Use Cases and Impact of Audio-Based Virtual Exploration

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ABSTRACT

Audio-based virtual navigation experiences present an opportunity for people who are blind or have low vision to increase their familiarity with an area before traveling. Such experiences could also increase people's excitement and confidence in exploring places. As a preliminary investigation, we developed the Audio-based Virtual Exploration (AVE) app. In a user study with 14 people who were blind or had low vision, we explored use cases of virtual navigation, how app features could support those uses, and how the experience could impact mental maps and interest

CHI'19 Extended Abstracts, May 4-9, 2019, Glasgow, Scotland, UK.
Position paper submitted to CHI 2019 Workshop on Hacking Blind Navigation. © 2019 Copyright held by author(s).
ACM ISBN 978-1-4503-5971-9/19/05.
DOI: https://doi.org/10.1145/3290607.XXXXXXX

KEYWORDS

virtual navigation; blind and low vision; mobile app

and comfort in travel. Participants proposed using virtual experiences for navigation, exploration, and augmented reality. We present research questions around developing experiences to support these use cases and defining metrics of success.

1 INTRODUCTION

People may use road layouts, points of interest (POIs), and directions to gain familiarity with an area before traveling. We use the phrase "previewing locations" to capture broad information needs including navigation and exploration. A sighted person may preview a location by virtually walking an area using tools such as Google Map's Street View. People who are blind or have low vision have fewer resources and additional information needs for similarly building knowledge of an area. Audio-based virtual location previewing is one promising approach for providing such information. Beyond navigation information needs, such as building mental maps, we are also exploring how virtually previewing locations can impact someone's interest and comfort in physically traveling.

Our work explored (1) use cases for previewing a location using virtual experiences and (2) metrics of success beyond mental map accuracy. Based on this foundational work, we bring our ongoing research questions to the workshop: (1) How can audio-based, virtual interfaces support diverse use cases for location previewing (e.g. route familiarization, open exploration); and (2) How can we appropriately capture more diverse success metrics for assistive navigation technologies?

As a preliminary exploration of these research questions, we developed an Audio Virtual Exploration app, AVE, which provides an eyes-free means to preview locations. We conducted a user study with 14 people who were blind or had low vision. Participants completed a tutorial on AVE's features, used AVE to virtually preview an unfamiliar location, and then physically navigated that same location using Soundscape [7]. In the sections below, we discuss functionalities of VR navigation apps, potential use cases, and how these experiences can impact an individual's mental map as well as their confidence and interest in traveling.

2 DESIGNING AUDIO-BASED VIRTUAL NAVIGATION FUNCTIONALITY

AVE extends Microsoft's Soundscape app [7]. Soundscape gives people in-the-moment audio information about their surroundings. For example, it will announce intersections and POIs using spatialized audio based on someone's location. We aimed for AVE to give an analogous virtual experience of spatialized audio callouts. The main components of creating audio-based virtual location previewing experiences, such as AVE, include orientation, virtual movement, and informative audio callouts. A large challenge in building virtual experiences is finding a design that balances engagement, efficiency, information, appropriateness, and fun. Additional details on AVE's design is presented in the video figure [9]. We present our design choices and participants' reactions. The next section discusses participant-proposed use cases and how the use may impact these design choices.

2.1 Orientation

Orientation covers how people establish where they are in the virtual space. Similar to prior systems [2,5], AVE established orientation to the starting point in a virtual space using automatic

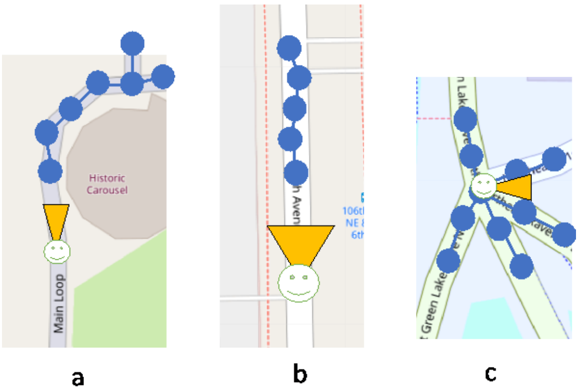

Figure 1: Examples of three types of road layouts and their virtual map representations. The roads illustrate different tensions between finding the correct angle to portray enough information without overly constraining movement: a) a physically perceivably curved road, b) a straight road with noisy data; c) a complex, 5-way intersection. A narrow angle may be more desired for the curved road (a) and the complex intersection (c) whereas road-straightening and a wider angle may be appropriate for the straight road (b).

and user-initiated callouts. We used a callout that stated the city, road orientation, and nearby intersections. People could pull additional information such as nearby POIs and the cardinal direction they were "facing" using the app's buttons.

Our study participants found orientation challenging. The lack of physical context (e.g. sunlight, traffic, familiarity) was a main contributor to their confusion. Solutions for improving orientation included using the app while in familiar locations (e.g. at home) where cardinal orientation was easier, or else using the app while physically at the location corresponding to their starting point in the virtual world. Promising prior work used spatialized audio icons to convey environment information [1,6,8]. Future work should investigate what information is most useful for orientation and how best to virtually simulate that information.

2.2 Virtual Movement

Interactions for virtually moving, similar to clicking on a street view image in Google Maps to progress down roads, is another key functionality. AVE movement included turning and "walking."

Prior systems implemented turning using dialog pop-ups and button presses [6] and moving the phone [4]. In AVE, users turn by physically rotating their body while holding the phone. The angle range defining when a user was facing a "walkable" direction attempted to balance conveying complex road structures with usability (Figure 1). Some participants liked the kinesthetic feedback of physical rotation. Others had difficulty mapping the rotations to meaningful information. Additional considerations included the social acceptability of physical rotation in public spaces.

In AVE, people "walk" by pressing a button while facing the direction of a road. Participants that enjoyed "walking" envisioned using the app to practice a route or enjoyed hearing POIs. Other participants found the interaction tedious. Participant-proposed interactions included intersection hopping or skipping roads that are not of interest.

3 USE CASES

Much of prior work focused on using virtual previewing to help people navigate relatively short turn-by-turn routes [3,4,6]. We explored how some properties of prior systems worked with larger, more complex spaces. Our study was conducted over three city blocks, with a shortest route distance of 900 meters. Participants had to make at least 4 turns and heard dozens of callouts. We probed for diverse use cases for virtual location previewing and how the experiences could impact confidence and interest in traveling. We discuss participant-proposed use cases, the functionalities that could support those cases, and their impact. We break use cases into navigation, exploration, and augmentation. Navigation is traveling with a destination. Exploration is traveling without a specific destination, e.g., just for the fun of being out and discovering new places. Augmentation shifts from purely virtual experiences to experiences that further enhance *in situ* physical navigation.

3.1 Navigation

In our study, we asked people to virtually and physically navigate to a destination without turn-by-turn directions. People followed a spatialized audio beacon that came from the destination's direction. The task was liked by one participant who found that independent route planning increased her interest in exploring. Other participants desired more support such as the app remembering the turns they took. Most participants, however, did not feel route creation was a compelling use for virtual previewing. Rather, they thought previewing could allow them to practice and enrich existing turn-by-turn directions. Useful context for navigation may include landmarks, number of intersections between turns, or road layouts.

3.2 Exploration

Participants found exploration a very compelling use case. They mainly wanted to explore known areas such as their neighborhoods or work places. Exploration goals included discovering locations, testing area walkability, and getting motivated to go out. As P1 stated "I would like to be able to explore [my area] and then be more confident of being able to walk around." With familiar areas, we can layer rich information. If the focus is safety or walkability, crosswalk and sidewalk callouts may be most beneficial. If location discovery is the main goal, POIs may be more important.

Participants also discussed exploration supporting *ad hoc* needs. As an example, P10 noted wanting to find a place for lunch and that "it's kinda cool that I would be able to get that information, rather than having somebody just tell me, 'This is what I see'." For in-the-moment use, interaction efficiency and social acceptability may play a larger role.

3.3 Augmented Reality

Virtual navigation could enhance *in situ* navigation supports, (e.g. Soundscape). One use case was flagging callouts during virtual navigation to filter callouts during physical navigation. For example, flagging places of interest, or unhelpful callouts so that only the most interesting information would subsequently be presented in the physical space. Additionally, space annotations could be added in virtual navigation, such as noting tricky intersection information that is later announced while physically walking at that intersection. These cases highlight tensions in information density; if the purpose is to filter, one may need to hear a higher density of callouts in the virtual experience to make an efficient *physical* experience.

Participants wanted to determine what major intersections were along a road without the effort of virtually or physically walking. One participant-proposed solution was an "ahead of me" feature that named the next few intersections, usable in both virtual and physical scenarios. Another suggestion was to virtually travel down a road ahead of them during physical navigation. This idea occurred when the participant was physically standing at an intersection. They described wanting to virtually travel down one road, hear the POIs, roads, and orientation to the destination then doing the same experience for the other roads before physically committing to one.

4 WORKSHOP INVOLVEMENT

Our prototype and user study highlighted the potential for people who are blind or have low vision to use virtual audio-based location previewing for a diversity of use cases and surfaced open challenges in supporting them. We believe that this work points to a rich space in the exploration of new useful, engaging, appropriate, and fun navigation experiences. The CHI 2019 workshop in Hacking Blind Navigation offers an opportunity to continue such exploration.

REFERENCES

[1] Jeffrey R. Blum, Mathieu Bouchard, and Jeremy R. Cooperstock. (2012). What's around Me? Spatialized Audio Augmented Reality for Blind Users with a Smartphone. . Springer, Berlin, Heidelberg, 49–62. http://doi.org/10.1007/978-3-642-30973-1_5

[2] Anke Brock, Philippe Truillet, Bernard Oriola, Delphine Picard, and Christophe Jouffrais. (2012). Design and User Satisfaction of Interactive Maps for Visually Impaired People. . Springer, Berlin, Heidelberg, 544–551. http://doi.org/10.1007/978-3-642-31534-3_80

[3] Erin C. Connors, Elizabeth R. Chrastil, Jaime SÃ¡nchez, and Lotfi B. Merabet. (2014). Virtual Environments for the Transfer of Navigation Skills in the Blind: a Comparison of Directed Instruction vs. Video Game Based Learning Approaches. Frontiers in Human Neuroscience, 8, 223. http://doi.org/10.3389/fnhum.2014.00223

[4] João Guerreiro, Dragan Ahmetovic, Kris M. Kitani, and Chieko Asakawa. (2017). Virtual Navigation for Blind People: Building Sequential Representations of the Real-World. Proceedings of the 19th International ACM SIGACCESS Conference on Computers and Accessibility - ASSETS '17, 280–289. http://doi.org/10.1145/3132525.3132545

[5] R Dan Jacobson. Navigating Maps with Little or No Sight: An Audio-Tactile Approach. http://www.aclweb.org/anthology/W98-0214

[6] E. Loeliger and T. Stockman. (2014). Wayfinding without Visual Cues: Evaluation of an Interactive Audio Map System. Interacting with Computers, 26(5), 403–416. http://doi.org/10.1093/iwc/iwt042

[7] Microsoft Soundscape - Microsoft Research. https://www.microsoft.com/en-us/research/product/soundscape/

[8] Peter Parente and Gary Bishop. BATS: The Blind Audio Tactile Mapping System. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.10.6189&rep=rep1&type=pdf

[9] Anne Spencer Ross, Edward Cutrell, Alex Fiannaca, Melanie Kneisel, and Meredith Ringle Morris. Use Cases and Impact of Audio-Based Virtual Exploration. https://www.microsoft.com/en-us/research/video/ave-audio-virtual-exploration-for-people-who-are-blind-or-low-vision/