1. SCOPE

The objective of the STEM expo is to test a student's ability to innovate given the opportunity and resources. This engineering report is made regarding my group's entry to the STEM expo; additionally, to demonstrate the goal, procedure, and conclusion of my group's entry, "The Acoustic Gauntlet".

2. PURPOSE

The Acoustic Gauntlet is a proof of concept. The goal of the device is to provide an alternative to a real acoustic guitar, as the Acoustic Gauntlet is inexpensive, yet still retains the core functionality of a genuine guitar, being able to play most if not all songs and tunes with practice. Additionally, it demonstrates the ability to provide means of learning and entertainment to those who are incapable of playing a real guitar due to a disability or impairment through innovation of an already developed musical instrument.

3. COMPONENTS

The Acoustic Gauntlet uses two MakeyMakey's, one Raspberry Pi 3 Model B, and one usb power bank. Additionally, a pair of Spyder Chamber gloves are used, which are modified to contain silicon wire and five metal tabs on each finger, for a total of 10 metal tabs and 10 lengths of wire. The metal tabs are painted with Bare Conductive brand electric paint. On the back of the tabs, a layer of SteelStik Epoxy Putty is followed by a layer of liquid electric tape to ensure the wire does not break. The previously mentioned MakeyMakeys are adhered to the back of the gloves using hot glue. The entirety of the components is enclosed in an Apache 2800 protective case. The total cost for the entirety of the project, when purchased from a third party, is just under $120.

4. BACKGROUND

The MakeyMakey is a board capable of keyboard output through a connection from its ground wire to various pins. This, combined with the Raspberry Pi 3 Model B, means that physical actions can be recorded and translated into a digital output and subsequently interacted with in all ARMv6 programming languages. This feature is utilized in the operation of the Acoustic Gauntlet, and is core to its function.

5. PROCEDURE

The purpose of these procedures is not to document any errors during production, but to describe the process in recreating the Acoustic Gauntlet as close to the original as possible. The procedures are finished when the user is left with a device that resembles the Acoustic Guitar, is presentable, and can be used consistently without error.

Procedure: MakeyMakey reconfiguration

1. The two MakeyMakey's can be reconfigured online at makeymakey.com/remap by following onscreen directions.
    a. The Acoustic Gauntlet has been modified in the following way: the "up", "down", "left", and "right" pins have been reconfigured to the keys "q", "w", "e", and "r", respectively.
2. Remove 3 female pin headers on the board.

Procedure: Raspberry Pi 3 Model B configuration

1. Begin by installing Raspbian OS onto the Pi.
2. Create the guitar software.
    a. Keep in mind that each glove only has five fingers.
    b. Keep in mind your previous reconfiguration of the pins on MakeyMakey's.
    c. The software for the original Acoustic Gauntlet is written in Scratch 1.4, ported to Java. The software polls which fingers are being held at a rate of once every 50 milliseconds. This, combined with a system of gestures, allows for up to eight frets and six notes.
3. Once the software is completed, create a script in the Raspbian boot file that will launch the .jar file on every startup.

Procedure: Construction of the gloves

1. To begin, the metal tabs are bent approximately 25 degrees from the center, with the rough side facing inward.
2. The silicon wire is cut to about three inches longer than the distance of your glove's finger to its palm.
3. One side of the silicon wire is soldered to the back of the metal tabs.
4. Once cooled, create a service loop on the back of each tab with the wire and adhere it to the tab with the steel putty. Allow to set.
5. Following the putty, paint a layer of liquid electric tape to the back of the tab. Allow to set.
6. Create an incision on the tip of each glove's finger and route the wire through the glove to another incision at the back of the glove's palm.
7. Once all tabs are inserted, super glue the back of each tab to the tip of the each of the fingers in a comfortable position. Allow to set.
8. Solder the other side of the silicon wire to the configured MakeyMakey, making sure each finger is soldered to the appropriate pin.
    a. The Acoustic Gauntlet has been soldered in the following way: the thumb is soldered to the "GND" pin, the index finger is soldered to the "up" pin, the middle finger is

soldered to the "down" pin, the ring finger is soldered to the "left" pin, and the pinkie finger is soldered to the "right" pin.

9. After all the wires are soldered, hot glue the MakeyMakey to the back of the glove. Allow to set
10. Once set, tuck the remaining wire into the incisions.

6. RESULTS

The result of following all three procedures leaves you with a device that, if created in accordance with the Acoustic Gauntlet's original design, can produce 48 different pitches of a guitar. This is feasible through the integration of gestures, allowing up to eight frets with six different notes. This device can recreate any song that requires a maximum of eight frets. This device cannot recreate chords.

7. CONCLUSION

Given the resources and opportunity, my group was capable of producing a device that we believe is innovative and addresses a real-world issue. The Acoustic Gauntlet is relatively inexpensive, capable of recreating the experience from a genuine guitar, and 100% student-made.

8. APPENDIX

Following are various bits of information that are not appropriate for the other sections of the engineering report.

- A small delay is required in the software between the physical contact of the two tabs and the playing of the note, 0.005 seconds to be exact. This is required for seamless operation of the Acoustic Gauntlet, as otherwise, the gestures would require inhuman precision to activate.
- Each finger of the glove is color coded to prevent confusion during soldering.
- During the assembly of the glove, I ran into issues of contacting the tabs through the glove. My final solution was to add a layer liquid electric tape on the back of the tabs to avoid conductivity.
- In addition to the previous problem, a service loop was added to the back of the tabs, as the solder for the silicon wire was repeatedly tearing off. The purpose of the service loop is a backup of sorts, if a large amount of force is applied, instead of the solder breaking, the service loop breaks.
- Unintended lag will used to occur during operation of the software, this was fixed by porting the software from Scratch 1.4, over to java.
- The enclosure I used was waterproof, now it's not… because I drilled a hole in it.

- Lots of searching went into finding the right glove, more than I'd like to admit. It couldn't be stiff, but at the same time, it couldn't be too loose. It also had to have more than one layer to be able to route the silicon wire through it.
- SteelStik putty smells like sulfur when mixed and it's horrid.
- Flux smells like cinnamon when burned and is probably not good for my health.
- Admittedly, the glove could have been made to look a lot prettier, however, multiple mistakes and the fact that I had hit my budget (fancy word for no more money) meant I had to make do.
- During production, one of my MakeyMakey's had mysteriously stopped functioning, I don't know the cause, but I had jot it down as a manufactures defect. This may or not have something to do with the removal of the female headers.