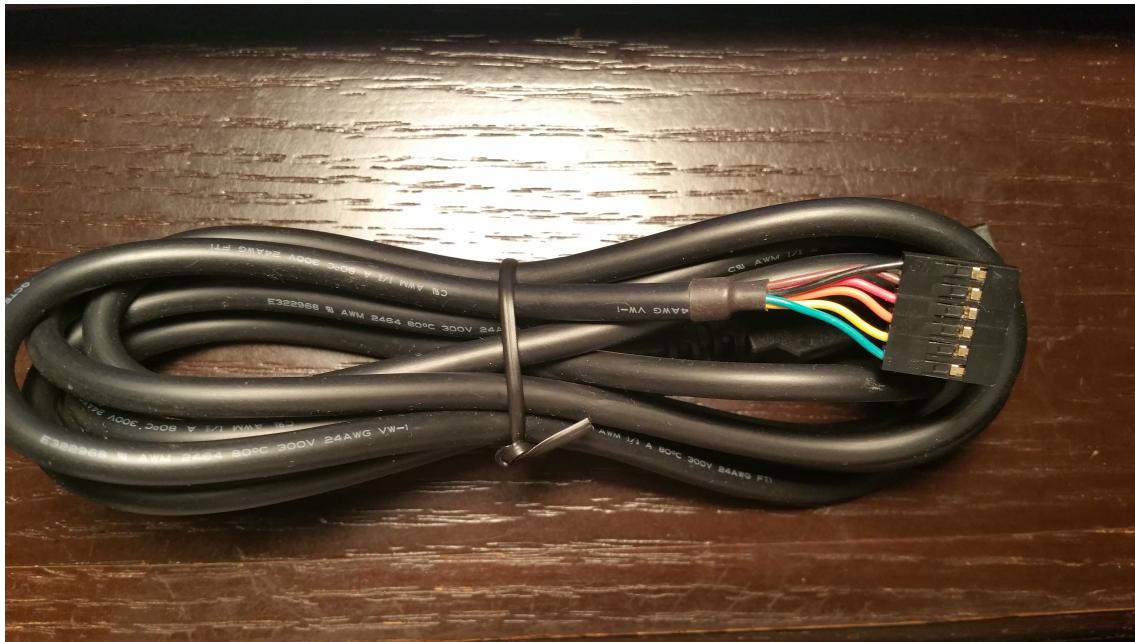
3.2 Program Description

Section to be added to in subsequent days. Please refer to annotations in code for the time being.

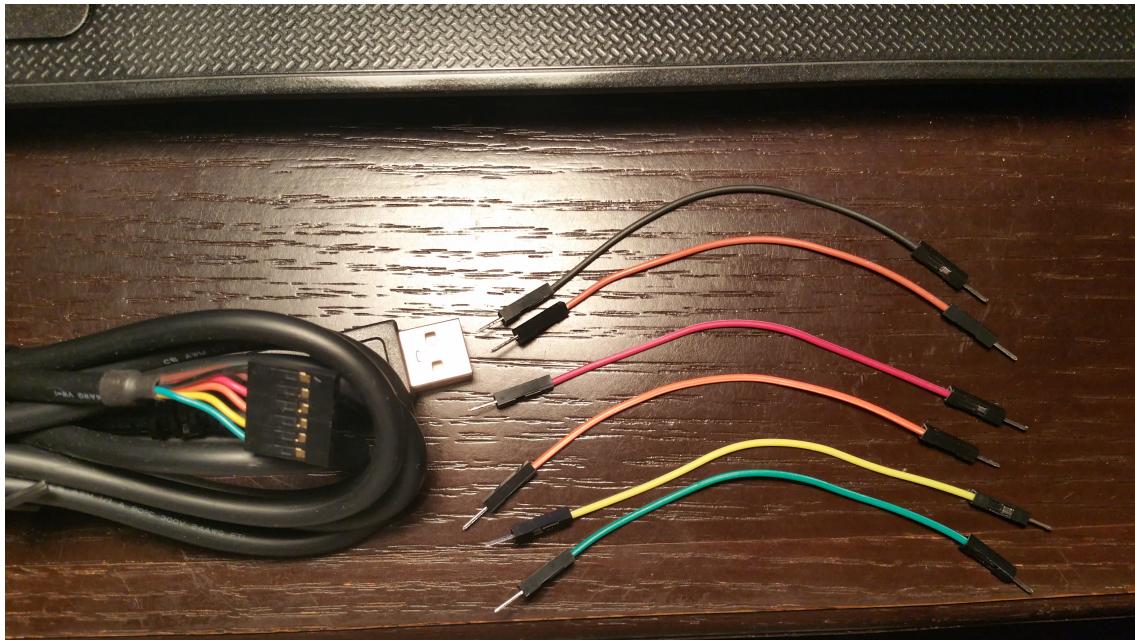
3.3 Uploading a Sketch

In order for the cable to act as a serial port, a driver may need to be downloaded[4].

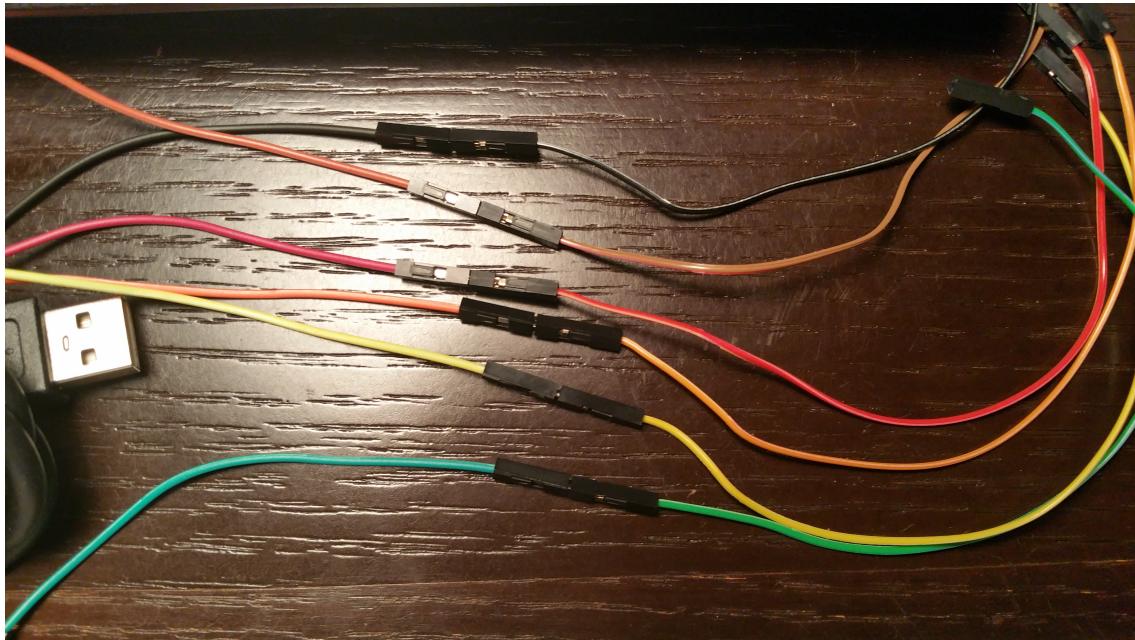
The following photographs outline the wiring necessary to upload an Arduino sketch to the Arduino Pro Mini. After wiring is complete, identify which COM port the Arduino is occupying and ensure that the information is reflected in what is displayed under **Tools > Port**. Also ensure that the board information under **Tools > Board:** and **Tools > Processor:** are correct. They should be "Arduino Pro or Pro Mini" and "ATmega328 (3.3v, 8MHz)", respectively.



FTDI chip cable. This is used to upload the Arduino sketch to the Arduino Pro Mini.



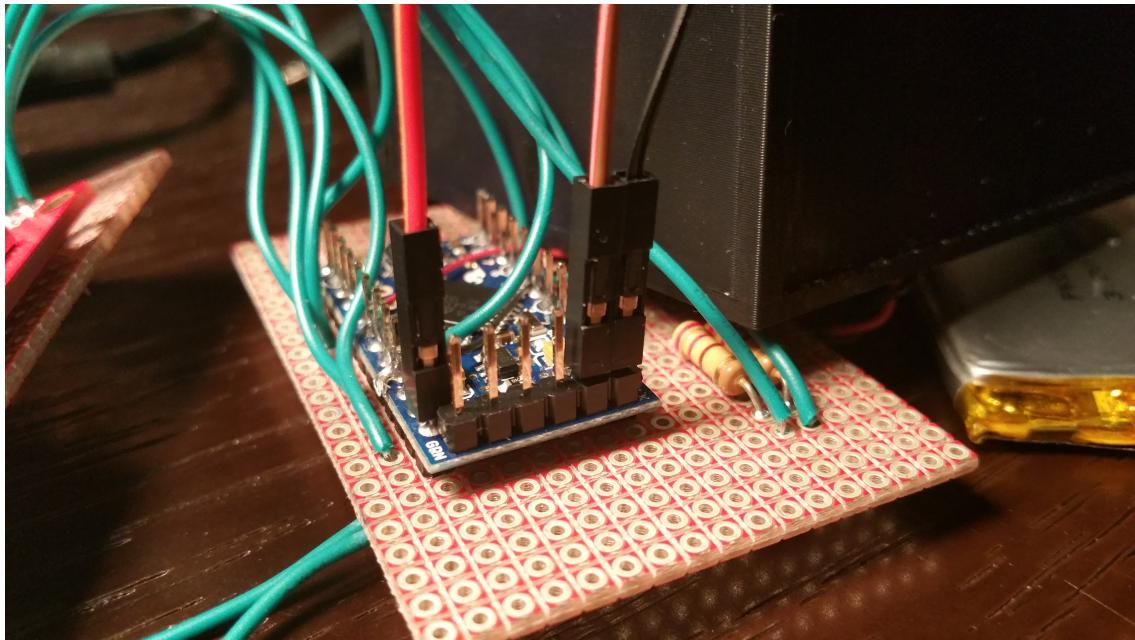
Gather six male-male jumper wires, each matching the cable's wire colours for ease of connection. These will be used to link the wires in the connector to the programming header pins on the unpowered Arduino.



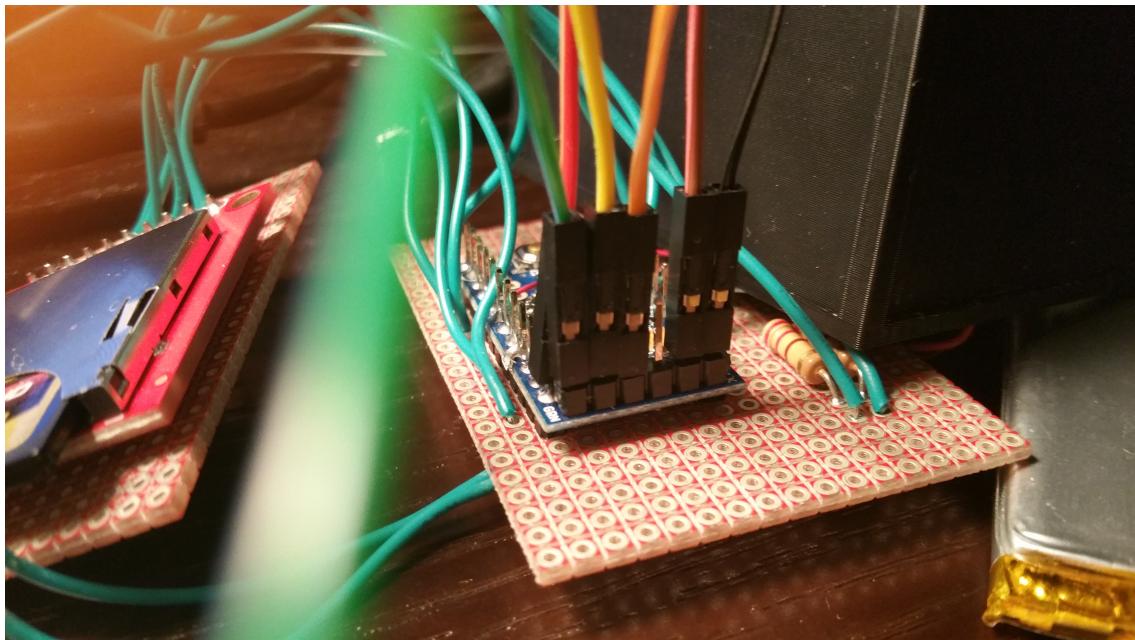
Gather an additional six female-female jumper wires of the same set of colours and connect the correspondingly coloured wires together.



Plug the male end of the wire assembly into the cable connector.



Locate the end of the programming header that is labeled **BLK**. Mate the black female jumper wire to the header pin closest to the label. Next, mate the brown jumper wire to the adjacent pin. The third wire (red) will connect to the pin labeled **RAW**. This is because the Arduino operates at 3.3V and the voltage coming from a USB port is 5V, which is too high. The **RAW** pin regulates the voltage down to 3.3V.



Mate the remaining three wires in the same order as they are arranged on the connector. Plug the USB end into a computer USB port and the wiring setup needed for programming is complete.

4 Suggestions for Further Development

Section to be expanded upon in subsequent days. Optional reading. The original plan was to incorporate a two-function button to access PLAY/STOP and RECORD features. Since only the PLAY/STOP features are currently supported, the two-functions button code has not been used in the sketch.

<http://jmsarduino.blogspot.ca/2009/05/click-for-press-and-hold-for-b.html>

Supplementary Information & Links

[1] Sketchup

<https://www.sketchup.com/3Dfor/3D-printing>

[2] Arduino Pro Mini

<https://store.arduino.cc/usa/arduino-pro-mini>

[3] Breakaway male header connectors

Manufacturer part number: PRPC040SAAN-RC

Digi-Key: <https://www.digikey.ca/products/en?keywords=s1011ec-40-nd>

[4] FTDI USB-serial cable

Manufacturer part number: TTL-232R-3V3

Digi-Key <https://www.digikey.ca/products/en?keywords=768-1015-nd>

Driver: <http://www.ftdichip.com/Drivers/VCP.htm>

[5] Sparkfun SD card breakout board

Manufacturer part number: BOB-12941

Digi-Key: <https://www.digikey.ca/products/en?keywords=1568-1284-nd>

Sparkfun: <https://www.sparkfun.com/products/12941>

SD card pin outs: http://www.interfacebus.com/Secure_Digital_Card_Pinout.html

[6] Tactile switch

Manufacturer part number: 1825910-6

Digi-Key: <https://www.digikey.ca/products/en?keywords=450-1650-nd>

[7] LiPo battery

Adafruit: <https://www.adafruit.com/product/258>

[8] LiPo charger

Manufacturer part number: PRT-11231

Sparkfun: <https://www.sparkfun.com/products/11231>