Using Bodystorming to Create a Prototype to Increase Accessibility of Spatial Awareness in VR*

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***Abstract*—As virtual reality becomes more popular, accessibility becomes much more important to think about when developing games for Virtual Reality (VR). Currently, the main features that exist for spatial awareness are solely visual cues, and we want to change that to allow for audio and haptic feedback as well. Our objective is to create a "wizard of oz" prototype for a VR feature that can help increase the accessibility of users' spatial awareness when they are immersed in virtual reality. We used the Bodystorming method to better understand our users and create a feature prototype that solves this growing problem.**

***Index Terms*—Virtual Reality, Spatial Awareness, Accessibility**

I. Introduction

Since the main source of feedback for spatial awareness in VR is visual [1], this causes a lack of accessibility for visually impaired users who want to get into VR and feel confident about their surroundings. We want to provide features that don't rely solely on visual cues within a VR headset. Feedback options such as audio and haptic feedback can be implemented as well into a VR headset. This idea can increase the level of accessibility and spatial awareness for those users and allow them to be able to enjoy the full VR experience without worry. Our goal with this prototype is to give visually impaired users appropriate feedback without completely breaking the immersion of whatever they are doing in virtual reality. We aim to provide audio and haptic feedback features while ensuring that the feedback in place is not too distracting or overwhelming for the player. Finding the right cues to inform the user was the main goal of the bodystorming exercise.

II. Methods

The method that we used to gain information and feedback about our idea was Bodystorming. This method involves creating a use case revolving around a certain project. With this use case established, the goal is to have an 'actor' and 'observer' play out the use case and provide feedback or improvements about the project scenario [See Figure 1]. In our case, the scenario involved a blindfolded user walking around a fake virtual space without being able to see the boundaries of the play area. When getting close to the edge, instead of showing them visual feedback which is what the current headsets do, we made beeping sounds with our mouths and gave haptic feedback to inform the user that they were approaching the edge of the play area. The sounds were created from our mouths, which we 'played' from the location of the boundary so that the actors could identify where the boundary was using spatial audio. To simulate controller vibration, we tapped the users with a pen on the side of their body closest to the edge. This method allowed the users to be able to safely and freely walk around their virtual space and be confident about the boundaries without having to see them visually. This scenario was used for us to get a better understanding of how effective audio and haptics can be on their own without the use of any visual cues at all. We were able to gain insights into the user's needs and what would be most effective at getting the idea across without having the features be obnoxious for the user. Ensuring that the sound that plays for the user and the haptic feedback that is provided is non-irritating, was critical when reviewing our design. We feel that the implementation of said features will allow for a user's awareness to increase while retaining their immersion.

III. Results

Useful insights about our prototype were gained after performing the bodystorming exercise. To begin with, we found that the users preferred quicker short "beeps" over one long beep sound. This also allows us to be able to increase the frequency of the beeps the closer the user is to the edge. Originally, we made the beeping get louder based on the distance, but we found that increasing the frequency of the beeping helped the users more than just increasing the volume of a constant sound. Similar to the concept of the sound feature, we also found that the best way to apply the controller vibration is to increase the frequency and strength of the vibration based on the distance from the edge as well. Not only that, the vibration in each controller can be activated independently. For example, if the user only has their left hand close to the boundary but their right hand is still safe in the center, the left controller will begin to vibrate while the right will remain unaffected. We found that this gave the users a better understanding of where they were within the boundary, rather than them making a poor guess that they were close to the edge somewhere. Our next steps for this project include creating the working prototype within a VR world and improving our feature to be able to account for all of our user's needs.

IV. Appendix

A. Use Case

Refer to "Figure 1" in the "Figures" Section of the Appendix

B. Persona

Refer to Figure 2 in the Figures Section of the Appendix

C. Notes from Observer(s)

1) Lack of Clarity: After our actors provided their feedback, we put on the headset and attempted the experience ourselves. It became clear that without your sight, it is very hard to distinguish anything. Despite the actors using the same feedback we did when they wore the headset, it became clear that without spatial audio, it was difficult to discern where you were in the playspace (even after feedback was provided). This made it clear that it was critical for us to include dynamic vibrations and audio depending on which part of your body began to exit the playspace, rather than just depending on generalized feedback.

2) Retaining Immersion: While performing the bodystorming, we realized that some of our features may break the immersion of a player as they are playing a game. For example, if the auditory feedback was a constant irritating noise it would not be pleasant for the user to listen to. Additionally, this would need to be balanced appropriately in order for the user to not become overwhelmed by the feedback that we intended as a solution. This became critical while we developed our prototype.

D. Notes from Actor(s)

1) Spatial Audio: Actors mentioned that utilizing the left and right speakers in the headset to indicate which portion of a player's body is nearing the edge of the playspace would provide stronger feedback. The actors mention this form of audio feedback would notify themselves appropriately rather than playing a sound from both speakers at the same time.

2) Remove Headset Vibration: In our initial pitch to our volunteer actors, we mentioned that the headset would vibrate to inform the player if they are too close to the edge of the play space. Despite this, our actors expressed concerns against the idea stating that it would be too distracting/irritating to deal with your head vibrating every other time. Additionally, there was a mention of potential motion sickness that would result from the headset vibration. These points were taken into consideration

3) Dynamic Sound Feedback As mentioned before, we simulated auditory feedback by making "beeping" sounds with our voice when the actors got too close to the edge of the playspace. These actors mentioned that incorporating dynamic sound in the speakers that would slow down or speed up depending on how far or close you were to the edge, would make for a clear and concise feature. We believed this made the most sense for providing appropriate feedback and are looking to incorporate it into our project.

E. Bodystorming Breakdown Video

Bodystorming Video Link

F. VR/AR Prototype, Takeaways and re-written Use-case

The prototype that we came up with is a Unity scene that the user can walk around in using the joysticks on the controller. For this prototype of the feature, we must pretend that while walking around in this Unity scene with the joysticks, you are actually walking around in real life within the play area of a VR. The Unity scene contains an invisible barrier around the player that acts as the edge of the play area in the VR world. When the player walks close to the edge in the scene, depending on what is close to the edge, it will give the player audio and haptic feedback. If the headset gets close, it will play a beeping sound from the direction of the boundary. If one of the controllers gets close to the edge, it will vibrate that controller with more power depending on the distance from the edge. During the development of the prototype, we had some things that worked well and some that did not work so well. At first, we tried using Mozilla Hubs and Spoke to make the scene but it was very hard to get the proper functionality of the speakers and vibration working because Spoke did not yet have access to proper spatial audio for sounds. Also, just using a Mozilla hubs world on its own did not work as every audio source that we add is always visible to the user which defeats the purpose of having no visual feedback and only using audio and haptic.

FIGURES

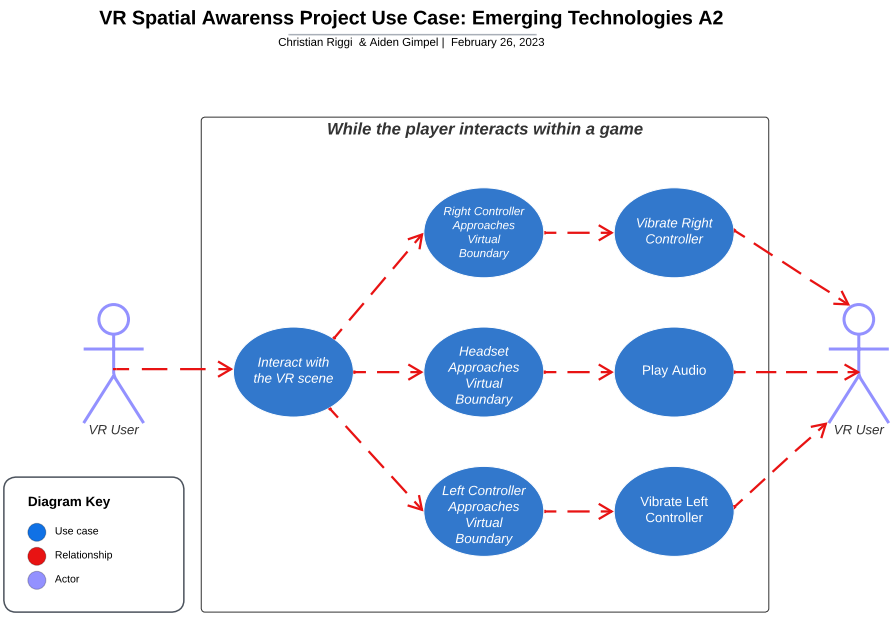

Fig. 1. Image showcasing the use case of a user interacting with our prototype.

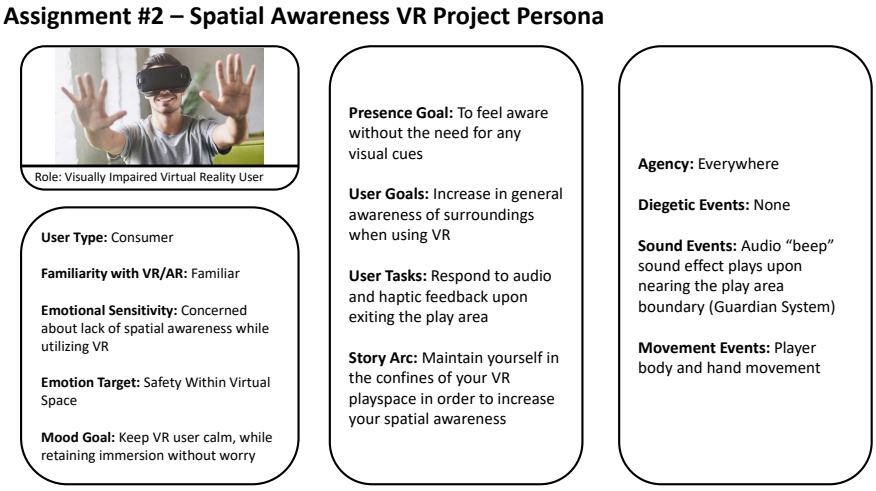

Fig. 2. Image showcasing the "Persona" of our intended users for our product.

REFERENCES

[1] Gibbs, J. K., Gillies, M., &; Pan, X. (2022). A Comparison of the Effects of Haptic and Visual Feedback on Presence in Virtual Reality, 157, 1–12. https://doi.org/10.1016/j.ijhcs.2021.102717