VR Sound Mapping: Make Sound Accessible for DHH People in Virtual Reality Environments

Ziming Li[1], Roshan Peiris[1]
[1]Rochester Institute of Technology

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I. INTRODUCTION

In-game audio plays an important role in enhancing the sense of reality and immersion in the gaming experience. In many games, sounds are also used to provide notifications and clues which are essential to the gameplay. However, in this case, the DHH (deaf and hard of hearing) players may fail to access the information conveyed by sounds, which degrades their gaming experience (Jain et al. 2021).

Prior work proposes a taxonomy for virtual reality (VR) sound representations, which provides helpful insights for accessible VR sound design for DHH people (Jain et al. 2021). The work from Mirzaei et al. presents vibration-based devices attached to users' ears, which can help DHH users find the direction of the nearest sound source in any VR application with 3D sounds (Mirzaei, Kan, and Kaufmann 2020).

In our work, "VR Sound Mapping", we explore several methods to present sound mapped visualizations for DHH people using VR. Our prototype software aims to evaluate the user experience and the user performance of DHH people while playing VR first-person games using our methods.

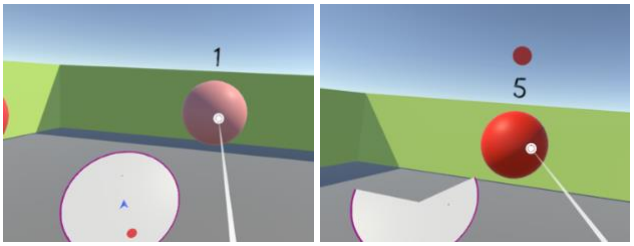

Fig. 1. (Left) Minimap based sound visualization, (Right) On-object sound visualization

To achieve our goal, we present a two-step comparative evaluation with DHH people. Both steps of the evaluation study require the participants to point out the object that produces the corresponding sound effect with the assistance of different sound visualization techniques, for example, as shown in Fig. 1.

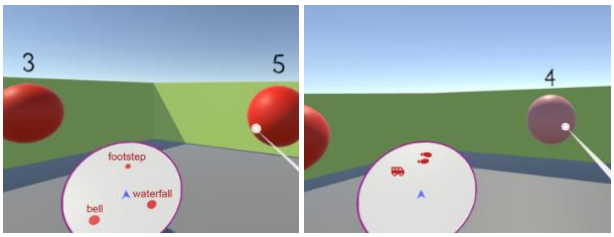

Fig. 2. Text-based and Icon-based sound visualizations

Here, in the first step, we try to identify the best visualization technique from six design combinations. The evaluated visualization techniques are combinations of minimap-based visualization methods (Fig. 1-left) and an on-object sound visualization method (Fig. 1-right). Based on the performance data, the best visualization technique is selected for the second step.

In the second step, we further explore the potential of the chosen sound visualization technique to present different *sound types* (e.g., footsteps, gunshots, etc.) of in-game sound effects. We aim to achieve this by exploring icon-based and text-based sound representation methods (Fig. 2).

This talk covers our experience of designing and evaluating the "VR Sound Mapping" prototype. During the talk, we share the quantitative result and the qualitative feedback of the study to help better understand designing audio visualization techniques for VR first-person games accessible for DHH players.

II. REFERENCES

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