

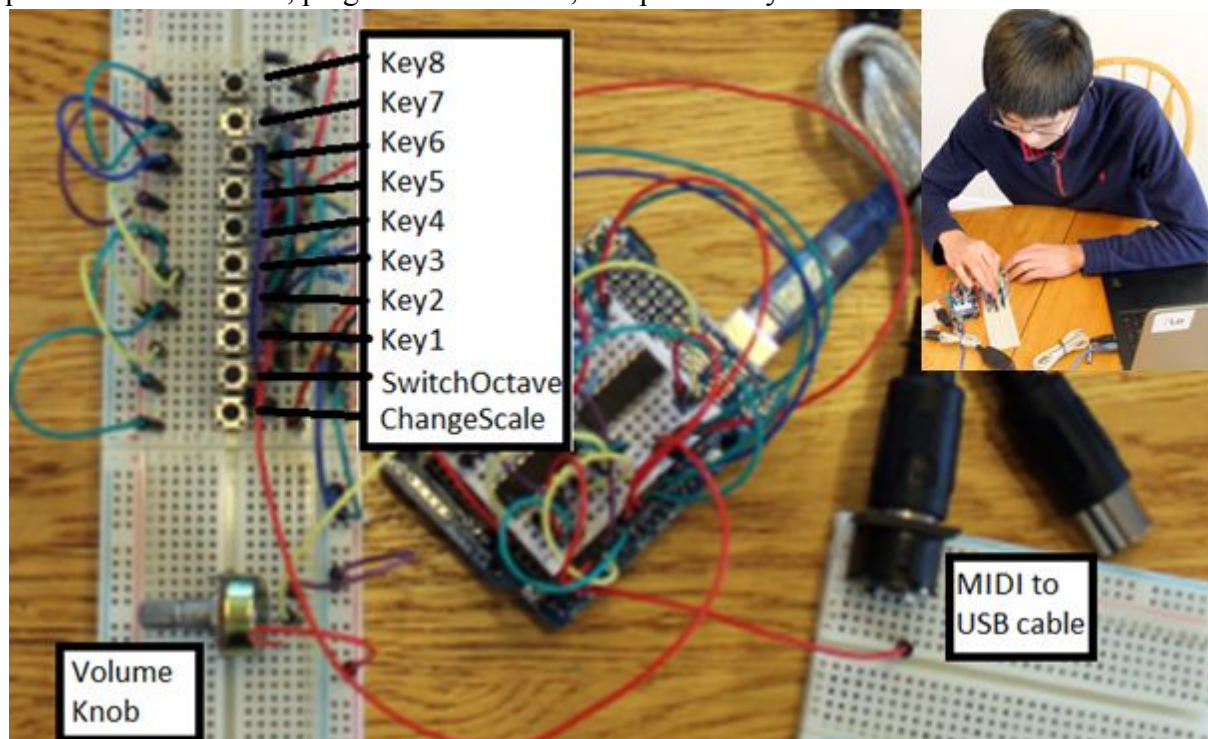
# Carnegie Mellon Supplementary Information

## Maker Project: MIDI Keyboard

This supplement will serve to concretize my interest in electronics. This project was completely self-initiated and self-directed.

### Introduction:

I've always wanted a MIDI keyboard, so I could mix my own music, as well as automatically turn what I've played into sheet music. (This project is different than my real-time Automatic Music Transcriber, a work in progress. Stay tuned!) So I made one using all ten of my buttons. The code I've written for the Arduino was able to support up to 64 buttons, so I would have made the keyboard bigger if I had more buttons. Regardless of its size, the keyboard provides enough features for the musician to play some tunes and jam. Simply power on the Arduino, plug in a MIDI cable, and press a key!



### Materials:

- 1x Arduino
- 1x MIDI to USB cable
- 1x Female MIDI jack
- 1x Potentiometer
- 10x Buttons
- 4x Diodes (generic)
- 6x Transistors acting as diodes (generic)
- 1x 74HC595 shift register
- 1x 74HCT165 shift register
- 4x 220 ohm resistor

### Features/Description:

- 8 keys. (Press a key to hear a piano note)
- 1 SwitchOctave Button. (Press this to access a higher octave. Release to access the default octave.)
- 1 ChangeScale Button. (Press this to rotate through the programmed key mappings; chromatic, pentatonic, major, and harmonic minor scales are supported.)

- 1 Volume Knob. (This changes the volume of the notes.)

### Challenges during the Completion of the Project:

#### 1. Removing the Ghosting Effect:

A problem occurred on an early version of my keyboard where the Arduino thought that some buttons were pressed when they weren't. After studying resources on the Internet, I learned that this was called ghosting, and often plagued early video game controllers, like the NES (Reference 1). The website also provided a solution: insert a diode at every input (Reference 1). However, I realized I didn't have enough diodes for all my inputs. After pondering for awhile what to do, I remembered that a transistor can be modeled as two diodes next to each other. So I used transistors as diodes for the remainder of the inputs. After that, the ghosting problem was solved!

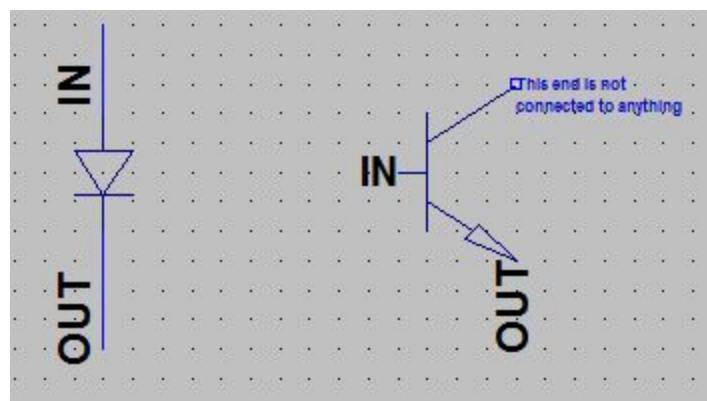


Figure 1. Regular diode to the left, a transistor acting as a diode to the right.

#### 2. Programming the Arduino:

I spent quite some time studying the datasheets of the 74HC595 and the 74HCT165 shift register chips. I then incorporated what I learned in my Arduino program.

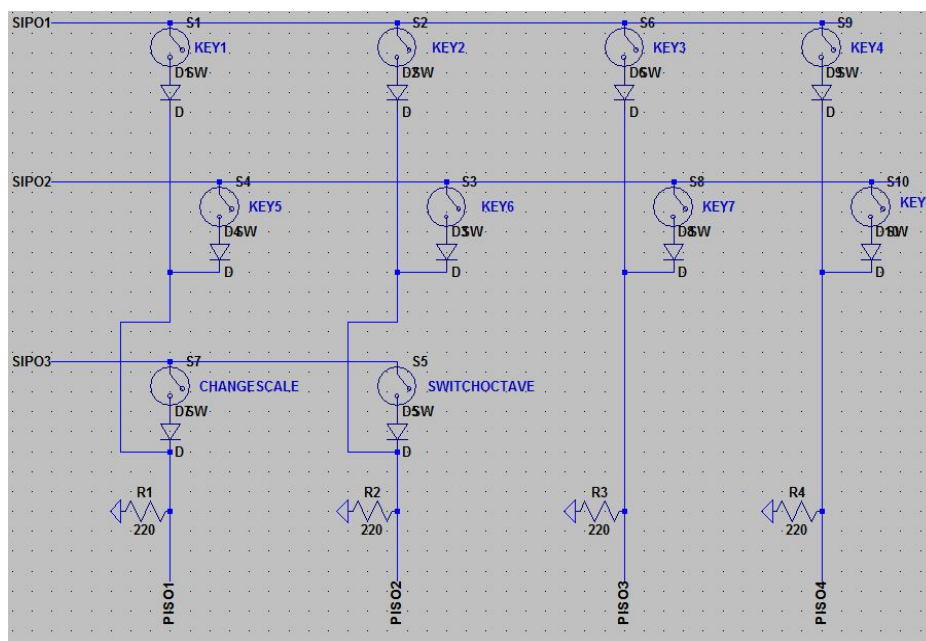


Figure 2. Schematic for Multiplexing 10 buttons, CADED with LTSpice. In the actual board, six transistors replaced six diodes.

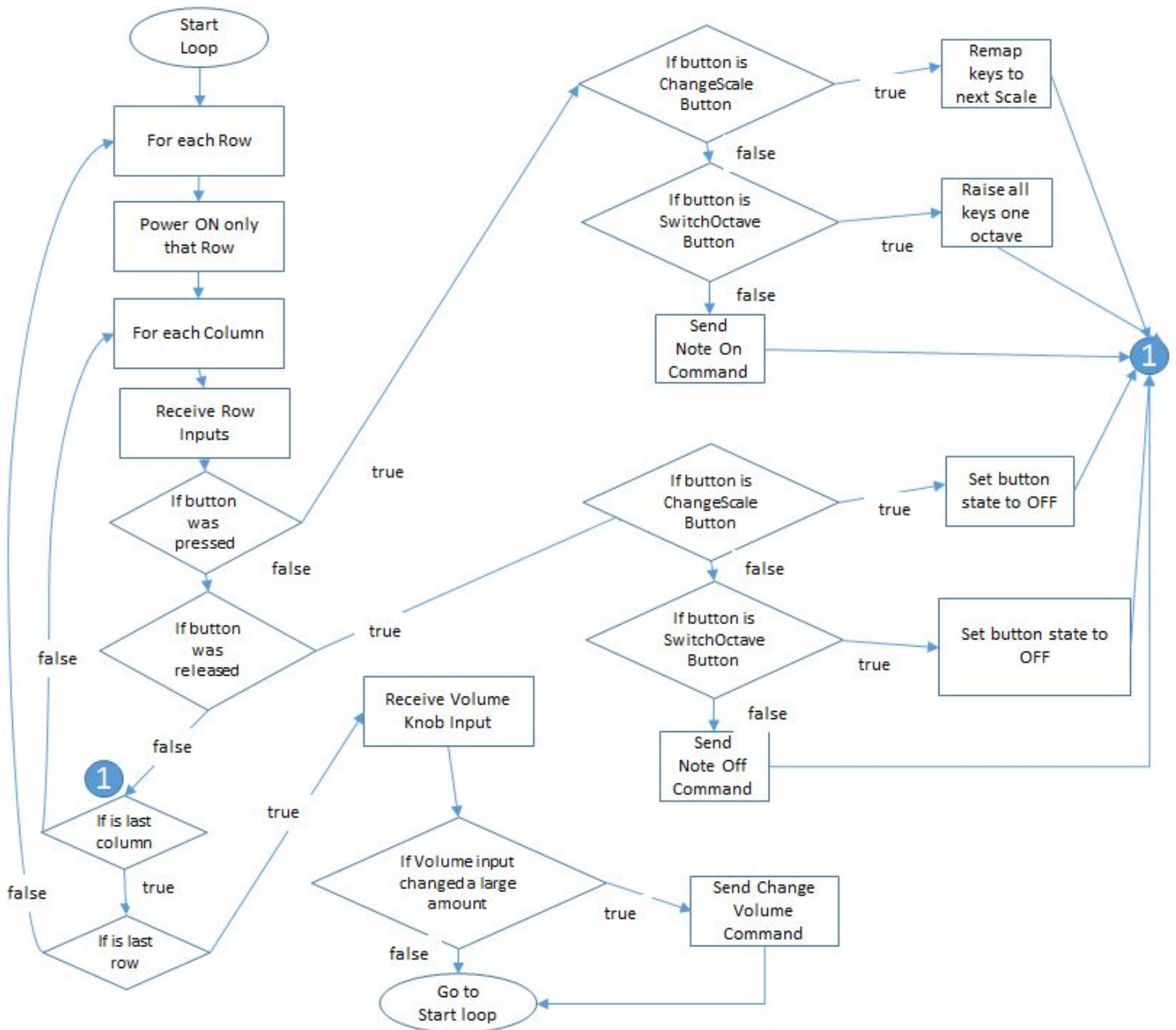


Figure 3. Flowchart of the Arduino MIDI Keyboard Program. Rows and columns correspond to the wiring schematic shown in Figure 2.

## References

1. Lazaridis, Giorgos. "How a Key Matrix Work." *How a Key Matrix Work*. PCB Heaven, 27 June 2010. Web. 01 Jan. 2017.
2. 74HCT165 Shift Register Data Sheet: [http://www.nxp.com/documents/data\\_sheet/74HC\\_HCT165.pdf](http://www.nxp.com/documents/data_sheet/74HC_HCT165.pdf)
3. 74HC595 Shift Register Data Sheet: <https://www.sparkfun.com/datasheets/IC/SN74HC595.pdf>