Embodying Sound to Create Bodily Experiences: Discussions Regarding the Creation Process of Haptic-Freq

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ABSTARCT

This pictorial overviews the Ardunio based interactive object named Haptic-Freq. The paper provides finer details of the journey process from ideation to prototype, and finally developed artifact. I will discuss my project intention, the prototyping process which provided feedback from others, the final artifact and its ultimate outcome, my observations / experience throughout the process, and lastly explore the potential future of the project, and improvements that could be made.

DESIGN NARRATIVE

The design narrative and overall intention of Haptic-Freq was to create an interactive artifact that introduced one to the idea of physicalizing sound through the motions of pulling and compressing. The basic physical interaction compares to that of an accordion instrument, though the intention is not to produce sound, but rather listen and modulate. In efforts to diverge from the traditional instrument behavior, I have decided to explore sound as a predefined input, and create varied tangible feedback as the output. In essence, Haptic-Freq explores the relationship between audible frequency and the ways in which the human body, and more specially the human hands react against haptic feedback. The user experience starts by wearing headphones and listening to a solid selected frequency. The user then holds the device in their hands, and pulls it outwards in an attempt to create the auditory wave in a physical notion. The device has two (2) haptic motors in each handle. Said motors vibrate rapidly when the user pulls the device outwards to match the arbitrary resistance value produced by the stretched sensor.

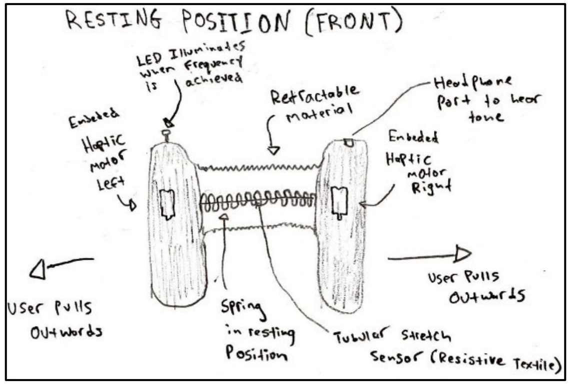

Figure 1: Initial sketch depicting expected user interaction.

This notion of interactivity sparked my attention when I was introduced to Digital Music Instruments (DMI) in a class presentation [1]. DMI's and their affordances allow everyone to play and manipulate sounds without skill or experience. The intention of my so-called inverted instrument is to argue the definition of instrument in popular culture, and provide realization that an instrument can be anything that creates any kind of modulation, whether its sound or something more abstract.

PROTOTYPE PROCESS

The prototype was a work in progress for nearly six weeks. I believe the concept of physical pulling illustrates the change of frequency in an easy-to-understand way. Therefore, I began to ponder concepts. The first iteration was constructed with two plastic pipes, and a bungee cord. One pipe fed into the other, and the bungee cord created high tension when the user pulled the pipes outwards. As the user let go, the two pipes returned to their resting state. As I concluded this test as a success, I began testing other materials such as plastic piping, wood, and a 300 mm spring.

Figure 2: 300 mm spring with hooks, and two plastic pipes measuring 6 ½ inches in height that act as handles.

The body of the object lacked structural integrity, and I needed to create a mechanism that would keep the object square while being pulled. Therefore, I created two (2) sliders by using four (4) 5-inch sections of ½ inch piping, and two (2) ten-inch sections of 7/16 inch wooden dowel. The wooden dowel slides inside the piping to allow for a square translational motion, and they provide added strength. Additional elastic bands prevented the object from being pulled to far.

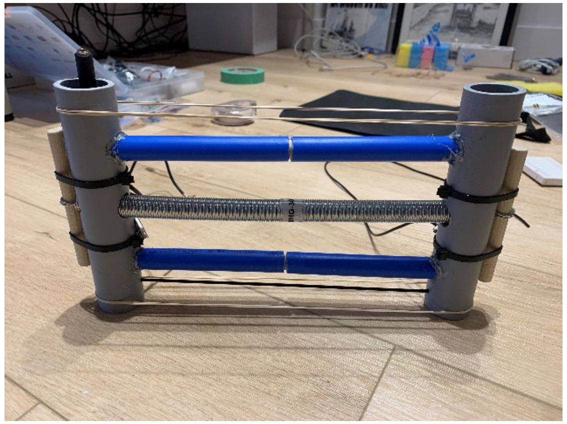

Figure 3: Inclusion of pipe, dowel slider mechanism, and elastics bands to constrain the tension amount.

Once the basic structure was built and functioning as desired, I began to test potential locations for the Ardunio and breadboard. The following image displays an initial layout of the electronic components, though it quickly became obvious that I would have to use the small bread board due to space constraints.

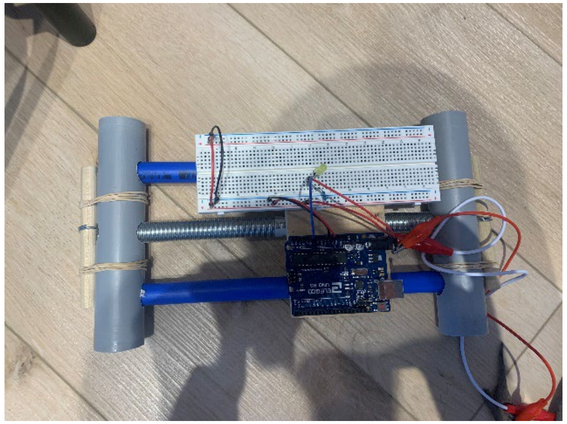

Figure 4: Potential placement of Ardunio and breadboard, with simple LED test circuit.

I started to consider various materials for the handles, as the device must provide comfort and afford all hand sizes. My initial intent was to source memory foam, though I could not locate a provider that would sell it in small quantity. Thus, I decided to mount two (2) foam sponges onto the handles for improved user comfort and general compatibility. The Ardunio, and breadboard was mounted via double sided tape, and most components were connected with alligator clips, or spliced cables affixed with electrical tape. Lastly, two haptic motors were placed on each foam sponge to provide the user with direction through haptic feedback.

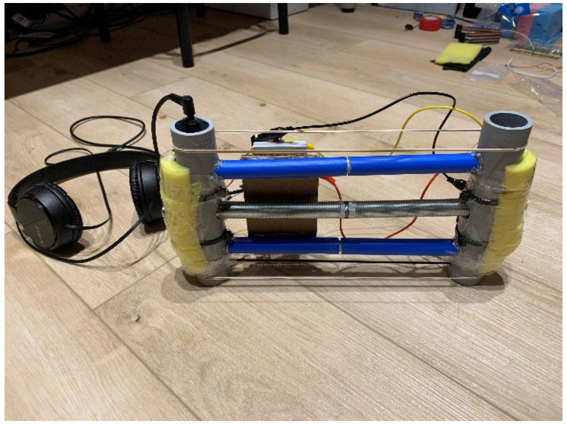

Figure 5: Completed prototype with Sony headphones affixed to the TRS output.

The prototype lacked visually aesthetic housing fabrics, and the code simply checked for any resistance at which the vibration motors would commence, and the outputted headphone frequency would pause. The prototype playtest allowed people to test the device, and provide feedback that I incorporated into the final artifact. Most people picked up Haptic-Freq and naturally new how to handle it, but wondered its purpose. I thus decided to reconsider it's initial physiological meaning and simplify it into a game, where the user must physicalize the motions of frequencies through ten (10) various states.

FINAL ARTIFACT

The first step of creating my final artifact was stripping down the prototype to its independent components, and re-building it from the ground up. I decided to do this, as I wanted to tidy up the wires around the handles to create a more comfortable holding experience, as well as mount the haptic sensors beneath several other components. Additonally, with the help of a peer, I was able to sew two handle covers made from oragnic cotton. This allows newly incorpeated foam sponges, and haptic sensors to stay tight together and hidden from the audience.

Figure 6: Completed cotton covers coupled with two (2) haptic motors and two blue sponges.

As the construction of the materials and individual entities progressed, I started to rebuild the circuit with a slightly larger bread board. I decided to do so, once the realization was made that I would need to include a second transistor for the second haptic motor, as the circuit is wired in series and requires additional voltage to adequately engaged the haptic motors. The breadboard swap was beneficial, as it also provided better access when wiring and troubleshooting. The next step was to test the device. I affixed the sponges to the handles, soldered the haptic motors, and temporarily wired the circuit using twistable wire connectors.

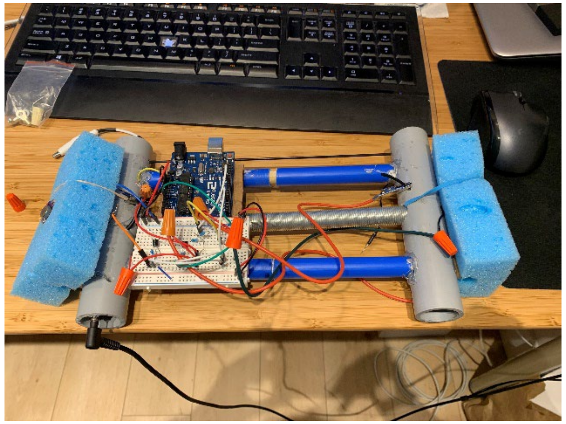

Figure 7: Haptic-Freq (temporarily) wired and functional.

The final physical steps included adding the cotton handle covers, a green LED to indicate Haptic-Freq's current state, soldering all of the wires for permanent connection, and applying an accordion like material that compresses and expands upon pulling and compressing the device.

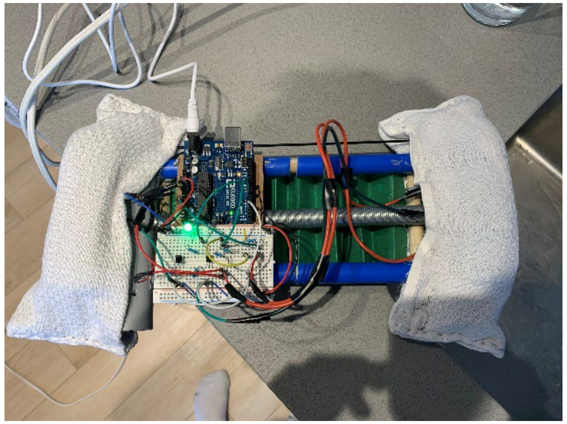

Figure 8: Haptic-Freq wired and functional.

The above image depicts the final circuit with the state LED implemented on the breadboard for testing purposes. All of the wires had been cut to length and taped for user comfort. Once the artifact had been tested several times, I repositioned the LED to the top handle beside the TRS output, and tightly sewed the handle covers.

Figure 9: Haptic-Freq in its final state. Wired and functional.

The artifact as a whole has slightly changed from the original intention as indicated in the previous section. As the user pulls on the device, they match the resistance to the indicated arbitrary value and make their way though ten (10) different frequencies. After testing the device, serval peers suggested that the device be turned into a game, where the user needs to get through the various levels. When one thinks about the user objective as such, it becomes apparent how to use the device. Nevertheless, guidance is still necessary to first explain the device's functionality. Once this information is obtained, the experience creates smiles and several participants laughed.

OBSERVATIONS

This project has taught me a lot about interaction design, time management, coding in C++, sewing, and creating custom analog sensors, and how their accuracy and behaviors may vary. I believe that my time management process was very successful. I ensured to build the project over the entirety of the semester, which permitted time to create changes, take new approaches, and troubleshoot elements. The result is a functional device that nearly follows all of my conceived ideas outlined the in the proposal. This being said, every project has areas of possible improvement, and this is no exception. I must explain the issues with the rubber stretch sensor. I have embedded an Adafruit conductive rubber cord. The cord's resistance value changes by roughly 350 ohms per stretched inch. As it returns to Its original state, so does the resistance, however the cord can prematurely degrade should one apply an immense stretched force. This will make it elongated and less tense. As the cord gets used the rubber takes time to compress back to its original size. The resistance can sometimes take up to two (2) minutes, depending on stretched amount [2]. This is problematic as my initial interactive intention requires the resistant data to change in real time to create ten (10) different conditions for ten (10) different tones. The below image depicts the resistance value slowly returning to its initial value in the Ardunio serial plotter module.

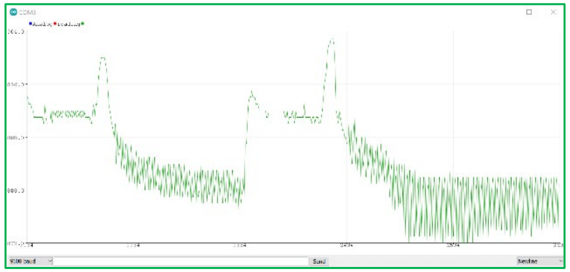

Figure 10: Serial plotter displaying analog value (0-1023). Focus drawn upon locations where the graph shows the resistance slowly returning to its resting state, indicating the cord takes time to shrink back.

On another note, the device fulfills my material expectations as it includes several materials that I personally sheared, glued, manipulated, soldered, sewed and assembled without any prefabricated materials. This demonstrates the time and effort put into the artifact, and creates an element of uniqueness that can only be observed in physical form. One user described Haptic-Freq's visual makeup and experience as "goofy but enticing", given its intense outputted frequencies, and joyful but sophisticated design.

FUTURE DIRECTIONS

I hope to learn more about interaction design, electrical engineering, and coding with C++. In the future I would like to research and test other methods for calculating changes in resistance. Brief class discussions brought up the idea of digitally calculating the device's stretched distance by placing an LED on one handle, and a photoresistor (LDR sensor) on the other. A simple calculation could measure the distance between the two handles, and assign an arbitrary value that would be inputted into a respective conditional statement that would ultimately change the haptic vibrations, and allow the object to function closer to the initial intention. I imagine I would receive more accurate results, and live data feedback with this method. The second large change I would make is to re-wire the circuit from series to parallel. The below illusatrtion depicts the current series circuit.

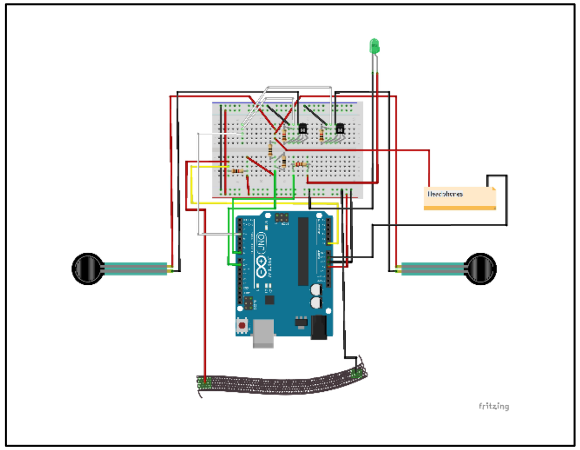

Figure 11: Series circuit diagram for Haptic-Freq created with Fritzing software.

A parallel circuit would allow equal voltage to each element, thus allowing adequate flow to reach the transitions, and in turn create a stronger vibration. Additionally, a parallel circuit is more reliable as the complete circuit will remain functional even if a component on a single branch fails. Lastly, I would consider visiting a professional seamstress to have optimal lightweight fabric and foams sewed tightly against the handles to create a nicer shape, and overall improved handling experience.

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