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Blindness Visualizer: A Simulated Navigation Experience

Claudia Krogmeier* Justin Heffron† Justin Legare‡ Michael Nelson§ Ziyi Liu¶ Christos Mousas‖

Department of Computer Graphics Technology
Purdue University, West Lafayette, Indiana, U.S.A

ABSTRACT

Exploration of the challenges faced by individuals who are non sighted or visually impaired has primarily been limited to physical methods such as blindfolds and controlled environments. Using virtual reality, we provide a simulation of blind navigation using a shader effect with scattered light. The scattered light represents the auditory and haptic feedback that the player receives while using a walking cane to navigate the virtual environment. We discuss methods of development, and goals for this simulation.

Index Terms: Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Virtual Reality

1 INTRODUCTION

Virtual reality allows users to experience situations and perceptions beyond the physical realm. When placed within a virtual environment, the user is able to embody new perceptions of self. Virtual reality creates new opportunities for empathy building due to an improved understanding of disabilities or abilities that the user may not have in reality. Our simulation offers a novel perspective of blindness via a navigation task. In our simulation, we use a walking cane, a tool commonly used by the visually impaired community, to navigate through space.

In order to visualize navigation, a shader program was developed to display the taps from the cane in scattered light. When the player taps the cane on the ground or on an object in the scene, haptic feedback is felt through the controller. Additionally, audio feedback that corresponds to the tapped object is played with each tap. The scene begins completely dark. The scattered light effect shows the user where her interactions take place and allow her enough spatial awareness to move through the environment and continue to tap. With the sound cues and physical vibrations that accompany the scattered light, we give the user a glimpse of her surroundings as well as an understanding of the difficulty she may have in finding her way.

2 CLOSEST RELATED WORK

To the best of our knowledge, "Notes on Blindness," a virtual reality experience, is the closest related work when compared to our blindness visualizer [1]. "Notes on Blindness" shows the viewer how a blind person might perceive the world, visualizing sounds with colored particles. Our simulation also visualizes sound, via scattered light, but instead places the user in the active position of exploration and challenge, as she must navigate with a walking cane. Unlike "Notes on Blindness," our simulation provides an environment in which the user can interact with her surroundings via the cane, in a world that is primarily unlit. With our simulation, the user has the opportunity to not only navigate in the dark, but also to experience an enhanced appreciation of audio and haptic feedback.

*e-mail: ckrogmei@purdue.edu
†e-mail: jheffron@purdue.edu
‡e-mail: jlegare@purdue.edu
§e-mail: nelso430@purdue.edu
¶e-mail: liu1362@purdue.edu
‖e-mail: cmousas@purdue.edu

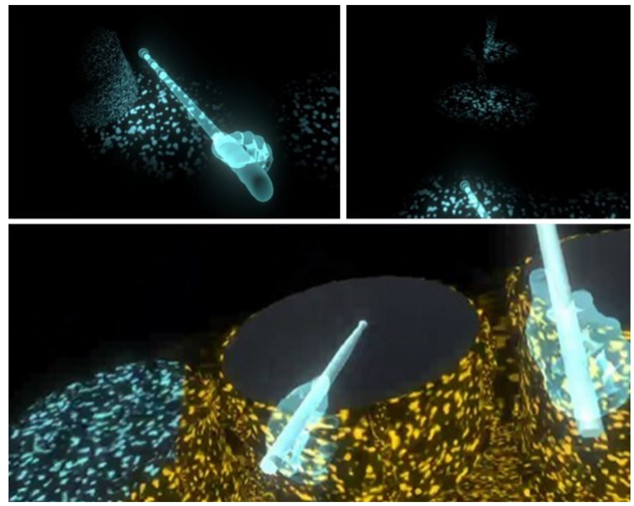

Figure 1: The Player's Perspective within the Blindness Visualiser. Top left: The player taps a suitcase. Top right: The player follows the Non Player Character (NPC). Lower: The player hits the drums at the concert venue.

3 DESIGN

Our design rested primarily on our story line: a blind musician must find her way to the concert venue to play a show. First, the user must find the door in her hotel room to reach the hallway. In the hallway, the user follows a non-player character (NPC) into a crowded lobby, where she must avoid obstacles such as guitars, chairs and other NPCs before arriving at the final door, which opens into the concert venue. The user experiences the scattered light feedback on tapped objects, as well as scattered light feedback to indicate ambient noises, such as people talking in the hotel lobby, and the clicking noise of high heels from the NPC who guides her through the hallway.

3.0.1 Player Interaction

This simulation was developed for Oculus using the Unity3D platform. An Oculus headset and a pair of controllers are used to track the head and hands. The user plays in place and may use the joystick to move forward. The player may use her physical body in order to rotate herself in the scene.

The player uses one controller for the walking cane, and the joystick of the other controller to move forward. We implemented a y axis threshold, above which users will not receive visual, auditory or haptic feedback upon taps. Any surface below the y axis threshold, which is about hip height, will receive the scattered light, auditory and haptic feedback when tapped. We developed this threshold in

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order to avoid users tapping too far above the ground, as this would not be a realistic way in which to navigate with a walking cane.

3.0.2 Scene Layout

Previous work suggests that individuals who are new to an experience may need landmarks in order to understand where they are within a new environment [4]. Therefore, we use landmarks such as furniture specific to each location in order to distinguish each space. We include different ambient audio in each scene in order to further indicate a change in rooms within the simulation. For example, when the play has successfully reached the end of a room, a door creaks open, which in turn initializes a scattered light effect on the door, before the player is transported to the following scene.

4 Features

4.0.1 Simulation of Blindness

In the blindness visualizer, all objects and surfaces are made with a dark, unlit material, rendering the scene completely dark when there are no sounds or taps. The blindness visualizer allows the player to see her hands as well as the walking cane via a glowing visual effect, similar in aesthetic to the scattered light effect for tapping. Increasing awareness of the player's hands was added with the intent to increase the player's feelings of presence in the virtual environment, in order to increase the player's emotional engagement [3]. Contingent upon further user testing, future iterations may include allowing the user to see not only the glowing hands, but an entire avatar body, in order to create a more full sense of self. Additionally, future iterations may include collaborations with NPCs.

4.0.2 Movement

In order to move forward in each room, the player uses the controller joystick on the hand opposite the walking cane. The player can change her direction by rotating her body in real life. Motion sickness was thought to be one issue for such a control mechanism. However, the darkness of the environment reduces the player's awareness of motion, which significantly mitigated the motion sickness in our preliminary user testing. In the current simulation, users are instructed as to how they may interact in the environment, and therefore users understand clearly how they move and rotate. In future iterations, we would like to design a tutorial scene in which the simulation itself explains the controls to the user. In this way, the simulation would be more intuitive.

4.0.3 Scattered Light Effect

The environment is constructed with unlit textures that accept an array of vectors to generate the scattered light feedback. When the cane collides with tap-able surfaces, it adds a point to the array, which generates a spherical effect at that point to illuminate any nearby objects.

4.0.4 Auditory Feedback

The audio feedback played in 3D space strengthens the spatial information for the player and assists in her ability to navigate. Audio feedback is also based on the type of object tapped; the sofa will play a softer thud when tapped, whereas a tapped guitar will sound metallic.

4.0.5 The NPC Guide

An NPC will lead the player through the hallway and to the door in the hotel lobby. The player can follow the sound of the NPC's high heels, which click and emit scattered light with each foot step. If the player becomes lost or falls behind, the NPC waits for the player to catch up.

4.0.6 The Concert Venue

The concert venue is the final scene, in which the cane is replaced by a drumstick in each hand. The player may hit symbols and snare drums as the drummer, while she sees guitar and piano players both visualized as they play. In this scene, the shader randomly assigns different colors to each tapped object, making this scene an explosion of color, sound and experience. With our final scene, we hoped to remind players that while non sighted individuals face challenges we may not be able to understand fully, non sighted individuals live fulfilled lives and participate in society as unique individuals. Therefore, we provide a colorful, highly interactive concert venue scene to conclude our blindness simulation.

5 Iteration

In order to find a balance between realism, referring here to the amount of darkness versus the amount of scattered light for visual feedback, and feasibility of navigation, we asked several students to play the simulation and provide feedback. Based on this feedback, we chose to create a more feasible scenario, rather than a very difficult, darker simulation. We made the simulation more feasible by increasing the radius of the scattered light. This allowed users an increased awareness of their surroundings based on the taps, while still maintaining a thought-provoking and challenging task.

We initially used the same "thud" sound for every tapped surface. Based on previous related blindness visualizations, we decided to implement different sounds based on which object was tapped, as providing varying audio feedback based on the type of object is desired by users [2].

One of our primary challenges was determining how the user should move through the environment. While it would be ideal to have users physically walk through the space with the cane, we realized this would not be possible with physical space limitations. We instead decided to use the controller joystick for movement. When several users reported slight feelings of disorientation, we removed the rotation ability from the joystick, instead allowing users to rotate by physically moving their bodies. We kept the joystick forward movement, as users reported little to no motion sickness from this type of movement, as the scene was primarily in darkness.

Initially, we implemented three types of haptic feedback felt via the controller, which were based on the tapped surface. However, we decided to remove any variation in haptic feedback, keeping only one vibration intensity, following blindness visualizer guidelines in previous work [2].

6 Conclusion

Our blindness visualizer was designed to challenge the player with the task of navigation as a non sighted individual. In playing our simulation, the user may be better able to empathize with those who are non sighted or visually impaired. We would like to continue user testing in order to improve upon our user interaction, as well as continue towards our goal of increasing understanding of the lives and experiences of non sighted and visually impaired individuals.

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