Tangible Music App for Deaf Dancers

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1 Introduction and Motivation

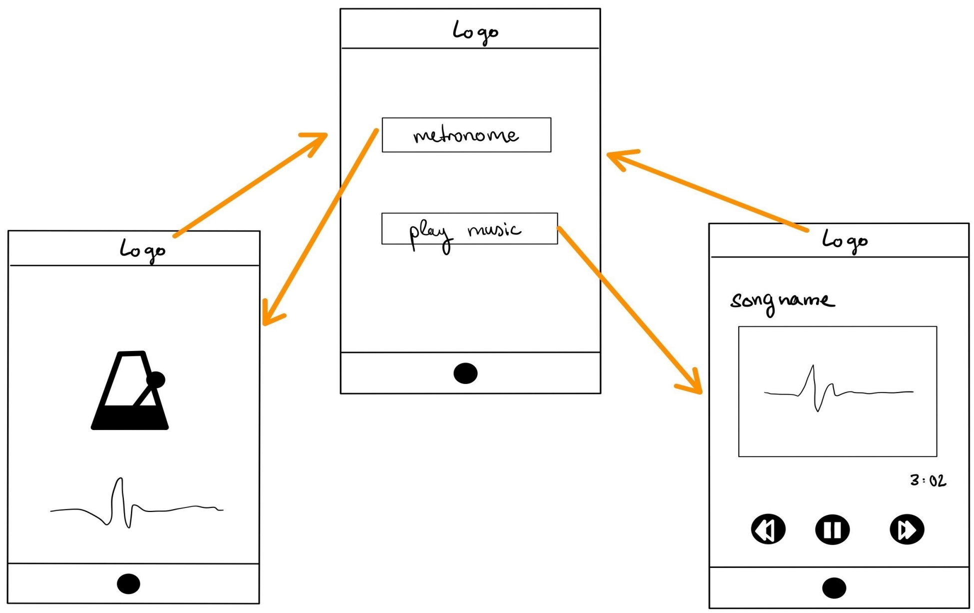
In this module, we have been introduced to deaf people and have been made aware of the different ways they experience life with the absence of one of the five main senses. In our fictional scenario there is a 31 year old woman who lost her hearing after a car accident. She is an ambitious dancer but struggles to find the correct beat of the song ever since. Additionally we found a deaf dancer named Shaheem Sanchez who tries to remember songs by laying his hands on the subwoofer and feeling its vibrations. This is an example of how vibration patterns can help deaf people experience music [1] [3]. Once he can remember the beat correctly he starts to learn his dancing performance to it. Based on that we wanted to develop a mobile app that helps deaf people to feel and connect to music through vibrations.

2 Related Work

A similar solution was created by the founders of the BeWarned app [4]. The BeWarned app was originally created to alert users of potential dangers in the area with vibrations and flashing lights if sounds like alarms, screaming, or honking cars are detected by the phone's microphone [2]. The creators of BeWarned then made a new addition to the app, called BW (BeWarned) Dance. BW Dance was made to create vibrations and visual animations on the user's phone screen to give deaf people a way to interact with music. However, the BW Dance app did not suit our purposes because we sought to provide a whole spectrum of vibrations. This includes giving the user the ability to choose if the vibrations are on the beat of the melody or harmony, treble/alto/bass ranges, etc.

3 Concept and Development

We developed an application for mobile devices, as they have all required components built-in. Mobile devices are owned by most people, so it provides a good solution for our target demographic.
The following figure shows the functionalities of our application in a wireframe:



We also looked into frameworks like React and Unity. Unity's built-in audio analysis tools gave us an easy head start. As none of them gave us enough control over Apple's vibration we decide to focus on developing our prototype for android exclusively.

To avoid further hardware limitations, we also stuck to testing vibrations derived from pre-existing audio tracks. So, we put back the microphone feature at first.

Our first design choice was to create a threshold for frequencies to trigger vibration. We then wanted to implement a visual representation of the frequency spectrum. This was to provide feedback for the user on which frequencies exceeded the threshold.

We then decided to reflect changes in frequency with a proportional change in vibration intensity. This operation gives the user a way to clarify changes in pitch. It also provides a way to retain some musical qualities that would be lost otherwise in translation from audio to vibration. Lower frequencies therefore correspond to weaker vibrations for basic rhythm. Higher frequencies are then produced with more intense accentuation.

Vibrations are only triggered when the rate of change in its respective frequency interval is positive. Therefore, only the attack of the note gets translated, which helps to separate individual notes and retain rhythm overall.

4 Evaluation of the Prototype

In order to evaluate our prototype, we tested our solution as follows: We downloaded the finished application and tested it out while the sound was muted. Afterwards we used the following questions to evaluate our prototype:

- Do you recognize a rhythm or musical qualities? More than vibrations during a telephone call?
- What feelings are conveyed by the vibrations? Do you connect those to a musical genre?
- Could you imagine dancing to vibrations?
- Do you recognize the song?

On the first impression, most people were a bit confused by our application and had difficulties differentiating or recognizing music. Even though it was hard to recognize a song through the vibrations only, at some parts a rhythm was noticeable. These difficulties also translated to problems in identifying a genre.
The frequency settings had a big influence on the vibrations so that automatic adjustments throughout the song could improve the user experience.
Another part of the application was a metronome feature. Most of our test users agreed that it could be a good orientation to dance to if you know the song and steps beforehand.
Afterward we also evaluated the differences in feeling the vibrations depending on which body part the phone was placed on. We tested the hands, chest, head, and back. In conclusion, the described feeling differentiated depending on the person but most users described the chest as an area where they felt the vibrations most intensively.
To the question, if they could imagine dancing to vibrations only, most answered positively if they would feel the vibrations throughout their whole body.

5 Discussion

The test subjects found that certain parts of songs get translated satisfactorily. The problems with translation seem to lie within song transitions, such as the bridge section of a song. Sometimes, transitions into other distinct parts of a song can be recognized with the adjustment of app settings. However, without this, the notes begin to blur together or aren't recognized distinctly at all. Also, the general consensus was that changes in pitch were only limitedly conveyed to the user.

These results mostly compare to the BW Dance app in the respect that not everything gets translated over to the user. Overall, even with the vibration spectrum, there is a loss of data and the full musical experience just isn't quite the same. This, however, is mostly due to our limitations since we can only translate a whole spectrum of frequency into a spectrum of tactile vibration. Even if we used another physical medium of translating frequencies, it would still have some laclustre aspects to it since we are comparing two different human senses that work in totally different ways. The best solution is to simply find more physical mediums of experiencing music, and to combine them in a way that gives a wider experience of the frequency ranges.

6 Future Work

Some possibilities for combining physical modes of experiencing music have been discussed. The main one is adding additional hardware onto multiple body parts. This makes use of different sensitivities on the human body to convey different sounds, pitches, volumes, etc. Another idea was to adjust trigger settings over time in order to keep the optimal trigger for different sections of a song. That way, section blending is less frequent.

Some research that hasn't been done yet, but could enhance our prototype is performing the analysis of dynamically-adjusted trigger settings to automate the process of setting the trigger for different sections in a song. Another feature idea is to make the user's microphone a new type of input for song analysis and vibration pattern production.

References

[1] AJ+. *How Do Deaf People Experience Music?* URL: https://www.youtube.com/watch?v=dwqSuvFzDdI&t=197s (visited on).

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[3] Pauline Tranchant. *Feeling the Beat: Bouncing Syncronization to Vibrotactile Music in Hearing and Early Deaf People*. URL: https://www.frontiersin.org/articles/10.3389/fnins.2017.00507/full (visited on).

[4] Taylor Leddin. *App turns music into vibrations and visualizations for the deaf, hard of hearing: Welcome to the 21st century*. Web. Chicago. URL: https://ncham-moodle.eej.usu.edu/news/2017/01/04/app-turns-music-into-vibrations-and-visualizations-for-the-deaf-hard-of-hearing/#:~:text=One%20such%20technology%20is%20the,vibration%20signals%2C%20and%20flashing%20lights. (visited on).