Leveraging Street Cameras to Support Outdoor Navigation for Blind Pedestrians

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Introduction: Outdoor navigation in unfamiliar environments is challenging for blind and low-vision (BLV) people. GPS-based assistive technologies, such as BlindSquare and Microsoft Soundscape, are commonly used; however, such systems fail to assist with other aspects of outdoor navigation that require real-time and precise knowledge of the user. Thus, we are exploring the use of street cameras to leverage support for outdoor navigation for blind low vision pedestrians. We hope to address the common challenges faced by developing a street camera-based navigation system using computer vision that provides real-time auditory feedback. We take steps to answer the following research questions:

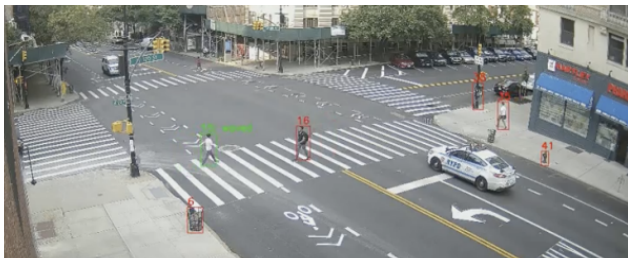
RQ1. What aspects of outdoor navigation do BLV people find challenging when using GPS-based assistive technology?

RQ2. How should street camera-based systems be designed to address these challenging aspects of outdoor navigation?

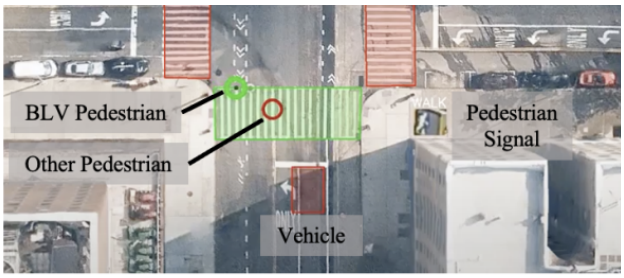
RQ3. To what extent do street camera-based navigation systems address these outdoor navigation challenges?

Methods: We answer RQ1 in the formative study. We recruited six BLV participants. We used a recent Critical Incident Technique, where we asked participants to recall and describe a recent time when they navigated outdoor environments using assistive technology. To analyze the interviews, we first transcribed the study in full and then performed thematic analysis involving three members of our research team. The street camera based system relies on a computer vision system that detects BLV pedestrian and obstacles, and an iOS companion app. In the next few weeks, we will conduct user studies.

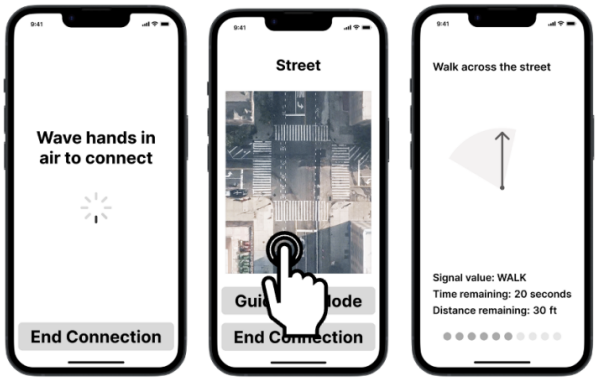
Results: As a result of the formative studies, we found that there are three main challenging aspects of outdoor navigation for BLV pedestrians: 1) anticipating environment layouts, 2) avoiding obstacles, 3) crossing street intersections safely. Therefore, we have designed a system to address these challenges by using street cameras to aid BLV users as they navigate. For challenge 1) we implemented map scrubbing feature to allow the user to understand the spatial environment, 2) street camera obstacle detection to alert for obstacles, and 3) audio/haptic feedback for safety to prevent veering and provide overall navigation support.



a) Street Camera



b) Bird's Eye View Map Representation



c) Companion App

Figure 1 Overall Street Camera Based Mobile App System. BLV pedestrians use the smartphone app (c) to interact with the street cameras (a-b) in receiving precise and real-time navigation assistance.

Conclusion: Our research team addressed major challenges that BLVs face when navigating outdoor environments. With user studies, we hope to attain insightful findings on our overall system, by identifying technical issues and necessary improvements to be made. We will compare our system to baseline navigation techniques. Our aim is to understand the extent to which street cameras can be used to support precise and real-time outdoor navigation.

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