Developing a VR Experience for the Visually Impaired Utilizing Haptic and Auditory Feedback

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***Abstract*—There are many people in the world who play video games, roughly 40 percent of the population. Out of these people, it is estimated that 23 million of them are visually impaired [1]. When it comes to developing video games, accessibility and inclusion should be a high priority. The purpose of this project is to develop methods and techniques in VR that can make games more accessible to the countless gamers who are visually impaired using haptic and auditory feedback. In order to generate a project idea, we brainstormed multiple possible ways of tackling this problem. We also reviewed several articles and studies about developing games for the visually impaired.**

***Index Terms*—Visually impaired, accessibility, haptic feedback, auditory feedback, Virtual Reality**

I. Introduction

When considering the history of games, video games, and game development, the majority of games developed and published are not specifically catered to the visually impaired population of gamers, with little to no features applicable to these users other than audio signals and minimal haptic feedback [2]. Game development itself can be a very cumbersome task at every stage whether it is design, graphics, SFX, gameplay mechanics or narrative. Oftentimes features for gamers with disabilities can be quite tricky to implement and most of the time not considered during the design phase. As a result, developers usually design and create new games specific to certain physical disabilities for example, audio games or specific sensory induced games rather than building and including features catered to specific disabilities in generalized games for everyone to play and experience [2]. In recent years, VR technologies and applications have increased and are still in demand in the gaming industry. In terms of the development of a VR experience for the visually impaired, the many challenges in which gamers who are visually impaired must be considered. Therefore, identifying and analyzing different types of games and features catered to the visually impaired was necessary for the research, design and development of this project [3].Taking this into consideration, the haptic and auditory feedback feature for the project would address those concerns directly by ensuring there are well integrated haptic and audio cues with respect to the application's design associated with specific in-game or in-app actions [4].

II. Methods

In order to begin this project, we first needed to brainstorm ideas. The theme for this project is "Accessibility and Inclusion" so that is where we began. First, we brainstormed multiple possible topics such as: color blindness, hard of hearing/deafness, one handed VR support, eye tracking, facial recognition, and visual impairment. Once we had a good list of ideas, we determined whether they were promising, viable, or absurd. After we decided which ideas were the best for this project, we gathered feedback from our peers and decided on a final topic. This topic was developing games for the visually impaired. Now that we knew what to focus on, we began a literature review. Here, we found and read through several articles and studies on people with visual impairment and how games are developed for them.

Our first literature review was on a VR game made for the blind and visually impaired called "Racing in the Dark". This is a racing game where the player goes up against several AI racers. The player cannot see anything and the world is pitch black. The game gives haptic vibration feedback to the players indicating the direction and intensity that the player needs to turn the wheel in order to steer the car. Player inputs are done through hand gestures, and an auditory voice system. Unfortunately due to the fast pace nature of this game, auditory information is not as useful as other games [5].

Another review was about a game created for the goal of creating a game that can be played by everyone. In this game, the non visually impaired player would be digging a tunnel to escape, while the visually impaired player tries to chase and locate the other player. The visually impaired person relies heavily on haptic vibrations to detect collisions with the wall. The audio is paired with the haptic vibration to simulate hitting a wall. The player being chased uses motion to dig the tunnel, while the visually impaired individual is attached to haptic devices [6].

Finally, we developed a project management plan. Each month will be led by a different member of the team, starting with Matthew for month 1, Jonathan for month 2, and finally,

Jelani for month 3. A trello board was created to keep track of the objectives that needed to be completed for this project (Fig. 1). First, we defined the problem and came up with a solution. Next, we move on to paper prototyping in order to create a clearer version of our solution. Then we move on to higher fidelity prototypes in Unity. After each iteration, testing will be required to update and improve on the design and functionality of the game. This will be done on repeat until we have a final prototype.

III. Results

Our literature review gave us good insight on how other projects have been developed and how haptic and auditory feedback can be utilized. However, we identified a gap here. While they do use these forms of feedback, none of the projects we reviewed utilized them to create spatial awareness inside a VR environment. Utilizing design thinking we set up the entire plan for this project. Empathize: we inquired into VR games for the visually impaired and what needed to be included for this type of project. We found that to best design for this type of impairment, other senses would have to be heavily relied on, most notably haptic and auditory feedback, ie. the senses of touch and hearing. Define the Problem: now that we had a clear idea of what we were working with, we could give the problem a clear definition. This definition is: VR games heavily rely on visual senses and as a result, people with visual impairments cannot play and enjoy video games. Ideate: we brainstormed several ideas on how to create an enjoyable VR experience for people with visual impairments. We decided that our area of focus would be on VR controller's haptic/vibration feedback as well as Unity's spatial audio support. Prototyping and Testing have not yet been done, but will be a priority moving forward. In order to solve this problem we have come up with a plan. We will use Unity to develop a VR prototype in order to test the usability of haptic and auditory feedback for the visually impaired. We will create a simple environment with objects of different shapes. The goal of the game is to match two of the same shapes together. In order to locate the shapes, each one will be set up with a directional audio source in order to guide the player to them. Each shape will have a different sound that is shared only with other shapes of the same type. In order to tell when you have picked up an object, haptic feedback will be utilized. The controller that you are holding the object with will vibrate. Similar to the auditory feedback, each shape will vibrate at a different frequency to make it easier to tell when you are holding two of the same shapes. When you have two objects, touching them together will check whether or not they are the same shape and give you auditory feedback signaling success or failure.

IV. Conclusion

Through our design thinking process and literature review, we determined a problem and a solution. People with visual impairment are almost always excluded from enjoying video games. Everyone deserves to be included and that is why this is an important problem to solve. Utilizing the capabilities of VR, we can come up with an effective way of including these people. Haptic and Auditory feedback are crucial for visually impaired people and VR headset along with controllers can be used in a way to solve this problem in ways that was not possible before. We looked into several other projects during the literature review. We found many projects that utilized audio and haptic feedback for similar purposes as our project, however, we noticed a gap. None of these projects utilized these methods for spatial awareness in the same way that we are attempting to do, leading our project to be a new approach to solving this problem. Looking forward, we plan to refine our idea to make it as functional and as usable as possible. We will also develop multiple prototypes using iterative design, starting with paper prototypes and leading into playable Unity builds. In the end, we intend to have a fully functional prototype, developed in Unity that can be played in VR.

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Appendix

A. Figures

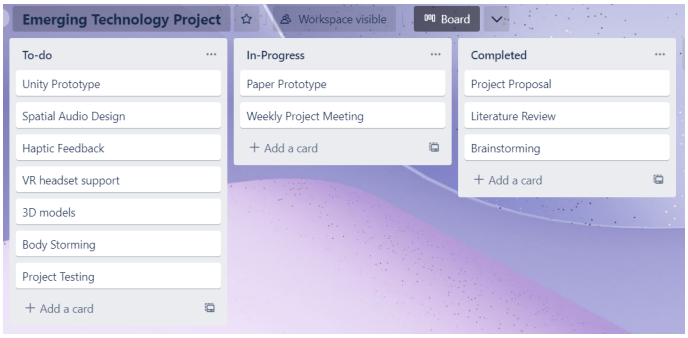

Fig. 1 - Trello Board

B. Team Contributions

All team members contributed equally to the entirety of this project.