Wayfinding and Navigating in Virtual Environment: Learning from Audio Games

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The recent developments of immersive audio technology have the potential to aid users in wayfinding and navigating in unknown virtual environments. Built around a 360-degree sphere, immersive audios have three components: multiple audio channels, ambisonics signals that are scene-based audio elements describing both the individual sources and the sound field as a whole, and audio object which is a mono track accompanied by metadata that specifies the exact position of that sound [3]. To simulate the way we hear and interpret the sound around us changes as we move, immersive audio utilizes the head-related transfer function (HRTF), where binaural stereo microphones are placed in the ears of a dummy and external sounds are recorded to create a head-print profile [1].

In this paper, we aim to understand the effectiveness of immersive audio in wayfinding and navigating in virtual environments. To that end, we conducted a pilot study with six participants (sighted, 3 males, 3 females), where each participant played an audio game, namely *A Blind Legend* [2] for 30 minutes. We chose this game because of its immense popularity in the blind and low-vision community, the use of immersive audio technology, and its intriguing gameplay simulating audio-cue based wayfinding in virtual environments. The screen remains dark during gameplay. The user plays the role of a blind knight whose wife was kidnapped. The knight goes on a rescue mission, accompanied by his sighted daughter who provides vocal instructions from a distance. Relying solely on auditory senses, the knight fights against unseen enemies in different virtual environments, e.g., in the forest, market, field, and city.

The participants varied in age (mean: 23.6, min: 22, max: 25), and general gaming skill (novice: 4, pro: 2). None of them had prior familiarity with this game, or audio game in general. Each session was divided into four stages with four specific tasks: (i) triangulate and find the daughter, (ii) routing through a market, (iii) finding and using a sword, and (iv) fighting against enemies. After each task, the participants were asked to evaluate their experience on a Likert scale of 1 to 5, 1 being the most negative experience and 5 being the most positive. Each session culminated with participants making suggestions and recommendations.

We found that the environmental cues that provide context changes (e.g, ambiance noises in the forest, clash of swords) to be very useful. However, as the number of sound sources increased in the environment (e.g., in the market), the participants started to experience discomfort. Half of the participants reported that the presence of a continuous yet subtle source of sound to be helpful in identifying the target direction. They also preferred harmonic noises (e.g., foot-

steps of the daughter) that were constant but grew louder as they came close to the target. Some participants suggested having a feedback loop that would utilize both positive and negative sounds to indicate the selection of a correct path. Others suggested using different pieces of music to specific locations in the environment.

Overall, participants found the immersive audio information comfortable to comprehend, but with prolong progress, the audio information proved to be quite inefficient. In the future, we will examine the use of multiple, familiar voice sources, such as dad, mom, fiance, providing vocal instructions as a means to improving wayfinding in virtual environment.

References

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