Project Eye-Helper
An Assistive Technology for Blind Grocery Shoppers

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1. RESEARCH FIELDS

Assistive Technology, Wearable Devices,
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2. INTRODUCTION

Currently, when a blind person goes grocery shopping, the store management must provide an employee to guide the blind customer and heavily assist with most, if not all, of the shopping. This 'dependent shopping' situation often makes the blind person uncomfortable since it calls attention to the handicap and strips him/her of self-sufficiency. The project's motivation is to improve the shopping experience of the blind such that the user can shop independently and efficiently simply by installing new software onto the electronics that they already use daily. This will be done with a combination of crowdsourcing (in which a human will identify the desired grocery item, i.e. object recognition) and computer vision (in which the device will track the item from image to image and navigate the user to the product).

Over the past year, we have prototyped on a variety of platforms, such as the Google Glass paired with an Android smartphone application, the Raspberry Pi and Camera Module (integrating software subsystems via the ROS platform [4]) – see Figure 1– and most recently, the Google Tango [1]. The Google Tango tablet uses three cameras and an accelerometer to provide very accurate estimation of device position and orientation. Additionally, the Tango produces 3D point clouds that provide the location of objects of interest in the environment. Each platform brings a variety of possibilities for perceiving the environment and exploring potential avenues for human-device interactions.

This is following the growing trend of developing mobile device applications that utilize voice commands and other built-in accessibility features to create useful software specifically for the blind. The blind community is full of active smartphone users who appreciate mobile technology for everyday tasks such as email, internet browsing, leisure, and so on. Prior communication with the blind community about Eye-Helper resulted in strong interest, so there are confirmed opportunities for ongoing user testing and feedback from the target audience.

3. BACKGROUND AND RELATED WORK

As mentioned in the previous section, there is a trend in creating computerized assistive technologies for the blind. Examples include systems for obstacle avoidance [9] and travel aids [6] via a cane.

The GroZi project's [2] approach relies primarily on computer vision rather than a combination of crowdsourcing, computer vision, and design methods.

Crowdsourcing mobile applications like TapTapSee [5] have also been popular in the blind community – this validates the effectiveness of crowdsourced volunteers performing object recognition tasks at a large scale.

4. APPROACH AND UNIQUENESS

User-oriented design: By engaging with the target audience early and frequently in the development process, we crystallized candid insights on how to make the most impact and positive change in the lives of the blind. Understanding the user in interactive co-design sessions allows us to create an effective interface with a gentle learning curve. Co-design is the process of creating and iterating on the product idea in real time (meeting up with individuals from the target audience to simultaneously discuss, ideate, and craft prototypes together). This enables the users to be involved in shaping the technology's outcome, as well as share everyday, personal perspectives we would not have known by just hypothesizing or reading papers about the community. We want to make a device users would wholeheartedly choose over the current option of being accompanied in the store by an employee who has not been trained to assist the blind.

Crowdsourcing refers to using the efforts of many volunteers to accomplish various tasks, usually coordinated and done through a website. This 'micro volunteering' through a web application is often more appealing than other volunteer commitments, which typically require physical commute time, a search to find appropriate volunteer jobs in the nearby area, and coordination of specific volunteer shifts into busy schedules.

Computer vision refers to processing and analysis techniques used for obtaining useful information about a given image or video. An overview and examples of computer vision capabilities can be found in the OpenCV library tutorials. [3]

We will utilize the abilities of crowdsourced volunteers to recognize grocery items (which is easy for humans but a difficult computer vision task), and utilize computerized systems for object tracking (a relatively easy computer vision task) while navigating the user to the target item.

By combining these applications of computer science with wearable device platforms and a user-oriented design perspective, an intelligent system can be built to help a blind person shop efficiently and effectively without the assistance of a sighted employee. This project is a collaboration between computing, engineering, and design students with interdisciplinary minds and a passion to improve the lives of our target audience. As such, we will combine these methods to create something that has much more potential than just computer vision or crowdsourcing alone.

5. RESULTS AND ITERATIONS

In past year, we have been developing the Eye-Helper device in our on-campus lab and frequently visiting individuals in the local blind community, both to obtain insights on the current grocery shopping situation and to gather candid target audience opinions on our product. We are striving towards a proof of concept for this device. Once we have a robust prototype, we will investigate the crowdsourcing strategies and business model to make this project feasible on a larger scale.

The feedback from each user experience motivates the innovations for the next Eye-Helper iteration. We will now discuss results and insights from these iterations.

Firstly, we developed a software prototype for the computer vision functionality of this device. After testing a handful of computer vision feature descriptors, a combination of the SIFT (Scale Invariant Feature Transform, see [8]) and meanshift (see [7]) techniques were the most robust and reliable given our grocery store testing footage taken in various aisles of a local store. We used this as a starting point for the computer vision subsystem of Eye-Helper.

Soon afterwards, we integrated the computer vision features with a positional audio interface (a separate software prototype, also developed by us on campus), which generates a series of beeps which vary depending on the angle, distance, and height between the user and the target grocery item.

The next step was to assemble a wearable prototype to test the software in potential grocery shopping scenarios. See Figure 1 and 2 for visuals of our on-campus testing device and setup.

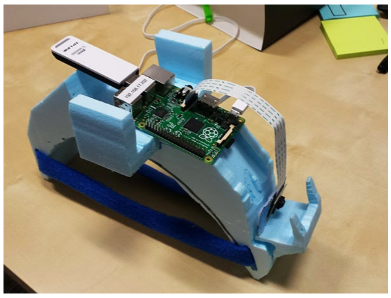

Figure 1: Eye-Helper prototype consisting of a Raspberry Pi, camera module, and blue foam headgear.

Figure 2: Left: Front view of user wearing prototype shown in Figure 1.
Right: Snapshot of on-campus user testing on a mock grocery store wall poster.

Based on experience testing, we determined that the device needs to:

- Be **more efficient than the current situation** (being guided through the store) for users to even consider adopting this technology.
- Be **hands-free** (because the user's hands are needed for shopping, pushing/pulling shopping carts, walking with a guide animal, and so on).
- Function when the user's **hands are in the camera's field of view** and/or when the **object temporarily exits the view due to user movement**. The Google Tango prototype addresses this.
- Precisely track an object **even when multiple objects of the same kind are next to each other** (e.g. multiple cans of the same grocery on a shelf).
- Have a **natural, intuitive way of telling the user where to go**, while not over or understimulating the user with information. Every user goes at a different 'pace' and has different movement capabilities, so this makes Eye-Helper personal.

We will continue applying an agile development methodology of iterating and interacting. Currently, testing is done on campus; we aim to test Eye-Helper in real-life situations in local grocery stores to motivate the next innovations. As such, there will certainly be even more prototypes, demo videos, and insights to share by the October conference date.

6. REFERENCES

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