In-vehicle media browsing interface

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ABSTRACT

Currently, vehicle music control systems heavily rely on touchscreens, lacking physical buttons or dials. This limitation not only raises safety concerns but also causes distractions for drivers. It also leads to complicated processes, requiring multiple steps to perform even basic tasks in the music library. This research proposes the integration of haptic rotary dials into the vehicle's music control system to revolutionize how drivers interact with their music collection. By utilizing haptic feedback, this innovative approach aims to reduce or eliminate the need for visual attention. This allows drivers to focus on the road while effortlessly navigating through their music library. By offering tactile feedback and user-friendly controls, this technology has the potential to enhance driver safety, minimize distractions, and simplify browsing music within the vehicle's control system.

Keywords
Media browsing; Haptic feedback; In-vehicle; Non-visual; Rotary dial

INTRODUCTION

There is no way of navigating the user's music library with buttons or tangible dials, as the primary method of interaction remains limited to the touchscreen. This restriction not only poses potential safety concerns, but also creates a potential source of distraction for the driver. Furthermore, the absence of alternative navigation options means that accomplishing even simple tasks within the music library can require multiple steps. These convoluted processes contribute to the creation of a series of continuous distractions for the driver.

I believe that integrating haptic rotary dials into the vehicle's music control system holds potential for transforming the driver's interaction with their music library. By leveraging haptic feedback, it becomes conceivable to design an interface that requires less visual engagement or even eliminates it entirely, enabling drivers to maintain their focus on the road while effortlessly navigating through their music collection.

BACKGROUND

During research, I came across a publication by Scott S. Snibbe and Karon E. MacLean called *Haptic Techniques for Media Control* where the authors introduce multiple approaches to media control using rotary dials and haptic feedback. Some of these prototypes are non-visual which caught my interested as my domain was non-visual interfaces for vehicles.

There were three artefacts in particular that inspired my work. *Haptic fisheye* was one of them, this prototype used pressure to increase or decrease data resolution, in case of Snibbe's and MacLean's work it was video frames that they were browsing.

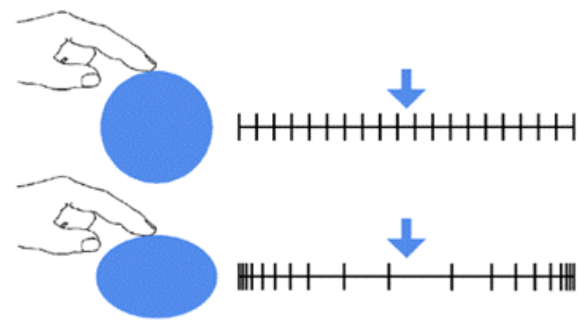

Figure 1. Haptic fisheye (Snibbe, S. S., MacLean, K. E., 2001)

Another prototype was called alphabet browser, where the resolution of data was increased by slowing down the rate of scrolling. This prototype featured auditory display and a rotary dial with a haptic feedback simulated detents to further enhance the audio feedback. The authors even suggested that this could be used while driving as requires no sight.

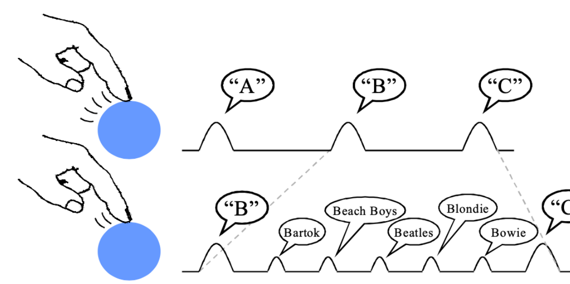

Figure 2. Alphabet browser (Snibbe, S. S., MacLean, K. E., 2001)

Third prototype did mainly demonstrate the potential use of vibrations as a texture. By applying vibration with variable frequency at certain points can enable user to foresee an upcoming marks.

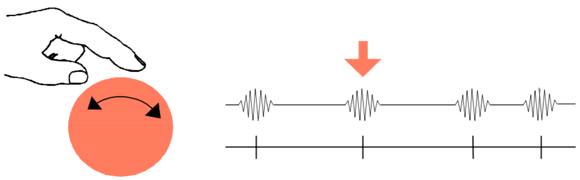

Figure X. Haptic foreshadowing (Snibbe, S. S., MacLean, K. E., 2001)

METHODS

Multiple methods were used during the course, in the beginning it was an observation which has enabled me to define most distractive actions. In the participant observation my role was only an observer (Pedersen, 2022) with little to no participation in the setting of a driving car. The observation could be further enhanced by giving a driver specific tasks, however this was not needed as my goal was to look for most distracting actions of any kind.

Furthermore, bodystorming contributed to the final feel of the haptic snaps which could still be improved according to the feedback from the user testing.

DESIGN EXPLORATIONS

After finishing research, my interaction design field and domain were set. The goal was to find out whether rotary dials with haptic feedback could be used to create non-visual interface and thus simplify the conventional ones.

To begin, I decided to identify the most distracting actions performed by drivers while driving. Although I was only able to conduct one observation, it proved sufficient to identify two major issues.

One prominent issue I observed was the need for drivers to type on the car's display keyboard when they wanted to play a specific song, leading to multiple distractions as they had to divert their attention to the touch screen. Given that some cars offer voice assistant search functionality, I chose not to continue this particular issue.

However, I did discover a similar problem when drivers attempted to navigate through their music library. Since there are no physical buttons available for this task that can be operated without visual input, drivers are left with no choice but to rely on the touchscreen.

DESIGN OPPORTUNITY

The design opportunity I formulated was *How might we make navigating through music library non-visual with the use of haptic rotary dials?*

I had multiple ideas from previous research such as previously mentioned alphabetical browser but to test them I had to make a prototype that would meet certain requirements. Those were: The prototype should simulate detents at defined points, The protype should be able to play variable sounds at those defined points.

To achieve this, I have used a stepper motor with a magnetic encoder attached to it. The encoder was used sense the angle of stepper motor. To make the prototype functional I had to use a microcontroller which would read the angle in the real time and provide desired haptic feedback.

After assembling everything together, I have started to experiment with different nudges that the motor could provide, and I have managed to recreate a feeling of a detent where the dial jumps to a set position when brought close enough to it. I originally wanted to add a resistive force before jumping into the detent, however I was not able to recreate this with the motor I had available.

When the artificial detents were working, I was able to set their density in one 360 degree spin. Multiple angles between each detent were tested, key insight was that there was a limit of my setup, where a difference of 30 degrees caused issues of detents interfering with each other. I have then set the angle to 60 degrees or 6 detents per one 360 degree spin, which has worked well since then.

I have also experimented with hard stops, where the motor did act as a break when a certain angle was reached, signaling the end of browsed data. This worked well, however I ended up not using it in any interactions.

In order to play variable sounds I have used the microcontroller to send signals to a computer which would play the actual sounds.

Now when the prototype was mostly ready, I have written down three possible interactions that I wanted to test. First was just to have to scroll through every option in media library, e.g., scroll through every album or artist. This was quickly proven to be inefficient as larger media took too long to scroll through and have sometimes created confusion.

Second proposed interaction was same as previously mentioned alphabetical browser where when scrolling briefly, only the alphabetical letters were played and individuals artists names emerging at slower scrolling rates. After testing, it was clearly a better interaction compared to the first one, however there was an issue of scrolling through large set of artists starting with the same letter. Due to the speed limitation the interaction became time-consuming.

The third interaction was inspired by the haptic fisheye, where the pressure controls the data density. While Snibbe's and MacLean's prototype was linear, meaning the higher the pressure, the higher the resolution, my supervisor suggested that the dial could act as a button when pressed from the top, which would switch to the higher resolution. Due to time constrains, I didn't manage make the dial work as button but instead I have used the computer's keyboard to act as one. I adjusted the code in order to work in this fashion. I haven't managed to do proper user testing on this interaction, however it was complimented by both my supervisor and attendants of our exhibition.

During the prototype assembly, I was also trying out different sizes of the dials and their variations. Initially I have tried 3D printing three sizes – small, medium and large. I have as well put an indicator (a small hole) on one of the dials to better see the movement of the dial while prototyping, which became beneficial when fine-tuning the motor. No marks were needed for the final prototype as the dial itself should not provide any visual affordances at this point. In contrast to Knobology 2.0, a visual affordances might create behavior expectations, which is not needed in my case.

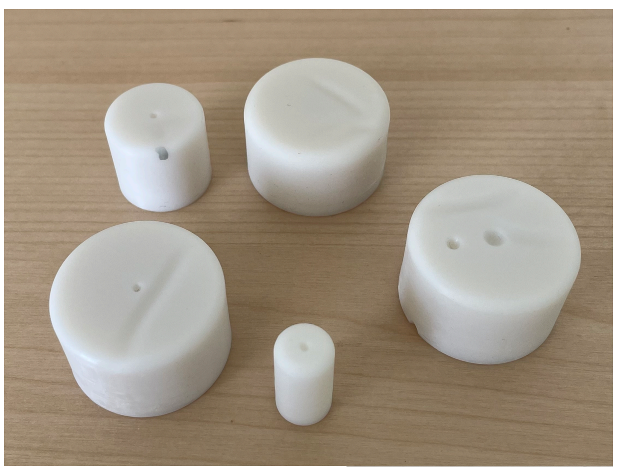

Figure 3. Dial design iterations

DESIGN QUALITIES

The latest design presents a dial with an auditory display (currently in the form of computer). When spinned, the user receives feedback in two forms.
First one is haptic, where the dial snaps into pre-defined positions, helping user to settle on a specific one. Without this, it took longer for the users to properly settle on one of the options, additionally they were significantly more confident with the snaps implemented.
Second form of feedback is auditory, where when the dial is spinned, an alphabetical letter played. If however the user presses down on the dial (this is currently done by pressing a key on the computer's keyboard), they are presented with the names of artists starting with the chosen letter.

Figure 4: Latest version of the prototype, front

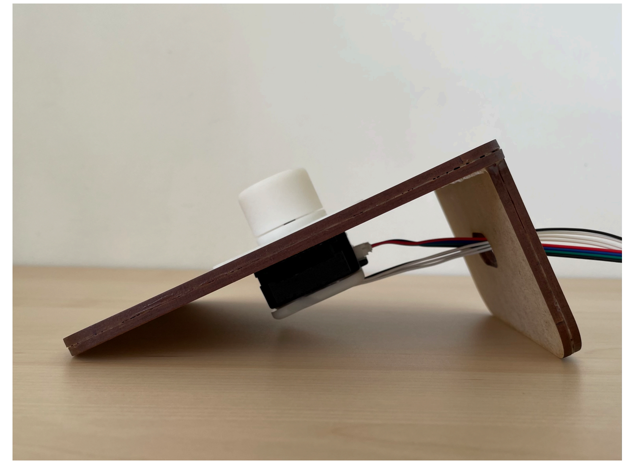

Figure 5: Latest version of the prototype, side

The prototype enables user to quickly browse through their artists collection without compromising the speed of scrolling and more importantly, without any visual confirmation. The assumption is that this should greatly improve drivers focus on the road and reduce distractions.

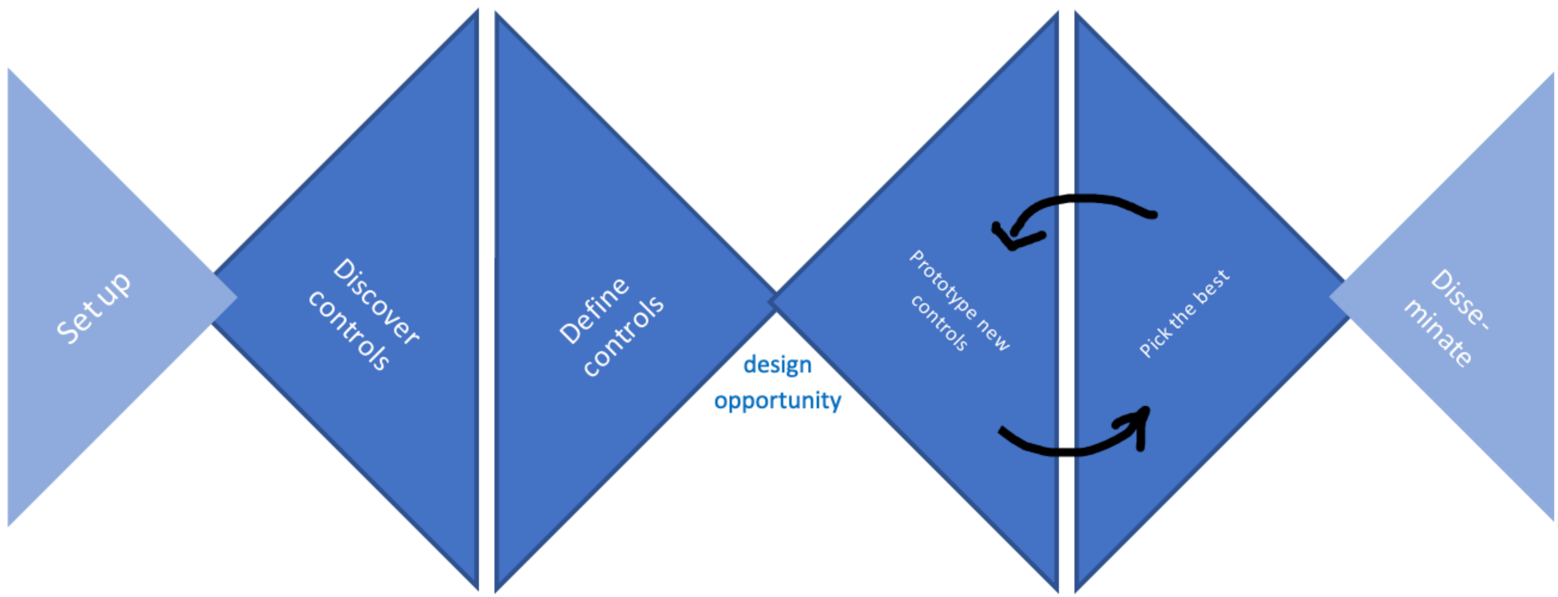

Figure 6. Design Process

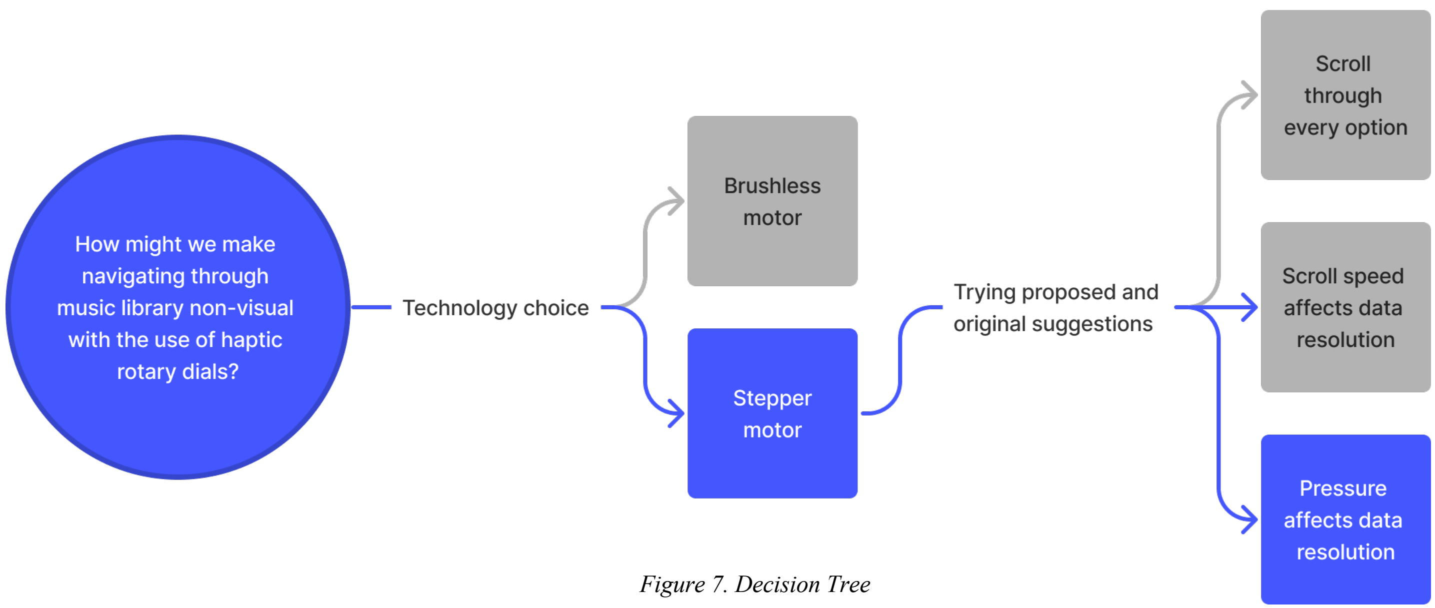

Figure 7. Decision Tree

RELATED WORK

As it was previously mentioned, my main inspiration was Snibbe's and MacLean's publication *Haptic Techniques for Media Control* which demonstrated multiple prototypes that could be used for different types of media control, including music library browsing or video editing.

Haptic fisheye was the most inspiring prototype as it demonstrated how could pressure be used to control the data resolution. In case of this prototype the relation between these two factors is linear, which is in my opinion is very nicely done tangible representation of data.

Alphabet browser was a creative approach on how to swiftly browse a larger collection of data. Their prototype had its flaws, however it has still contributed greatly to my final prototype.

Haptic foreshadowing provided an idea that haptic feedback could be used to foresee upcoming points when browsing the data. While they have used vibrations with variables frequency, variable force applied either in the direction of spinning or the opposite one could be used to indicate the upcoming event. Similar to the *Haptic feedback stimuli* from the *Knobology 2.0* design case.

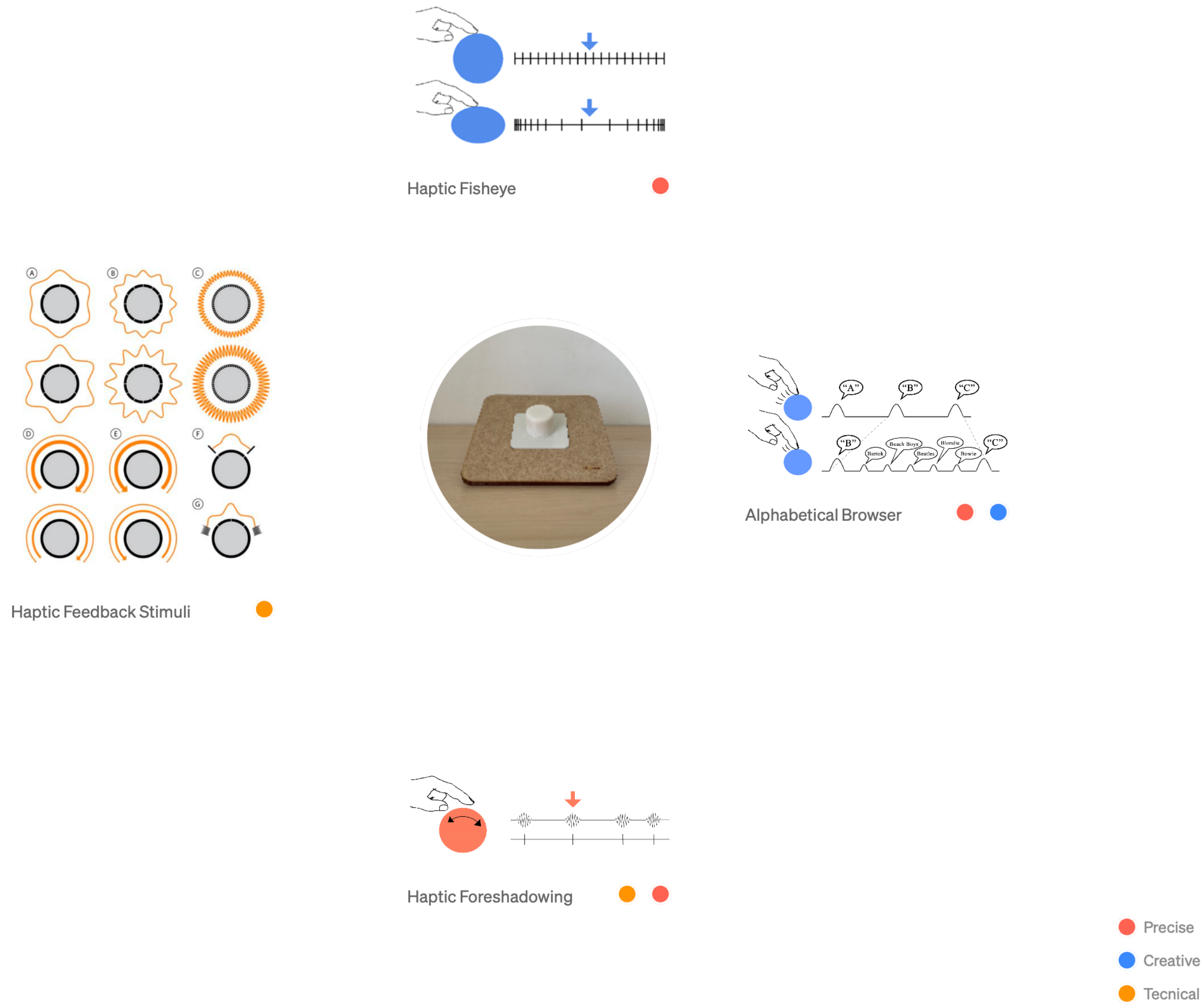

Figure 7. Annotated Portfolio

CONCLUSION

In conclusion, this research aimed to design a non-visual interface in order to simplify music library navigation in cars using haptic rotary dials. The prototype incorporated artificial detents and sounds, allowing users to navigate through the library. Three different interaction approaches were tested, from which only one was shown to be usable. The prototype's design and assembly involved experimenting with dial sizes and and haptic patterns. The final prototype avoided visual affordances to prevent unnecessary behavior expectations. Overall, this research offers a potential solution to reduce driver's distraction and improve music library interaction in personal vehicles.

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LIST OF VISUALS

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