LaunchGuide App

Project Proposal

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Executive Summary

Individuals who are blind or suffer from low vision, hereinafter referred to as VIPs, are usually fearful of venturing out on their own due to the environmental obstacles present outdoors. When VIPS do venture out, they find obstacles on sidewalks, and will eventually need to cross streets, many equipped with pedestrian crossing signals. These signals create challenges for VIPs as they lack audible information that tells VIPs their status with respect to crossing the street. Since it is imperative to improve accessibility, our project aims to create an app that will assist VIPs when navigating across busy streets through the auditory signal of information needed to cross the street. The app is comprised of two components: the accessible user interface and an image classification model to detect crossing signals. The user interface was coded in Android Studio using Java language and the on-device machine learning model was created with TensorFlow Lite. The image classification model has achieved an accuracy rate of 96%. In the future, this app can be made more reliable through the addition of distance triangulation and image detection of time signals at crosswalks.

Introduction

Globally, at least 2.2 billion people have a near or distant vision impairment (*Why Accessibility Is Important | National Center on Deaf-Blindness*, n.d.). Those who are visually impaired experience partial or complete loss of vision that causes problems not fixable by conventional devices, such as glasses (*Blind vs. Visually Impaired*, 2019).

Today, as intersections become more and more congested, signaling schemes often follow suit and become more complex. In the past, the standard design parameters were based on an able-bodied person, or one with good vision, hearing, and mobility (*Accessible Pedestrian Signals: Understanding How Blind Pedestrians Cross at Signalized Intersections*, n.d.). Unfortunately, these systems often fail to provide sufficient non-visual information for crossing decisions by VIPs. This is due to the information barriers that restrict an individual's ability to recognize and receive information from their surroundings. More importantly, it prohibits them from using this information to decide on a course of action.

As 26 percent of all Americans have some type of disability, and with that percentage increase, it is imperative to require design parameters to meet the needs of all pedestrians (CDC, 2023). With this in mind, our project aims to address the situation by implementing an app that will detect pedestrian crosswalk signals and return an auditory decision on whether the user should cross or not.

Visually Impaired Pedestrians

People who are visually impaired can travel and cross streets with human guides, white canes, guide dogs, and many other methods (*Can I Cross the Street? Considerations for a Blind Pedestrian | NADTC*, n.d.). Regardless of the aid that is used, street crossing often includes many steps. First, the pedestrian must determine if they have reached a street. Often, they use a combination of cues, such as the curb or slope of the ramp, traffic sounds, and detectable warnings (*Can I Cross the Street? Considerations for a Blind Pedestrian | NADTC*, n.d.). Next, they must recognize the exact street they have arrived at. This information is not typically provided in an accessible format, so VIPs must develop a mental map or seek assistance from other pedestrians (*Can I Cross the Street? Considerations for a Blind Pedestrian | NADTC*, n.d.). If the VIP has identified that they have come to an intersection, they must obtain critical information about intersection geometry, which is comprised of the location of the crosswalk, the direction of the opposite corner, the number of intersecting streets, the width of the street to be crossed, and whether there are any islands or medians in the crosswalk. In order to determine these details, they listen to vehicular sounds, traffic patterns, and search the sidewalk area for poles with pushbuttons (*Can I Cross the Street? Considerations for a Blind Pedestrian | NADTC*, n.d.). Unfortunately, it has become difficult to determine the type of traffic control at intersections that may fail to access the pedestrian push button and crossing at times other than the pedestrian phase. After determining the layout of the intersection, aligning to face toward the destination curb, determining that the intersection is signalized, and having pushed a button (if available), VIPs must recognize the duration of the walk interval.

Ultimately, VIPs have three types of problems at these intersections. First, they may not be able to wait through multiple light cycles to listen to vehicular signals as they would have to relocate the button and re-establish their heading. A second problem occurs when conditions do not allow the pedestrian to determine the walk interval. Finally, the pedestrian may not even be aware of the location of the push button. Additionally, some intersections may not even include a pedestrian phase or any auditory signals.

Fortunately, there have been many significant changes in the design of pedestrian signals that allow for more accessibility. These documents and procedures are detailed in the Americans with Disabilities Act.

Accessibility

It is imperative for ubiquitous appliances, such as pedestrian crosswalks, to be accessible. Accessibility is the concept of whether a product or service can be used by everyone-however they encounter it (*Why Accessibility Is Important | National Center on Deaf-Blindness*, n.d.). Not only does accessibility provide vital parts of user experience design, it also often benefits all users. These crucial statements have also been reiterated through the Americans with Disabilities Act of 1990. Specifically, the law outlines that the WALK/DON'T WALK cues from the visual pedestrian signal heads should be conveyed to pedestrians who don't have visual cues (Barlow, 2009).

In the context of crosswalks, the American Council of the Blind recommends the implementation of accessible pedestrian signals (*Accessible Pedestrian Signals (APS) | American Council of the Blind*, n.d.). Oftentimes, current signals can be confusing as people have difficulty remembering which tone is for which direction meaning the pedestrians did not know which direction to travel in. Additionally, the cuckoo-chirp sounds can be easily mimicked by birds (*Accessible Pedestrian Signals (APS) | American Council of the Blind*, n.d.). In an effort to decrease the complexity, the American Council of the Blind proposed an outline of more accessible features to implement into new designs.

Audience

This app identifies crossing signals and is specifically designed for visually impaired pedestrians. This app uses technology such as image classification to identify crossing signals and alert the user accordingly, allowing them to cross the street safely and with confidence. The app was made to be highly accessible, with features such as auditory cues, large fonts, and high-contrast colors to make it easier for visually impaired users to navigate. Ultimately, this app aims to provide essential service to a significant and often vulnerable population, helping to improve their independence, safety, and mobility.

Competition

Technology-centered approaches have become emergent solutions for pedestrians with visual impairment (Chanana et al., 2017). However, the true concern lies in returning environmental information in simplified and understandable forms.

Object Detection Systems

Obstacle detection systems include a variety of detection systems in order to determine obstructions in the field and convey information through haptics, audio, or tactile interfaces (Chanana et al., 2017). Some devices that utilize this system include Sonic guide, Path sounder, Mowat sensor, Sonic Pathfinder, and others. However, there are very few devices that are continuously improved and commercially available.

Mobility Cane

A mobility cane for the visually impaired aims to offer walking assistance. The user is able to get a better understanding of their surroundings from the sensor information that allows them to determine obstacles and orientation clues (*Types of Mobility Canes for Vision Impairment*, n.d.). Additionally, it allows others to identify visually impaired pedestrians and, thus, use caution around them (Crosby, 2021).

However, in the context of crossing busy streets, canes of any sorts can often fall short. As aforementioned, vehicular sounds are an important auditory cue for VIPs to grasp a better understanding of their environment. Unfortunately, canes are not able to detect speeding cars or silent vehicles when crossing an intersection. Cane travel can also be more challenging as the user is constantly receiving tactile feedback (*Guide Dogs Vs. White Canes: The Comprehensive Comparison – Clovernook*, n.d.). However, the VIP might also not get an adequate amount of tactile feedback as well.

Truncated Domes

"Detectable Warning" surfaces are often installed at major intersections, crosswalks, and transportation platforms across the United States. Truncated domes are the most conventional designs to provide VIPs tactile warning for potentially dangerous zones (*Detectable Warnings/Truncated Domes: Patterns - Perkins School for the Blind*, n.d.).

Unfortunately, there are some pitfalls to truncated domes. First, they can be damaged or removed as a result of constant plowing or shoveling (*Truncated Domes » Common Problems with Domes*, n.d.). This is a pertinent problem to the New England region as regular maintenance of snow can strip truncated domes. In accordance to the breakdown of the truncated domes, the panels are susceptible to cracks, peels, and lose screws or screw heads (*Truncated Domes » Common Problems with Domes*, n.d.). All of these compromise the structural integrity of the panel and create tripping hazard. Essentially, these problems take away the purpose of truncated domes in the context of VIP crossing.

Navigation Systems

Navigation systems provide directional information from a predetermined route. Most of these systems utilize GPS to assist VIPs to their destination (Chanana et al., 2017).

GPS-based Apps

For instance, BlindSquare is a widely used GPS-app developed for the blind, deafblind, and partially sighted (*BlindSquare*, 2022). This app is paired with a third-party navigation app and delivers auditory cues for points of interest and intersections. These points of interest are determined through algorithms that analyze popular cafes, post offices or libraries (*BlindSquare*, 2022). In terms of a return, BlindSquare uses Acapela voices, which utilizes many different languages, to announce this information regarding the surroundings. These cues can also be delivered through a hands-free experience (*BlindSquare*, 2022).

While GPS-based apps that follow similar outlines to BlindSquare can be a helpful addition to the navigation toolbox, there are some potential pitfalls to be aware of. One major concern is the reliability of GPS technology, which can be affected by factors such as poor satellite signals and interference from buildings and other structures. This can lead to inaccurate directions and confusion for the user. Additionally, BlindSquare relies heavily on user input and updating of information about points of interest, which can be time-consuming and difficult to keep up-to-date. Finally, BlindSquare may not be suitable for all blind pedestrians, particularly those with limited technology skills or those who prefer to navigate using traditional mobility techniques. Overall, while GPS-based apps can be a valuable tool for many blind pedestrians, it is important to be aware of these potential pitfalls.

Specifications

When developing an app for VIPs in Android Studio, there are key specifications to be considered. First, the app should be designed with accessibility in mind, using features such as screen readers and voice commands to make it easier for visually impaired users to navigate. The app should also use high-contrast colors and large fonts to improve visibility for users with low vision. Additionally, the user interface consists of standard logos and placements for directory buttons. By considering these specifications when developing a blind people friendly app using Android Studio, our project aims to be accessible, compatible, and user-friendly for visually impaired individuals.

In order to detect crossing signals, this app uses on-device image classification. Firstly, in order for the app to be effective, the images should be detected and classified in real-time. Our app is able to passively take pictures of the user's surroundings on five second intervals. Also, the app should be able to process these photos quickly as well in order to return a decision that is still relevant to the user's surroundings. Our most viable option to meet this goal was to utilize on-device machine learning. Traditionally, ML models would run on powerful servers in the Cloud. However, on-device machine learning allows you to perform inference with models directly on a device. Innovations like TensorFlow Lite framework allow our project to run on-device machine learning models on Android, iOS, and other consumer devices. After the model was built, it was then trained on Jupyter.

Feedback

Getting feedback from visually impaired clients is essential to ensure that our app meets their needs and is user-friendly. Our team will actively seek feedback from our visually impaired clients through a program run by visually impaired attorney Liz Myska. The program, WalkFit, aims to increase awareness for visually impaired pedestrians. The group is composed of visually impaired individuals as well as sighted individuals. Additionally, we are working under the direction of Jack Peacock of Peacock Communications, Inc. We aim to gather insights and suggestions on how to improve the app. Our team will carefully evaluate all feedback received, prioritize the suggestions based on their impact, and develop a plan to implement the changes. We will regularly update our clients on the progress and inform them about any new features and improvements to the app. Our team is committed to making the app accessible, user-friendly, and responsive to the needs of our visually impaired clients. By actively seeking and responding to feedback, we can ensure that our app is continually improving and providing the best possible service to our clients.

Potential Future Additions

Our project is comprised of four phases. The first two phases aim to complete the minimum viable product which is comprised of an accessible user interface with a camera that captures images on five second intervals and implements an on-device image classification algorithm. The next two phases are aimed at improving the app's decision for the user.

Triangulating Distance

Phase three is to triangulate the distance to the other side of the street. This new feature would utilize LIDAR or ARKit for determining the distance to the pedestrian signal across the street.

Identify Countdown

After being able to triangulate the distance, the next step is to be able to identify a countdown signal. This would allow the model to identify the status of the crosswalk signal's current time remaining for the cross and provide a more accurate decision.

Incorporate Pace and Time

The last phase is to incorporate the user's pace and determine whether the user has ample time to cross. This feature would provide another layer to a more accurate decision for the user.

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