# Leveraging Street Cameras to Support Outdoor Navigation for Blind Pedestrians

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## Abstract

Blind and low-vision (BLV) people use GPS-based systems for outdoor navigation assistance, which provide turn-by-turn instructions to get from one place to another. However, such systems do not provide users with real-time, precise information about their location and surroundings which is crucial for safe navigation. In this work, we investigate whether street cameras can be used to address aspects of navigation that BLV people still find challenging with existing GPS based assistive technologies. We conducted formative interviews with six BLV participants to identify specific challenges they face in outdoor navigation. We discovered three main challenges: anticipating environment layouts, avoiding obstacles while following directions, and crossing noisy street intersections.

## Research Questions

In this work, we investigate street cameras' potential for supporting aspects of outdoor navigation that require precise and real-time knowledge of BLV pedestrians' location and surroundings. To this end, we take preliminary steps to answer the following research questions:

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

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?


(A) Localization (B) Exploration Mode (C) Guidance Mode (d) Second Floor Street Camera View (e) Bird's Eye View Map Representation

**Figure. 1**. Overview of the street camera-based navigation system. Blind and low-vision (BLV) pedestrians use the smartphone app (a–c) to interact with the street cameras (d–e) in receiving precise and real-time navigation assistance. The system (a) localizes the BLV user by asking them to wave one hand, offering them the ability to (b) explore the environment layout, and then (c) guides the user to their destination while avoiding obstacles and veering off track, and assisting with crossing streets. Our supplemental video demonstrates the system in its current state.

## Formative Interviews

We conducted semi-structured interviews with six BLV participants to answer RQ1: What aspects of outdoor navigation do BLV people find challenging when using GPS-based assistive technology?

## Street Camera-Based System

We introduce a navigation system that we are currently developing to answer RQ2: How should street camera-based systems be designed to address the challenging aspects of outdoor navigation? The prototype consists of three components: street cameras, computational server, and smartphone app. Theses components interact with each other to facilitate two navigation modes that together address BLV people's challenges to outdoor navigation, which we discovered in our formative interviews.

## Future Work

We plan on conducting pilot studies to identify and fix any technical issues and to iterate over the system's design. To evaluate the street camera-based navigation system (i.e., to answer RQ3) we will conduct user studies with BLV pedestrians.

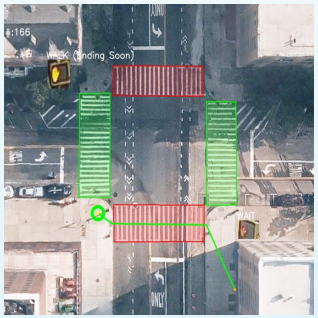

**Figure 2**. Overview of the system side street view. Once BLV users activate the smartphone app, the system senses their surroundings using computer vision algorithms.. The pedestrian always has the most up to date information. Collision and veering detection are calculated during navigation on the system in real time allowing for a safe transit.

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