

ABSTRACT

Title of thesis: A KINECT BASED INDOOR NAVIGATION
 SYSTEM FOR THE BLIND

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Team NAVIGATE aims to create a robust, portable navigational aid for the blind. Our prototype uses depth data from the Microsoft Kinect to perform real-time obstacle avoidance in unfamiliar indoor environments. The device augments the white cane by performing two significant functions: detecting overhanging objects and identifying stairs. Based on interviews with blind individuals, we found a combined audio and haptic feedback system best for communicating environmental information. Our prototype uses vibration motors to indicate the presence of an obstacle and an auditory command to alert the user to stairs ahead. Through multiple trials with sighted and blind participants, the device was successful in detecting overhanging objects and approaching stairs. The device increased user competency and adaptability across all trials.

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by

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Chapter 1: Introduction

Blindness is a severe disability that affects over 45 million people worldwide and presents formidable challenges and hardships in a visually-dominant world [1]. Even mobility in one's surroundings is traditionally dominated by visual perception [2]. Corn and Sacks' survey of visually impaired individuals showed that a majority are frustrated by a lack of spontaneous movement [3]. Accordingly, the blind community strongly desires a device that allows for further independence in unfamiliar environments [4]. Morton and Yousuf found that assistive technologies allow the blind to feel more confident when navigating through their surroundings [5]. Although many electronic travel aids have been produced to ease navigation for the blind, many have not been widely adopted due to high cost, inaccuracy, or inaccessibility. The blind must still rely primarily on the same tools, namely the white cane or the guide dog, that they have for decades.

In recent years, previous Gemstone team Vision (2009) aimed to provide an alternative solution to existing blind assistive technology. Team Vision utilized a global positioning system (GPS), inertial navigation unit (INU), computer vision system (CVS), and a speech-based interface to provide walking directions to certain buildings in an outdoor environment, and to identify and locate objects and signs

via audio feedback to the user [6]. We continued this research theme of practical technological solutions for the blind by developing a portable, noninvasive, and cost-effective product that allows users to maneuver indoors. The goal of this project was to develop a device that can supplement the cane in order to allow blind individuals to navigate with more efficiency and ease. The final prototype utilizes the Microsoft Kinect, which is a popular commercial sensor commonly used for gaming. It is a robust imaging system, which contains an infrared sensor, an infrared projector, a microphone array, and a RGB camera [7]. Using these sensors, the Kinect can create a depth map, which gives 3D information on the space within its field of view. We used the environmental information from the Kinect, processed the data on a Microsoft Surface Pro tablet, and returned actionable information to the user via haptic and audio feedback. This device performs obstacle avoidance and has two key features the white cane does not currently provide: It can detect the presence of overhanging obstacles and alert the users in the case of an approaching staircase. The device uses a non-intrusive feedback system, with vibrating motors to alert the user of objects in his or her path and an audio cue to tell the user if they are approaching an ascending stair. To better understand how to develop a travel aid for the blind, we sought to understand their navigational challenges, the existing technology available, and computer vision algorithms useful in gleaning information about the environment. We conducted numerous interviews with blind individuals, collecting data about their preferences regarding assistive technology and testing recently developed computer vision algorithms for this project. We approached the design, build, and test stages of this assistive device through an iterative process.

We built the system modularly, so that each functionality from feedback to obstacle avoidance could be built and tested separately. Our final product was tested with blind individuals and we determined its effectiveness using the Psychosocial Impact of Assistive Devices Scale (PIADS) [8], a survey developed specifically to assess the psychosocial impact of assistive devices on the user. Blind participants using our device felt a positive improvement in competence, self-esteem, and adaptability when navigating indoor environments.

This thesis will discuss our approach to the product development process and research into intuitive user interfaces for the blind. It will also provide an overview of the hardware and software system components of our prototype and our testing process and results.

Chapter 2: Literature Review

2.1 Electronic Travel Aids

Electronic Travel Aids, otherwise known as ETAs, have long been used as assistive devices to increase the mobility of the blind. Research shows that the blind desire and benefit from using assistive devices that help with both navigation and object recognition [9]. ETAs consist of three main components; the sensors that take in data from the surrounding environment, the software that processes this data, and a useful feedback mechanism that supplies environmental information to the user. In the past, many ETAs have relied on a wide variety of sensors for collecting environmental data, including ultrasonic, pyroelectric, and inertial devices, as well as GPS. To provide useful information to blind users, many ETAs have used audio and/or tactile feedback.

Many research institutions, including New York University, University of California Santa Barbara, and Florida University have made efforts to create electronic travel aids for the blind. An example of an early ETA developed in 1998 was the People Sensor. This device specifically addressed the problem of bumping into people by using pyroelectric sensors to detect body heat, and ultrasonic sensors to identify their location. With this ETA, vibration was used to indicate whether or

not the obstacle was human [9]. However, the functionality of this device is limited by its purpose. While it helps users to avoid slow-moving or stationary people, it was not meant as a primary mobility device. Instead, it was meant to be used in conjunction with a white cane or other device and only provided feedback when a person is detected.

Another example of an Electronic Travel Aid that made use of the pyroelectric and ultrasonic sensor combination was the Drishti device, developed in the early 2000s [10]. This device was far more advanced than the previously developed People Sensor as it had both indoor and outdoor modes and could also gather information on location and destination using GPS. The Drishti device had two major setbacks. From a technical standpoint, the system could not determine height and thus only worked on a two-dimensional plane and could prove problematic when the user sat down or changed their pose. This could become an even bigger issue if the user encountered stairs, as the device would not reliably detect them. Secondly, the device was physically large and involved wearing several different components: a headset, a wearable computer, and the ultrasonic and pyroelectric sensors. This was not as convenient for its users as a smaller, more low-profile device.

Another device that attempted to aid in blind navigation by utilizing GPS was developed at the University of California, Santa Barbara. Using GPS in conjunction with a compass, velocimeter, and inertial sensor, this device was designed to aid their users in navigating tight indoors spaces. However, the use of GPS became the critical problem for this device, as the signal strength decreased or disappeared indoors and produced inaccurate information [11].

To address this difficulty in indoor navigation, a more recently developed ETA aimed to ease navigation indoors by using Radio Frequency Identification (RFID) tags [12]. RFID tags placed throughout the building provided the user with information on the building's layout. The user vocally indicated the desired destination to a small laptop computer. The user's location was tracked using information from the nearest RFID tag. From their location a remote server determined the best way to arrive at their destination, guiding the user through audio feedback. While this device showed some promise, the main drawback was the connection to their remote server. It frequently experienced communication delays on startup which resulted in delayed feedback.

The Kinect has been used in Electronic Travel Aids to provide real-time indoor navigational feedback to users who are blind [13]. Barroso et. al. used raw depth data along with a neural network to classify obstacles. The network was effective at pattern matching and showed promise for identifying obstacles, particularly stairs. This device was mounted on the user's chest and sought to augment the functionality of the white cane. Testing proved that the Kinect is a viable sensor for an Electronic Travel Aid. Unfortunately, the device did not provide any feedback to the user on how to avoid obstacles, and testing was limited.

A recent hybrid ETA combines infrared and ultrasound technology in order to detect obstacles directly in front of the user [14]. Combining two different methods of detection provides more detail and detection accuracy. The device uses infrared sensors to determine the location of the obstacle with respect to the users feet. The ultrasound capability of the device helps determine how far the object is away from

the user. The output from the device is relayed back to the user using two vibration motors. Different signal filters are used to minimize noise and reduce lag time.

In addition to these electronic travel aids, there has also been a recent trend towards the use of biotechnology to improve vision for the blind and visually impaired. One such approach is Argus II Retinal Prosthesis System, or the “bionic eye”, which was recently approved by the FDA [15]. This device consists of a chip implanted on the retina as well as a camera mounted on a pair of eyeglasses. This camera transmits images to the retina chip which then relays information to the brain via the optic nerve. While this device helps restore some vision, in its current state it has several significant drawbacks that prevent it from being an effective travel aid. For one, the bionic eye only offers very low vision and only allows its users to see points of light. Additionally, the device is very expensive, costing over \$100,000 and would not be able to benefit all blind people, only those suffering from damaged photoreceptors.

With all these different assistive devices, there must be a way to measure their degree of success. Researchers at the Assistive Technologies and Research Center have reviewed many such electronic travel aids, surveyed blind participants and classified specific benchmarks for success. The ETAs they reviewed were each classified by how they provided feedback to their users. Their conclusion was, that among other metrics, the targeted blind users desire a device that is wearable, cheap, robust, and able to operate in real time. Based on their interviews, they concluded, “There is no system incorporating all the features in a satisfactory degree” [16]. While their study included many other ETAs, they found the lack of real-time

capability to be a major setback. The stipulated metrics have become critical in the design of our device.

2.2 Sensor Technology and Applications

The Microsoft Kinect is a device that utilizes infrared light to generate a depth map that can be used for a variety of purposes. In addition to its 3D imaging capabilities, the Kinect also includes an RGB camera, a motorized pivot, and a microphone for speech recognition. While initially developed as a game controller for the Xbox 360, the Kinect has since been adopted for many computer vision applications due to its affordability and advanced 3D imaging capabilities. One such study involved using multiple Kinects in order to obtain a more comprehensive 3D image of an object. The detailed image was then used to design intricate customized avatars [17]. Another study presented an algorithm that integrated a color image and the corresponding depth map from a single Kinect to form similar high-quality personalized avatars [18]. These studies demonstrate the Kinect's capacity to recognize and process facial and full-body images efficiently. This also validates the Kinects ability to provide data that can be processed with OpenCV, a commonly used computer vision library. The Kinect can also be used for object detection and avoidance. In a study at the University of Guanajuato, the Kinect captured several images of a room in order to optimize the movements of a robot [19]. This process illustrated the viability of performing fusion in real time on RGB and depth data from a Kinect. Another application used both the Kinect and Asus's similar infrared Xtion device

to create an intuitive interface for 3D virtual globes. The Kinect and Xtion assimilated information about the movements of the user and interpreted them in order to interact kinetically with Google Earth [20]. An application in a similar vein was developed for viewing medical images during a surgery [21]. All of these studies validate the notion that the Kinect can be used as an effective computer vision tool.

The Kinect has also been used as an electronic travel aid. The NAVI system used a head mounted Kinect for obstacle detection and internal navigation using augmented reality markers while using Arduino Lilypads worn on the belt to provide haptic feedback. The obstacles were identified using a depth histogram [22]. Another system was developed using both the Kinect and a stereo camera system mounted on the head and chest. This cognitive guidance system made use of fuzzy logic and RANSAC algorithms to compute paths through hallways and around obstacles [23]. Another Kinect application was an algorithm developed by Perez-Yus et al. to detect stairsteps using a chest mount. It was evaluated and validated with Kinect data but is applicable to any similar depth sensor [24].

2.3 Computer Vision Algorithms

2.3.1 Discriminately Trained Part Based Models

Felzenszwalb et. al's discriminatively trained part-based models relies on the histogram of gradients (HOG), which predates this algorithm [25]. HOG relies upon normalizing an input image, computing the gradients, and comparing it to known spatial blocks before running the image through a linear support vector

machine [26]. As a result, an object can be identified even if its scaling differs from the training data. Felzenszwalb et. al. refined this approach by including deformable models, which allows one to identify an object in different poses along with its principal components. For instance, if one used this approach to identify a person, one could identify both a person sitting and standing, along with finding the head, body, and limbs. NAVIGATE researched this approach as a potential option for obstacle detection and tested various code demos. While the algorithm is accurate and reliable, it does not run in real-time and its authors only have MATLAB implementations currently available.

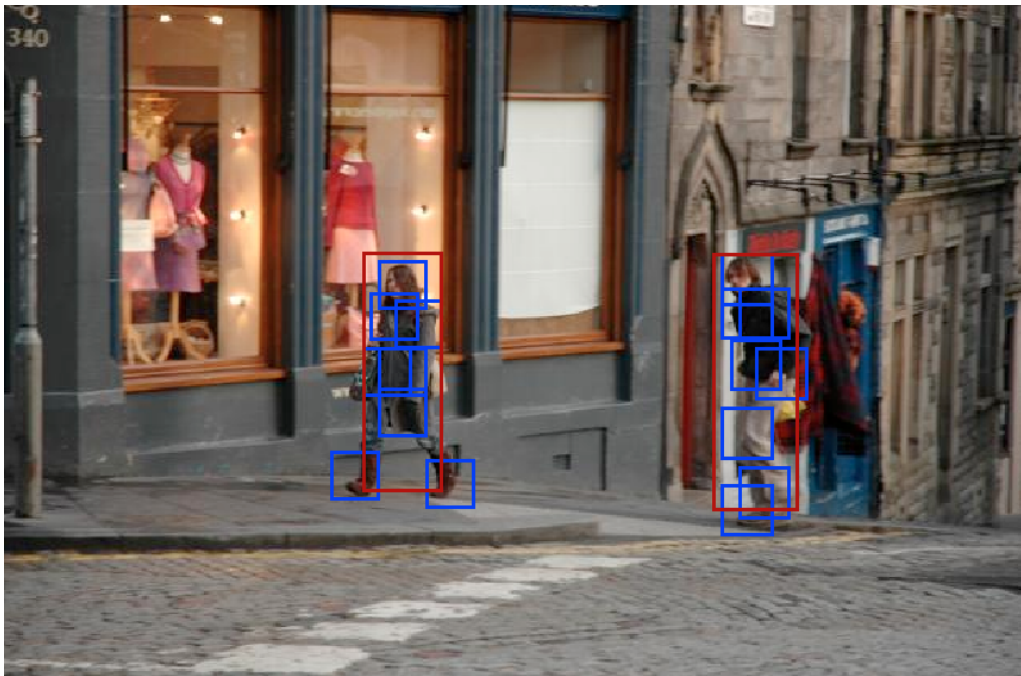


Figure 2.1: Discriminatory Part Based Models [25] used to locate people in an image.

2.3.2 Recovering the Spatial Layout of Cluttered Rooms

Hoiem et. al's algorithm for recovering the spatial layout of cluttered rooms works by identifying long lines within an image [27]. These lines are used to find vanishing points, where the projections of parallel lines intersect in a perspective image. Using the most likely vanishing points, aforementioned lines, and other features, a set of estimates for the room structure is generated. These estimates attempt to find floor-wall and ceiling-wall boundaries. The set of estimates is then ranked using a trained structure learning algorithm. The top sets of boundaries are used to redetermine important features, and using these redetermined features, the algorithm produces a second, more accurate, ranking in a similar manner. Our adoption of this algorithm revealed that it was not suitable for real-time applications. Furthermore, the Kinect SDK offers an alternative to image-based 3D reconstruction by readily supplying a live stream of accurate 3D data.

2.3.3 Planar Detection using Random Sampling Consensus

RANSAC, or RANdom Sampling Consensus, is a very popular and general algorithm often used in computer vision to estimate desired parameters in a dataset containing a large amount of outliers. There are a diverse number of applications of the RANSAC algorithm, having been used in various experiments, including recognizing repetitive patterns in images and planar fitting for autonomous vehicle navigation [28] [29].

The RANSAC algorithm first takes a random sample from the larger data set

and performs the calculations necessary to produce the desired model based solely off of that subset. The next step in the algorithm is to apply this model to every other data point in the larger set and determine how accurately that model fits the other data within a certain allowable error margin. The process is iterated until an algorithm is found that best fits the entire dataset.

For planar determination using the Kinect, the RANSAC process begins with selecting three points at random from a point cloud. Once these points are selected, the initial model is created when all plane parameters are calculated. The rest of the points in the cloud are then treated as if they are on the plane and the distance from each point to the plane is determined. If the point is within a certain distance from the plane, then it is considered to be on that plane. Then the accumulator, which tracks the number of points that fit each plane model, is incremented. This process is then iterated for various randomly selected points in the point cloud. Once the algorithm has run on all points in the point cloud, any plane with an accumulator value above a certain threshold is determined to be a real plane, which can be a floor, wall, table, or other flat surface.

Chapter 3: Methodology

Team NAVIGATE is comprised of twelve undergraduate students enrolled in the Gemstone Honors Program at the University of Maryland, College Park. Gemstone is a four-year, team-based interdisciplinary research program designed to provide students an opportunity to pursue research in an area of interest. Teams are composed of honors students from diverse academic backgrounds, guided by an expert mentor in the project’s field.

At the suggestion of our mentor and based on training received in Gemstone’s team dynamics course, we chose an iterative product development process for our methodology. Inspired by Dix et al.’s product design , our process was divided into three stages: problem specification, iteration, and conclusion [30].

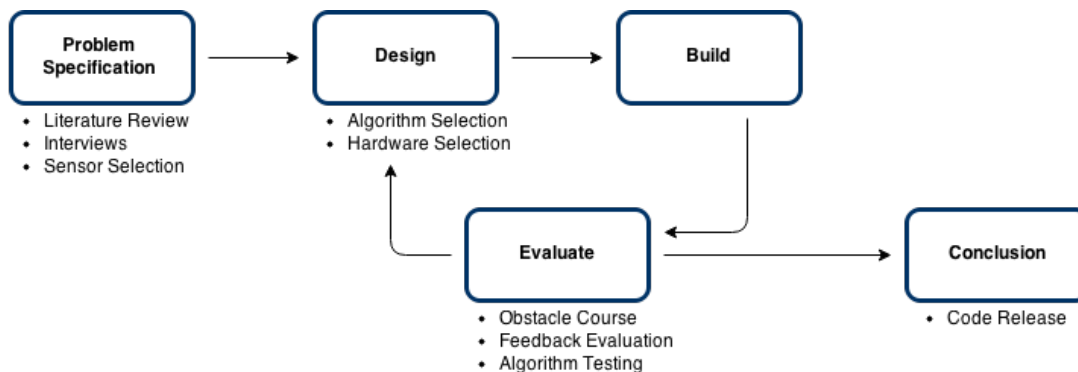


Figure 3.1: Project Design Methodology

In the problem specification phase, we evaluated existing electronic travel aids

for the blind through an extensive literature review. We also interviewed members of the blind community to gain their perspectives on the assistive devices they use and on specific features to incorporate into our system.

Our intention was to select a robust sensor and avoid costly backtracks that would require learning new SDKs and purchasing new sensors. We chose the Microsoft Kinect as our sensor because of its affordability, accessible SDK, and accurate depth data.

At the end of problem specification, we interviewed 27 blind individuals recruited through organizations such as the National Federation of the Blind, Columbia Lighthouse Institute for the Blind, and the American Council of the Blind. The chief lessons learned from this stage were that our device should be able to detect stairs and overhanging obstacles and should have a combination of audio and haptic feedback to communicate information about the environment.

The second phase, iteration, was a cycle of smaller steps: design, build, and evaluate. In the design phase, we took the feedback gained in the problem specification phase and designed a prototype. Each part of the modular system we created was built and tested separately before being integrated into one cohesive design. We tested the feedback system separately with blindfolded individuals. We then tested each functionality individually, from obstacle avoidance to the detection of overhanging objects and stairs. This process allowed us to identify bugs and anticipate and integrate user feedback early. We completed three iterations of design, test, and build with our prototype. The first two iterations were tested with blindfolded sighted participants and the last iteration was tested with blind subjects. Feedback

from each stage gave way to an improved iteration of our design for the following stage.

Our conclusion phase is the open source release of our code under the MIT license.

Chapter 4: Interviews

4.1 Blind Interviews

In order to identify and integrate desirable features into our indoor navigation system, we interviewed blind individuals associated with National Federation of the Blind (NFB), the Columbia Lighthouse Institute for the Blind (CLB), and the American Council of the Blind (ACB). We conducted semi-structured, phone-based interviews, each over a duration of 30 minutes. Of the 27 subjects interviewed, 16 were male and 11 were female. All subjects were 18 years or older, with a median age of 44 years old.

4.1.1 Background

The first several interview questions included the onset of blindness for each individual, the cause of blindness, experience with other navigational devices, and most common navigational difficulties faced by interviewees on a daily basis. Following that, we asked the interviewees specific questions about our proposed device, including their openness to using our device, the ability of our device to complement the cane, their preference for the best placement of our device on the body, and the

best method of feedback from the device.

The onset of blindness, whether the subject was born blind (most often due to congenital defects) or if they developed blindness later in their life, is a significant measure of the perceptive capabilities of the blind individual. Those blind from birth are more likely to have better skills with traditional navigation methods like the cane and have superior echolocation abilities than those who became blind later in life [31]. In our sample, 33% of subjects were born blind and 66% of subjects developed blindness later in life. The cause of blindness varied from individual to individual. Some common causes included retinoblastoma, congenital glaucoma, later-onset glaucoma, optic nerve damage, juvenile cataracts, and retinopathy prematurity.

We surveyed the field of existing assistive navigational technologies for the blind by asking whether they currently use a navigational aid or have used one in the past. Of the blind individuals interviewed, 59% said that they currently use assistive devices other than the white cane. These devices include the Apple iPhone, which offers applications that utilize its GPS capabilities to assist in making daily navigational tasks easier for a blind individual. In reference to a specific iPhone GPS application, one participant said, *“I tend to use them to do comparisons. I use them in areas I am familiar with, and I have relied on them more than not, so I do find them helpful”* (Participant 12).

We also took into account past experiences with assistive navigational technologies that may influence the openness the blind feel towards our proposed device. Of the interviewees, 33% noted that they have not used other assistive devices in the

past, while 67% discontinued use of a device for various reasons. Individuals stopped using devices such as the Trekker Breeze by HumanWare (a talking handheld GPS) and canes using ultrasonic frequencies because of learning curves and technological complications (e.g. unreliable information, disruptive cues, or undesirable product design). Most of these devices strived to replace the white cane, but in the end, they presented more hassles than they were worth. One subject remarked, *“There was a learning curve that you have to learn you have to interpret what sound meant what, and also being that Im totally blind and dependent on my hearing, it was distracting more than really helpful”* (Participant 9).

We also asked blind interviewees to discuss the most challenging aspects for them when navigating through their surroundings. Most respondents stated that they struggle most with finding their way around in unfamiliar environments. In particular, many respondents noted that they had difficulties determining their exact location and detecting overhead obstacles that could not be detected by their white cane (e.g. tree branches, low-hanging signs/poles, and doors). One respondent expressed this difficulty with low-hanging objects, noting:

“Those are dangerous because your cane does not tell you that theres a head-level thing, this head-leveled bar, straight ahead of you. Yeah its a problem with tree branches as well, so something that is head-level, face-level with nothing below that the cane wont tell you those are trouble. So thats the kind of thing one would enjoy hearing about, or having a sense about that theres something in the path. Things like theres a chair there or theres a person there.”(Participant 13)

Another participant commented, *“utilizing a navigational aid is very important, especially if Im going into a crowd, or a crowded place, or anywhere around*

town or just to find the obstacles in my way, and also in the workplace. Sometimes people put things in the middle of the hall and they dont tell me” (Participant 3). Other difficulties that multiple interviewees mentioned included unexpected obstacles, passersby not paying attention while traveling, noisy environments, finding doors to buildings, and wide open spaces lacking landmarks or reference points.

When told that we planned on creating an indoor navigational device to assist the blind in recognizing objects and humans in daily travels, 74% of participants said that they would be open to using such a device, 22% answered that their openness would depend on various factors, and only one participant said that they would not be open to such a device. The largely positive response to our proposed device showed that most blind respondents are eager to use technology that fits their needs. According to one participant, *“Were not all cut the same and we dont all travel the same. Our needs are not the same for information, so I think having all of those options are good”* (Participant 10). To provide “those options” to the blind population, we must then evaluate the various specifications that blind respondents would want from our proposed device.

When asked if our proposed device would efficiently complement the cane rather than be a hindrance for them, 56% of the blind participants agreed that the device would complement their cane, 30% said that it depends, and 14% said that it would not complement the cane. Team NAVIGATE created the device in an effort to add on to the functionality of the cane. We did not want to replace the white cane as using it is second nature to most blind individuals. Taking it away could have possible detrimental effects to the user. For example, one participant who has

been blind since birth commented, *“The white cane is not broken, there’s no need to fix it or add to it or any of that. We just want something to do what the cane can’t physically do”* (Participant 10).

4.1.2 Device Preferences: Feedback Mode, Device Placement, and Haptic Interpretation

Most blind subjects desire and benefit from assistive devices that help with both navigation and object recognition [9]. Thus, in striving to create such a device, it became imperative for us to find the best method of communicating information about the external environment to the user. As seen in Table 4.1, 56% of the subjects wanted a combination of audio and haptic feedback as the primary method of communication. Other responses specified single mode preferences, such as only audio feedback or only haptic feedback. Also seen in Table 4.1, 22% of participants wanted just audio feedback while 7% wanted just haptic/tactile feedback.

A fundamental challenge in the field of assistive navigational devices is selecting what information about the environment should be communicated to a blind individual and how it should be communicated. Auditory and haptic information that blind individuals receive from the environment are arguably the most crucial cues for forming their perception of the external world. Thus, blind users want to avoid an overload of sensory information, which many past devices have failed to account. Several participants commented on this fact, noting that the overstimulation of one sensory modality would be *“distracting, if not downright interfering”*

(Participant 2). One user that preferred haptic feedback opted against the auditory mode because it would, *“interfere with what youre hearing and your location of things”* (Participant 9). Therefore, technology that is considered useful should be tailored to convey only the essential environmental information.

Feedback Mode	Number of Respondents	Percent of Respondents
Auditory/Tactile Combination	15	56%
Auditory	6	22%
Other	4	15%
Tactile	2	7%

Table 4.1: Blind User Preferences for Mode of Device Feedback. A majority of blind participants desired the option and/or combination of auditory and tactile modes (15 participants). Of the remaining participants, 6 of them preferred auditory feedback only and 2 participants preferred tactile feedback only. The participants who suggested other feedback modes include an option of both auditory and tactile, but with a stronger preference towards tactile (3 participants), or a combination of an auditory and Braille display mode (1 participant).

The responses were also variable when blind subjects were asked the preferred placement of the device on the body. After providing a brief description of the device that included the dimensions of the Kinect sensor, the most common preference of blind respondents was to place the device on the waist and/or chest (Table 4.2). The underlying factor for placement was the desire for the device to be as inconspicuous as possible. In regards to optimal placement of the device, one participant remarked, *“Well it kind of depends on how it works. If you want it to be a sensor-oriented, kind of pointed forward sort of thing, probably chest”* (Participant 2). Several factors prevented us from placing the Kinect sensor on the waist as a belt. Stabilization concerns for gathering a consistent stream of Kinect data, the inflexibility of the GoPro mount, and optimization of object detection (i.e. detecting as many obstacles as possible within an optimal vertical range) ultimately confined the placement of

our device to the middle chest region.

Device Placement	Number of Respondents	Percent of Respondents
Waist	11	41%
Chest	8	30%
Chest or Waist	4	15%
None	2	7%
On Left(non dominant) side	1	4%
Hidden	1	4%

Table 4.2: A majority of respondents desired the placement of the device on the waist (11 interviewees) and chest (8 interviewees). The placement of a device on the waist was usually recommended in the form of a belt. The appealing factor for the placement of a navigational aid is its discreetness from view, so that blind individuals do not stand out from the rest of the population. Those who wanted the device to be “Hidden” suggested a device that is functional when placed in ones pocket or other place in clothing so that it blends in.

For haptic feedback, we wanted to determine the standard interpretation of a haptic vibration on either the left or right shoulder. The two assumed interpretations of the haptic vibrations are:

1. The vibration is object-directed; therefore the user should avoid the direction of the vibration.
2. The vibration is path-directed; therefore the user should move towards the direction of the vibration.

When asked to imagine feeling a haptic vibration on one side, nearly all the blind subjects interpreted the vibration in an object-directed manner. One blind respondent explained the intuitive reasoning for this, “*Because similar to the cane, if you felt something on the cane on the left, then you would think theres a thing there*” (Participant 6). Therefore, the haptic vibrations emitted from the miniature

motors on the shoulder straps of the harness will mean that an object (i.e. obstacle) is on that side, so the user should maneuver away from it.

Given time constraints and logistical issues, we knew that it would not be feasible for blind participants to meet with us several times in the development of our device. In an effort to still receive valuable input in terms of haptic feedback, we tested a basic version of our device with sighted individuals located on the University of Maryland campus. The protocol and results of this testing are discussed in further detail in Chapter 7.1 Haptic Testing.

4.2 Sighted Interviews

We also conducted interviews with sighted people who have had some contact with blind individuals. The purpose of interviewing these sighted individuals was twofold: to explore the behaviors of more “experienced” individuals in their social interaction with the blind, and to evaluate a sighted persons response to a blind individual using our device. The responses of the sighted community are relevant to the development of our device because the implementation of our device could influence blind-to-sighted interactions. Their responses also influence the blinds comfort level when using our device, which was discussed in the previous section (4.1 Blind Interviews).

Our team specifically wanted responses from individuals who had some degree of interaction with the blind in order to gather a more complete and well-informed picture of the nuances involved in blind-sighted communication. Our participant

pool aimed to provide a more in-depth look at a small sample of the sighted population whose views are rarely recorded in the literature concerning blind-sighted interactions.

We recruited participants from the University of Maryland Honors College community and personal contacts by email. Out of a population size of about 2,000 faculty and students in the Honors College, only 4 people responded and qualified for our interviews, having had at least some experience with blind individuals. The rest of our participants were recruited through personal contacts.

The team interviewed a total of 9 sighted participants (7 females, 2 males) either by phone or in person. The age range was 18 to 57 with a median age of 49. Among the sighted participants, 6 identified as white, 2 were Asian or Pacific Islander, and 1 was Hispanic/Latino. The highest degree of education varied, with 1 obtaining a doctorate/professional degree in law, 3 obtaining a Master's degree, 2 Bachelor's, 1 Associate's degree, 1 some college education, and 1 high school diploma/GED. This limited sample was not representative of the general population, but the fairly diverse sample could still provide a valuable and insightful indication to the characteristics involved in blind-sighted communication. Their responses also informed us on how we could tailor our device to be as unobtrusive as possible.

The first question of the interview after gathering demographic information asked participants how often they interact with the blind. As seen in Table 4.3, 2 interviewees responded with "Rarely," another 2 indicated "Sometimes," and 5 participants responded with "Often." An interaction that qualified as "Sometimes" was communication with a blind person that occurred about once a year on average.

For instance, one respondent is employed in the healthcare field and stated that she examines a blind patients eyes “once in a while” (Participant 8). Examples of interactions that qualified as “Often” include going to church with a blind individual or interacting online with a blind individual (via email and Facebook) about once a week. The selection of participants clearly skewed towards sighted individuals with more experience in interacting with the blind. Again, the purpose of gathering information from this select group was to gain a better understanding of the unique interactions that occur between the blind and sighted that is often not reported in the literature. The second question we asked the interviewees was whether they experienced any difficulties when interacting socially with the blind. All but one of the respondents answered “No.” Even though most of the respondents indicated no difficulties in interacting with the blind, they did indicate many ways in which their behavior changed when interacting with a blind individual. A common behavioral change that 3 of the participants cited was modifying their verbal communication by speaking louder and/or more slowly. Though 2 of these 3 participants realized that doing so was “ridiculous” and they try to “check” themselves to prevent treating the blind individual any differently, the other participant indicated that she did so “to make sure they understand.” Two of the sighted people who have frequent interactions with the blind indicated that more verbal communication is essential. Specifically, it is important to “make sure everyone speaks so that they recognize peoples voices,” and advised sighted people to, “always identify yourself before speaking,” or else it is “rude to just start talking and [assume they] know who it is.”

The next series of questions pertained to the sighted individuals reaction during a hypothetical encounter with our device. We first asked them, “How would you react if you saw a person equipped with a navigational device on their chest?” The choice of responses were: “Uncomfortable,” “Neutral,” or “Intrigued.” Most of the participants said they would be intrigued, 2 would be neutral, and 1 would be uncomfortable (Table 4.3). Along a similar vein, we asked the participants, “Would the implementation of such a device make you hesitant to interact with the individual? Why or why not?” A majority of the participants said “No,” 1 indicated “Maybe,” and 1 said “Yes” (Table 4.3). Many of the participants reasoned that if the device helped the blind individual with increasing their independent mobility, they would be tolerant of the device. Some participants found such technology “fascinating” and would be curious and interested to find out how it worked, while others indicated a degree of familiarity with similar navigational aids for the blind and would thus be unfazed by our device. The individuals who indicated that they would be initially “Uncomfortable” and hesitant to interact with a blind individual equipped with our device explained that they would become more comfortable and less hesitant once they were informed of the purpose of the device.

It is important to note that there is still clearly a bias with their responses just as with any population that has prolonged interaction with a marginalized group in that the more experience one has with the blind, the more open and accepting he or she would be of abnormal-looking technological devices the blind may use. This is in part due to the sighted individual’s emotional connection with and exposure to more blind people compared to the general population. As one participant said,

Interview Question	Response	Number of Respondents
How often do you interact with the blind?	Often	5
	Sometimes	2
	Rarely	2
	Never	0
How would you react if you saw a person equipped with a navigational device on their chest?	Intrigued	6
	Neutral	2
	Uncomfortable	1
Would the implementation of such a device make you hesitant to interact with the individual?	Yes	1
	No	7
	Maybe	1

Table 4.3: The results of our interviews with sighted people show that most would be very tolerant and open to interacting with the blind if they were equipped with our device. Most interviewees would not be hesitant to interact with a blind individual wearing a device on their chest. This positive response could possibly be influenced by other factors such as the interviewees previous social interactions with blind individuals which made them more accustomed to these technologies. Another factor is the social desirability bias in which people tend to respond in a way that portrays them as an overall good person with accepting attitudes and no prejudices.

it is the “curiosity and discomfort with the unknown” that seems to be the basis of human interaction.

Chapter 5: System Overview

Our system is comprised of three components, each with unique functionality: sensory input, image processing, and directional feedback. To effectively collect environmental information, we used the Microsoft Kinect. Data processing was performed on the Microsoft Surface Pro tablet. The directional feedback system was designed and built specifically for our system, using haptic motors and an Arduino Microcontroller to communicate directional information. When our system is in use indoors, the Microsoft Kinect captures depth and color data from the surrounding area, which is transferred to the tablet. The tablet then runs the algorithms for image processing in real time and provides directional guidance to the user through the haptic feedback system. One of our objectives for our proposed system was to have an accessible user interface driven by blind user feedback. As a result, we mounted the Microsoft Kinect on a GoPro mount placed centrally on the users chest to make the system portable and stable, and used both audio and haptic feedback, only using which is most appropriate for the information being relayed to the user. Sound is used to warn of an approaching stair, while vibration is used to warn of nearby obstacles.

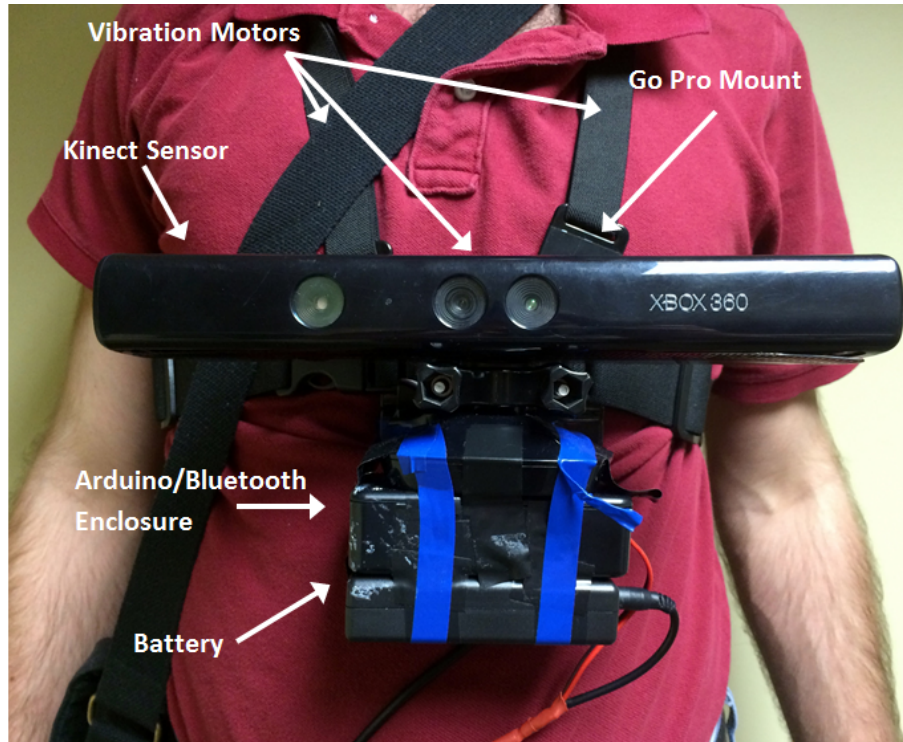


Figure 5.1: Device Prototype

5.1 Hardware

5.1.1 Microsoft Kinect

The Microsoft Kinect has a depth map resolution of 640 x 480 with 11-bit depth information, a color camera with 1280 x 960 resolution, and a microphone array. The Kinect depth sensor range is between 0.4 meters and 8 meters, with a viewing angle of roughly 45° vertical by 60° horizontal.

The sensor has been used in various successful applications for the visually impaired which attests to its accuracy and precision. Previously, the Kinect has been used to identify predetermined indoor environments using optical markers, and allow users to determine hand gestures to facilitate social interaction [22]. Its

limited viewing angle and size are its largest drawbacks. However, Kinect remains the most affordable alternative to an appropriate custom designed LIDAR device, and is available commercially off-the-shelf. The Kinect is also very well documented, with multiple SDKs available.

5.1.2 Microsoft Surface Pro

We opted to use a Microsoft Surface Pro tablet as our processing platform. The Surface Pro has a capable Intel i5 grade processor and runs the desktop version of Windows 8 making it fully compatible with the Microsoft Kinect. The Surface also has a built in standard size USB port so it does not need any adapter to connect to the Kinect. Despite all those features, it weighs about 1.5 pounds. These qualities combine to create a powerful and mobile device that fulfills all of the requirements of a portable computer needed for a navigation aid.

5.1.3 Power

The Kinect and haptic feedback system are both powered by a 12V 3800mAh lithium ion battery. The battery can power the system for approximately 10 hours.

5.1.4 GoPro Mount and Tablet Carrying Bag

The system is fastened on a GoPro chest mount for portability. We modified the GoPro mount by removing a section of the plastic mounting frame and clamping the Kinect into place using a separate GoPro attachment. We also attached to

the system a plastic black box, which stores the Arduino and lithium ion battery, beneath the Kinect. We embedded three vibration motors: one under the right and left strap and one under the chest plate of the mount, all of which communicate environmental cues to the user. This mounting system rests on the middle torso, which allows the user to walk comfortably while keeping the Kinect stable. The Microsoft Surface Pro tablet is stored in a satchel that the user can sling over his/her shoulder. This system was devised to be portable and give the user the greatest degree of motion possible.

5.2 Directional Feedback

The system is fastened on a GoPro chest mount for portability. We modified the GoPro mount by removing a section of the plastic mounting frame and clamping the Kinect into place using a separate GoPro attachment. We also attached to the system a plastic black box, which stores the Arduino and lithium ion battery, beneath the Kinect. We embedded three vibration motors: one under the right and left strap and one under the chest plate of the mount, all of which communicate environmental cues to the user. This mounting system rests on the middle torso, which allows the user to walk comfortably while keeping the Kinect stable. The Microsoft Surface Pro tablet is stored in a satchel that the user can sling over his/her shoulder. This system was devised to be portable and give the user the greatest degree of motion possible.

5.2.1 Haptic Design

The haptic feedback system utilizes three motor controllers that each power a generic 3.3V DC vibration motor. The motor power is regulated via pulse width modulation (PWM) generated by an Arduino Micro, a popular hobbyist microcontroller. The Arduino communicates over Bluetooth with the tablet, to determine the intensity of each motor vibration. Each motor can operate at 256 distinct intensities, from off to full power.

There are three separate motor drivers with configuration shown in Fig. 5.2. The 33 Ohm resistor limits the voltage across the motor to approximately 3.3V. For different motors, different values may be needed. The diode and capacitor in parallel with the motor reduce voltage spikes. This, in effect, smooths motor operation and prevents damage to the microcontroller, which supplies 5V. The bipolar junction transistor is used to switch the motor on and off, and isolate the microcontroller from the circuit. SIG represents the PWM signal from the microcontroller.

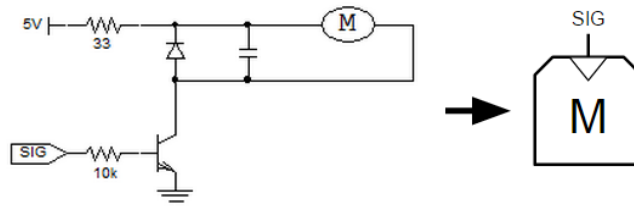


Figure 5.2: Motor Controller Schematic and Equivalent

The Arduino Micro communicates to the tablet via Bluetooth. This was intended to reduce the amount of wires necessary for the device to operate, improving the aesthetic and portability of the device. An excessive amount of wires can be

cumbersome to someone who cannot see them. The Arduino communicates with the Bluetooth radio over a standard serial interface with a Baud rate of 9,600 symbols per second. This Bluetooth radio then communicates to the tablets Bluetooth radio, effectively creating a direct serial connection from the tablet to the Arduino. Fig. 5.3 provides an overview of the system.

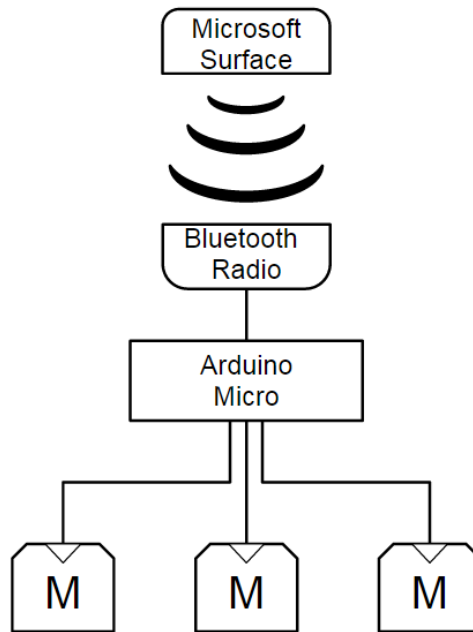


Figure 5.3: Haptic Overview

The interface to change the motor power was implemented as follows: A V ASCII character is sent from the tablet signifying the start of a vibration command. The following 6 ASCII characters sent represent the power to each motor in hexadecimal format. The left two digits specify the power of the left motor, the center two digits for the center motor, and the right two digits for the right motor. For instance, sending V0050FF sets the left motor to a PWM magnitude of 0 (off) the center motor to 80 and the right motor to 255 (fully on).

The haptic system is powered by the 12V lithium ion battery. The Arduino Micro has an on board voltage regulator and can be connected directly to the 12V battery. The Arduino regulates 3.3V used to power the bluetooth radio and the 5V sources used to power the motors. The Bluetooth chip connects to the standard TX and RX serial pins on the Arduino, and three PWM pins provide the signals to the individual motor controllers.

5.3 System Operation

The user wears the modified GoPro camera mount much like a backpack, with the Kinect, haptic controller, and battery attached together. The Surface tablet is carried in a satchel on the users side and is connected to the Kinect using a USB cable, and to the haptic controller via Bluetooth. The tablet runs the custom software to process Kinect data and communicate to the haptic system.

When the device is running, the user will receive feedback based on the obstacles around them. If the Kinect locates an obstacle on the users left, the motor on their left will vibrate at a particular intensity to indicate the presence of the obstacle. Similarly, if there is an obstacle ahead or to the right of the user, the center or right motor will vibrate, respectively. The motor will continue to vibrate as long as there is an obstacle on that side of the user. The definition of an obstacle to the side of the user is discussed in Chapter 6. Overhanging obstacles are treated in the same manner as obstacles near the floor. By vibrating to indicate the presence of an obstacle, along with audio cues regarding stairs, users will be well equipped to

avoid obstacles in their path.

Chapter 6: Software Design and Implementation

6.1 Introduction

The software requirements for the system were derived from the teams interviews with the blind and research into effective electronic travel aids. Our system requirements are as follows:

1. The device needs to detect obstacles in front of a user based on data from the Kinect.
2. The device must also be able to detect overhanging objects, which may not be picked up by the white cane, and identify stairs, which are walkable but not on the floor plane. Our goal is to bring functionality to this navigational aid that is not already provided by the white cane.
3. All environmental information must be conveyed to the user by a combination of tactile and audio feedback. We determined this preference for feedback through interviews with the blind.
4. Information collection, processing, and output must run in real time.

As detailed in Chapter 2, we evaluated numerous algorithms in computer vision for potential use in our project with varied success. Our final product is a robust, original software design which uses the C++11 standard libraries, the OpenCV image processing library, and the Microsoft Kinect Software Development Kit. The program first acquires data from the Kinect, converts the three-dimensional representation of the room into a two-dimensional image, then analyzes the two-dimensional image to find obstacles, and finally relays the location of obstacles to the user.

6.2 Kinect Interface

The first task for the application is initializing the Kinect. Then, once the applications setup process is complete, the Kinect interface must capture and store depth data from the Kinect. Its final task is to take the depth map generated by the Kinect and convert it into a point cloud, which is an array of three-dimensional cartesian coordinates for every individual pixel in the room. In order to accomplish this, the team built a wrapper around Microsofts official Kinect Software Development Kit (SDK).

6.2.1 Kinect Initialization

When the program first starts, it checks to make sure a Kinect is connected to the computer. If this function, part of the Kinect SDK, returns zero, no sensors are connected and the program exits. Provided a Kinect is found, the program proceeds as normal. Another SDK function is used to open up a connection to the sensor.

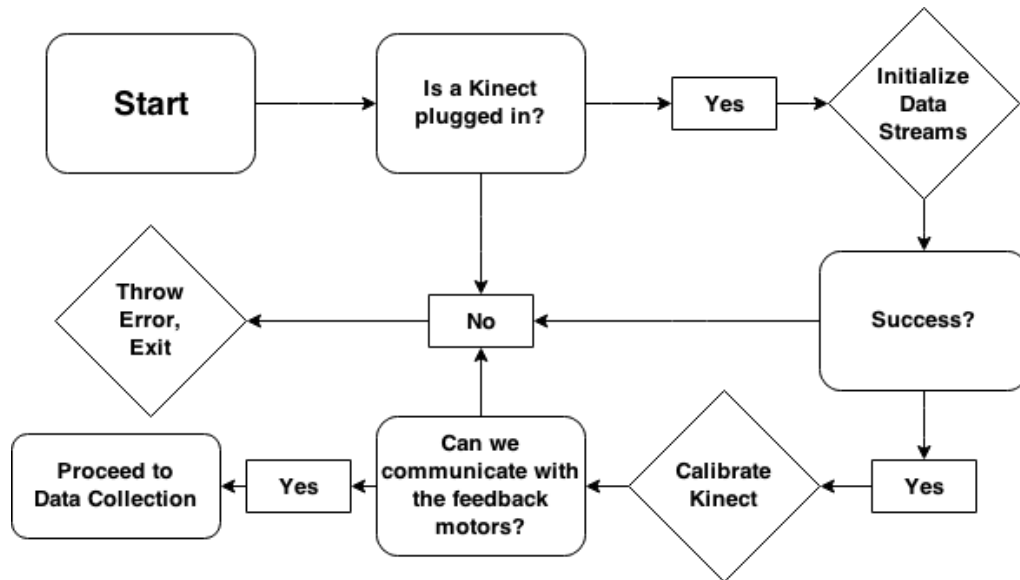


Figure 6.1: System Initialization Routine

Then, the program sets up two data streams: the depth data stream to gather three dimensional data and the skeleton data stream to locate the floor plane. Each stream contains two elements: the data itself and a trigger which indicates when new data is available. A flag is passed to the depth stream indicating a 320 by 240 pixel image size is desired. Once these data streams have been established, the program requests skeleton frames, which track the floor plane and any people in view. Determination of the floor plane from each frame allows us to calculate the Kinects height from the ground. This value is critical to successful obstacle detection, so the program checks for consistent height values across several frames. Once a value is obtained with a high degree of confidence, the program stores it for use during obstacle projection. Since the height of the Kinect can be reasonably assumed to remain constant, this value is only obtained once at the start of the program.

Once the streams initialize, the data they contain is made available to other

parts of the program. A single update method retrieves new data from the Kinect when it becomes available. The most important use for the raw data is the point cloud generation and transformation process.

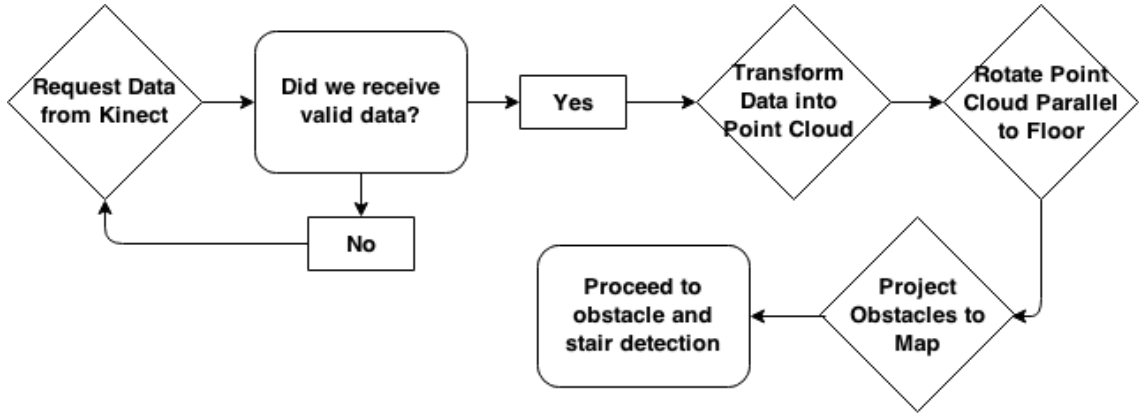


Figure 6.2: Data Collection and Transformation Routine

6.3 Point Cloud and Floor Plane Utilities

The programs obstacle and stair detection abilities hinge on the exploitation of the depth data generated by the Kinect, which is transformed into a three-dimensional point cloud. A point cloud is simply a representation of each pixel or “point” the Kinect captures in Cartesian coordinates. In this coordinate system, the x value represents the horizontal location of the point, the y value is the height off the ground, and the z value is the distance from the Kinect. Using this coordinate system allows the program to use fairly standard linear algebraic transformations to manipulate the data.

6.3.1 Retrieval of Kinect Data

In order to construct this point cloud, the program accesses the latest depth frame stored by the Kinect data stream. Each depth frame contains a depth value for each pixel in the image. The Kinect also uses an onboard accelerometer to retrieve its pitch (up/down) and roll (left/right) angles relative to the ground. These values are critical in obstacle projection. However, since they are not reliably constant, they must be updated every iteration.

6.3.2 Transformation into Point Cloud

The next step is to transform the depth image into the Cartesian coordinates necessary for the point cloud. The Kinect SDK once again provides a function to perform this task. However, this function must be run on every pixel of the latest depth image. Nevertheless, the image size is small for a modern computer system and pixel by pixel operations are fairly common, so run-time efficiency is maintained.

Once the values are converted into Cartesian coordinates, they are stored in the program for further manipulation, done by leveraging the C++ standard libraries. Each point returned by the conversion function is a Microsoft data structure designed to hold specific x, y, and z values, and is then stored in a C++ vector data structure. The points are placed into the vector based on their pixel coordinates in the original image. So, Cartesian points in the point cloud are referenced by their original location in the depth image. However, because the points contain unique, identifiable data, the order in which they are stored is actually unimportant. A

vector data structure is advantageous in that access time is quicker compared to more complex data structures and the program can add and remove points at will. Another benefit to using a vector is simplicity of data access.

6.4 Obstacle Projection

The point cloud provides an accurate three dimensional representation of the room. The next challenge is to identify obstacles from the point cloud. However, one of the three dimensions provided is not necessary. The device needs to know where an object is on the horizontal, or xz , plane. It does not need information on the height of the obstacle. Therefore, projecting all points onto a horizontal plane, namely the plane represented by the floor, reduces the problem to a two dimensional search.

6.4.1 Image Rotation

Since the Kinects field of view is not parallel to the floor, the entire point cloud must be rotated so that the floor plane coincides with the xz plane. Each point is represented by a vector, thus this transformation can be accomplished by multiplying each point by a rotation matrix. Each point is adjusted for the pitch, roll, and angles of the floor obtained during data acquisition. It also translates each point so that the floor has a height of zero and all obstacles are above that value. The translation uses the height captured at the start of the program as its reference value.

6.4.2 Obstacle Projection

Once the rotation has happened, the program checks each point for its y value, or height above the ground. Any zero results, plus or minus a small margin of error, are considered part of the floor and no action is taken. Any other y value corresponds to an area not level with the floor, and thus can be considered an obstacle. The x and z values of each of these obstacles are used to color corresponding coordinates of a grayscale image. Once all points have been checked and the proper ones colored, the image, stored in an OpenCV Mat data structure, represents a black and white map of the xz, or floor, plane. This is, essentially, a top-down map of the room from the Kinects perspective.

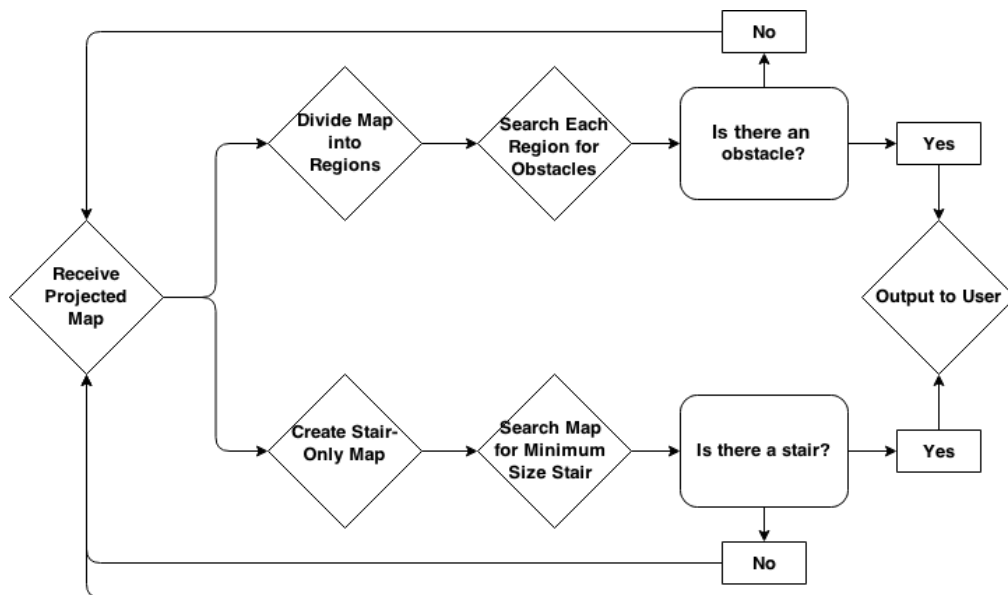
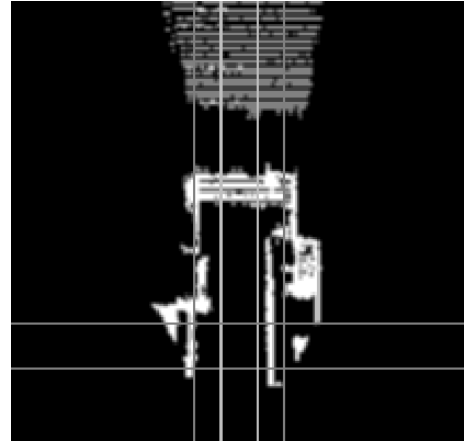


Figure 6.3: Obstacle Detection Routines



(a) The Kinect's View of a Kitchen



(b) A Top Down Projection of the Kitchen in Figure

6.5 Obstacle Detection

At this point, the challenge of navigating a three dimensional environment has been reduced to a two dimensional problem. The region within the Kinects view can now be represented as an image, stored in the OpenCV Mat data structure like in Figure 6.5. Thanks to the matrix projection described above, any region colored black represents the floor while any white space shows an obstacle. In this image, the user is always located at the bottom center of the image.

The first step is to take the image described above and filter the map projection to remove any noisy data. This helps prevent false positives and overloading the user with information. After experimenting with several filtering algorithms provided by OpenCV, we settled on Gaussian Filtering as our choice smoothing implementation.

After removing the noise from the image, a buffer zone is established inside the image surrounding the users location. The purpose of this region is to limit the search space for obstacle detection to a region close to the user. We further

subdivide this zone into three sectors: left, center, and right. This provides a sense of direction that we can communicate with the haptic feedback system. Next, OpenCV's *count_nonzero* function counts the number of nonzero values within each of the three regions. If the count within a matrix is not equal to zero, then there is a contact in that region.

If a contact is identified in a region, the region in question can then be subdivided further into four smaller matrices and checked separately to see if an obstacle exists. This functionality can be used to refine the location of the obstacle. All three regions are searched sequentially from left, center, and right. If a contact is found in one region, the search is terminated and the hit is communicated to the user. Likewise, if a region has no contact, no decompositions are performed.

6.6 Stair Detection

While the obstacle detection algorithm alone can successfully detect overhanging objects, the devices other specific detection case, stairs, requires a different algorithm. Since they are not obstacles, but would appear so to the obstacle detection algorithm, a different method is required to locate them.

This technique leverages the flexibility of the projection algorithm. While the standard obstacle detection projects the point cloud onto a plane at floor height, the stair detection does the same projection, except to a previously determined stair height. The result is an OpenCV Mat image as above, except that any stairs are not highlighted as obstacles.

The next step is to isolate stairs in the image. Since stairs appear in the initial projection, but not in the second projection, “subtracting” these two images via an OpenCV image transformation results in an image containing only possible stairs. However, not everything picked up will necessarily be a stair.

In order to determine what is, in fact, a stair, several conditions must be met. First, an object in the stair image must meet a minimum width to be walkable, but must not exceed a certain maximum width. The object must be a minimum length as well. If it is too short, it is likely a small ledge rather than a stair. Finally, the object must be persistent through several frames. If it appears and then subsequently disappears, the “object” is more likely an image artifact than a physical entity. If an object which appears in the stair image meets all of these conditions, it is flagged as a stair and sent to the devices output. The output then determines how to inform the user of the stair.

6.7 Communication

The tablet communicates with the haptic feedback system using Bluetooth. Microsoft implements communication over Bluetooth as a serial communication port (COM port). This COM port allows easy transfer of ASCII text. Using the Microsoft SerialPort class, a connection to the Arduino is established over its respective COM port. By sending the command described in Chapter 5, the three haptic motors can be controlled based on data from the obstacle detection algorithm.

6.8 Haptic Feedback

Choosing the haptic feedback intensity has been the source of much contention. Originally, there were two motors, one on each shoulder, that would vibrate at full power if there was an obstacle on that particular side. Both motors would vibrate simultaneously if there was an obstacle ahead. Initial testing revealed that the full motor intensity was overwhelming and uncomfortable. With the addition of a third motor in the center, it was decided that the motors should vibrate at different intensities depending on the proximity of the obstacle. Thus vibration intensity for each motor was changed in relation to the distance from the nearest obstacle on that side. It was then determined through testing with sighted individuals that this results in information overload and confusion. The final iteration returned to simplicity, the motors would vibrate at a moderate intensity if there was an object to the users corresponding side. The center motor would reveal an obstacle directly ahead.

Chapter 7: Testing and Results

Our system provides blind users with the ability to navigate unfamiliar indoor environments by communicating the presence of obstacles, overhanging objects, and changes in elevation. There are two different groups of participants we used for testing: sighted individuals and blind individuals. The obstacle test course is designed to test that the system not only successfully provides the functionalities listed above, but also that it is intuitive and non-intrusive for the blind user.

As mentioned in the methodology (Chapter 3), we completed four rounds of testing with our prototype: one round of testing with sighted subjects assessing our haptic feedback system, two rounds of prototype testing with sighted participants, and one round of prototype testing with blind participants. The choice to do sighted testing was due to the greater accessibility of sighted participants to test and improve our device. This allowed us to validate our prototypes design early and avoid pursuing a poor implementation with blind subjects (the target population). Our testing procedure was constructed carefully to consider familiarity with the cane and to account for the learning curve for our device.

To determine the qualitative effectiveness of the final system, we used the Psychosocial Impact of Assistive Devices Scale (PIADS) [8], which is a psychometric

measure developed specifically to assess the psychological and social effects of an assistive device on the user population. The effectiveness of our device was also measured in terms of the participants accuracy in navigating through the test course. Accuracy was mainly assessed by the incidence of avoiding objects in the users pathway. Additionally, we measured the time it took for the user to navigate through the test course when using the device and cane compared to when using just the cane. Although we acknowledge that time alone is not an effective assessment of the devices success, we are interested in determining if the user is still capable of traveling within their baseline time as measured with the cane.

The more significant component of determining a users accuracy is their ability to effectively avoid objects in their pathway. This will exemplify the success of our device because a novel component of our device is the way in which we communicate object detection to achieve obstacle avoidance. However, there are also instances when a user may want to find an object and therefore object recognition is another important ability to measure. Object recognition entails correctly identifying a desired object, which in the case of our device, is its ability to recognize a stair. It is essential that this feature is tested as a measure of accuracy in order to determine the full functionality and success of our navigation device.

7.1 Haptic Feedback Tests

We discovered through interviews that our user base preferred to have haptic feedback incorporated into the device, as noted in Chapter 4.1. As a result, we set

up an experiment to determine the users intuitive response to directional vibration motors.

Our testing course consisted of an empty hallway. Each sighted subject was blindfolded and led to the hallway wearing the system. We disabled the Kinect for the tests and remotely controlled two haptic motors placed on the left and right straps of the GoPro mount. During the test, the subject was instructed to walk down the hallway while the motors were triggered individually in a randomized pattern. Each motor was triggered at least twice during the test. We observed the direction of movement for each of the 15 subjects in response to a vibration on the right or on the left.

As mentioned in Chapter 4.1, we wanted to determine the standard interpretation of a haptic vibration on either the left or right shoulder. The two assumed interpretations of the haptic vibrations are:

1. The vibration is object-directed; therefore the user should avoid the direction of the vibration.
2. The vibration is path-directed; therefore the user should move towards the direction of the vibration.

Of the 15 sighted subjects with a median age of 20, 6 were male and 9 were female. More than half of the participants consistently moved away from the side of a vibration (Table 7.1). Four moved toward the vibration, one moved toward the vibration and then shifted away, and two were unresponsive to the buzzes. Accordingly, most participants said that when they initially felt the vibration, they



Figure 7.1: Member of the team doing a trial run of haptic feedback testing

interpreted it to mean that an obstacle was on the side of the vibration, so they were compelled to move away from the vibrating side. When asked to explain why they interpreted the vibrations in this manner, some indicated that they believed the vibration to be a “warning sign” and it was simply more “natural” to avoid the side of vibration. One subject elaborated, *“If a person was guiding me around an obstacle, I would interpret a light, short signal (like a tap or push) as a signal to move away from the origin of the signal”* (Participant 7). Another participant indicated that perhaps existing technologies such as cellphones that regularly use vibrations have “trained” individuals to react to vibrations as if they are a notification of

a tangible object in space rather than a notification of a text message or email (Participant 8). This intuition is consistent with that of blind participants - that is, a haptic response from tapping their white cane is similar to the haptic response of vibrations - both inform them of the presence of an object (Chapter 4.1). As a result of these responses, we programmed our prototype to trigger vibrations on the motor as indication of an obstacle.

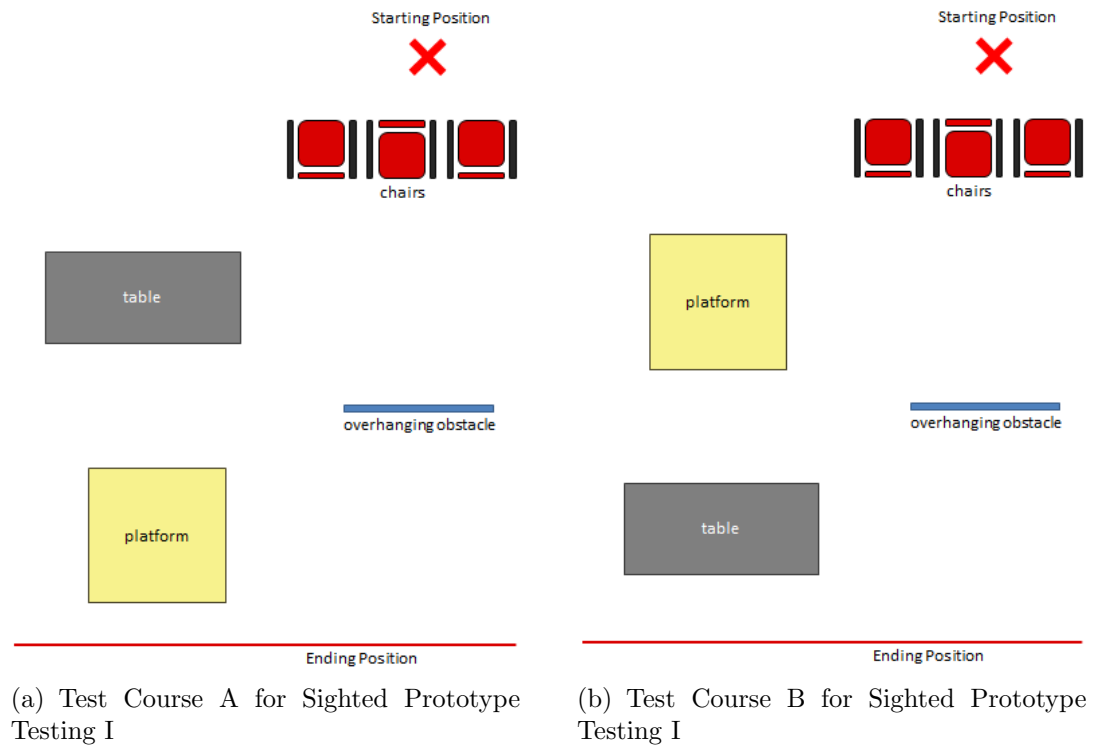
Reaction to Vibration	Number of Subjects
Away	8
Toward	4
Toward then away	1
No reaction	2

Table 7.1: Summary of results for haptic feedback interpretations

7.1.1 Sighted Prototype Test I

After the completion of the initial prototype, we performed our first full test of the device with blindfolded sighted subjects. Our objective was to verify that the prototype worked in action and to identify any problems with the prototype design.

We designed our test course to reflect the functionality of our device. We tested the prototype by sending each subject through an indoor obstacle test course. We had two separate course configurations - Test Course A (Figure 7.2) and Test Course B (Figure 7.3). These two configurations were randomly assigned from participant to participant in either an ABA or BAB pattern. Each course contained tables, chairs, an overhanging obstacle (a poster hung from the ceiling), and platforms to simulate stairs. Each course also had a fixed starting point and a finish line. Crossing the finish line completed the trial in the test course. We also had course boundaries



marked with tape - crossing the line prompted a team member to verbally direct the participant back onto the course. If the subject was unable to reach the finish line within 10 minutes, we concluded the trial.

The testing process for sighted subjects required them to complete the test course while blindfolded. To gain familiarity with the cane, the participants first navigated a “pre-test” course before going to the primary test course. The device was calibrated before each test and participants heard a script instructing them on how to interpret the vibrations. The device was always used in conjunction with the cane. Sighted subjects first walked through one configuration of the test course blindfolded using only a white cane. Once equipped with our calibrated device, the subjects walked through another configuration of the course. After course completion, we administered a post-test survey to the participant.

7.1.2 Sighted Prototype Test I Results

In this first round of testing, 12 blindfolded sighted subjects navigated through the test course. Of these, 11 were able to complete the course and 5 of them successfully avoided the overhanging object when using the device (Table 7.2). It was more difficult to evaluate through observation whether it was the white cane, the device, or a combination of the two that were responsible for guiding the user around the platforms. This was due in part to the difficulty in determining the timing of the object detection - that is, whether it was the cane or the device that detected the platforms first. Furthermore, the team had not yet implemented the stair detection algorithm for this iteration of testing which includes audio confirmation of stair detection.

	Overhanging Obstacle Detection	
	Without Device	With Device
Participant 1	0	1
Participant 2	0	0
Participant 3	0	1
Participant 4	0	0
Participant 5	0	0
Participant 6	0	0
Participant 7	0	1
Participant 8	0	1
Participant 9	0	1
Participant 10	0	0
Participant 11	0	0
Participant 12	0	0
Total Avoidance Incidence:	0	5

Table 7.2: Object Detection Results for Sighted Prototype Test I. A designation of “1” indicates successful avoidance of the overhanging obstacle. A designation of “0” indicates a failure to avoid the overhanging obstacle.

Despite these shortcomings in assessment, many participants provided positive responses for our device. Most participants agreed or strongly agreed that the device was accurate in its ability to detect an object in his or her path (8 participants) and to navigate the user away from obstacles (10 participants) (Figure 7.4). However, responses were most varied when asked how easy the device was to use. Some participants felt that the individual vibrations were indistinguishable and that a gradient vibration system based on distance would be more useful. The most common suggestion was to reduce the intensity of vibrations. One participant remarked: *“It was stressful to have the device buzzing all of the time. I think I got caught up in paying attention to the vibrations of the device and didnt use the cane much at the beginning. Then I started using the cane more and got overwhelmed with all the different things happening cane hitting things and device vibrating and got more lost than before.”* (Participant 5).

On the other hand, another participant had a positive experience with the device, stating: *“The vibrations were easy to interpret and they were helpful overall. I felt more confident walking forward with the device when there were no vibrations than with a cane alone because I trusted I would not hit anything. They were helpful in allowing me to better visualize my surroundings,”* (Participant 12).

With this constructive feedback in mind, we amended and improved upon many aspects of our device, testing protocol, and test course in preparation for our second iteration of testing with sighted subjects.

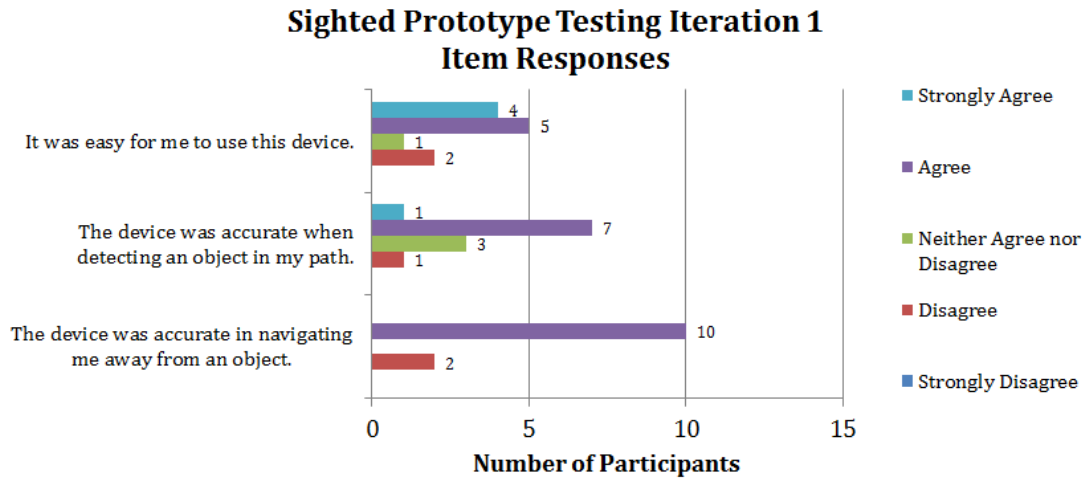


Figure 7.2: Sighted participant responses after one trial with the device

7.2 Sighted Prototype Test II

For this iteration of testing, the course was made longer in order to provide more complexity. This time, the test course was set up in a hallway instead of the room used in the first round of testing (Figure 7.5). The obstacles that were strategically placed in this hallway included tables, chairs, trash bins, platforms to simulate stairs, and a 3x2 foot overhanging obstacle attached to a string. A hallway was thought to present several advantages over the previous room: the layout and clear, forward directionality of a hallway prevents users from confusing their spatial orientation (which resulted in some individuals walking in circles during the first iteration); and it allowed for a longer test course and thus more space between obstacles to prevent the continuous stream of vibration from the haptic feedback motors. With the results of the first iteration of testing in mind, the prototype was also further developed. A third motor was added in the center of

the device. Additionally, the intensity of the motors was lowered, and the intensity varied depending on an obstacles distance from the Kinect (i.e. greater intensity with greater proximity to an obstacle and vice versa). The wires on the haptic feedback system were replaced with stronger ones that were less vulnerable to breakage. The obstacle detection algorithm was also replaced with a more efficient method. An early version of stair detection was also included for this round of testing. Finally, the angle of the Kinect to the floor was calibrated for each subject, and this step was added to the testing protocol.

7.3 Sighted Prototype Test II Results

Nine sighted subjects were recruited for this second round of trials, all of whom were female. All nine subjects were able to reach the end of the course. Equipped with out device, four subjects avoided the overhanging obstacle and seven of the subjects detected the stairs.

The survey responses from sighted users suggest that the device improved in its ease of use and accuracy in detecting objects. All 9 subjects agreed or strongly agreed that the device was easy to use and 8 of the 9 agreed that the device could accurately detect objects (Figure 7.6). However, the written feedback by subjects and lower scores in the perceived accuracy of the device to navigate users away from objects suggested that the haptic feedback still required some improvement. In their comments, subjects were confused by the varying intensity of the vibrations or not being able to discern these changes at all. Sighted participants from both rounds

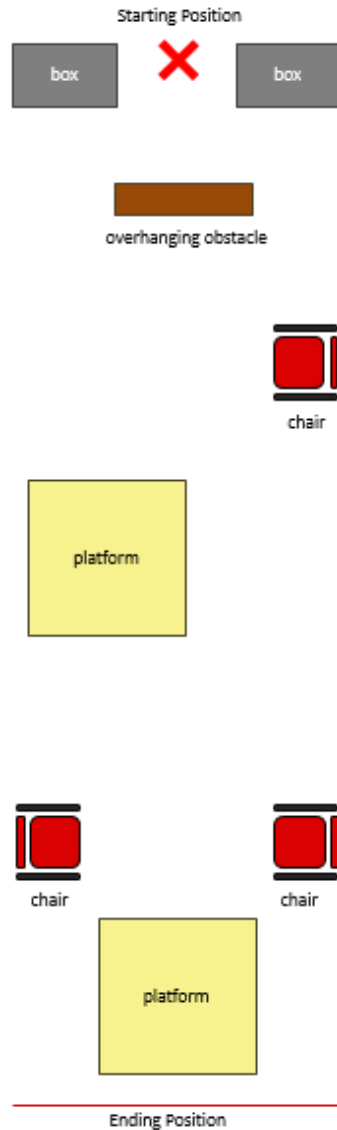


Figure 7.3: Test Course for Sighted Prototype Testing II

of testing indicated that they would have performed better with additional time to familiarize themselves with the device and felt that the learning curve hindered their performance. During our after-action assessment, particularly of the stair detection algorithm, we located the issues within the code, fixed the problem through debugging, and verified the solution with several internal tests with the test course and isolated obstacles (i.e. stair only).

	Overhanging Obstacle Detection		Stair Detection	
	Without Device	With Device	Without Device	With Device
Participant 1	0	0	1	1
Participant 2	0	1	0	1
Participant 3	0	0	1	1
Participant 4	0	0	0	1
Participant 5	0	1	1	1
Participant 6	0	1	1	1
Participant 7	0	0	0	0
Participant 8	0	0	0	0
Participant 9	0	1	1	1
Total Avoidance Incidence:	0	4	5	7

Table 7.3: Object Detection Results for Sighted Prototype Test II. A designation of “1” indicates successful avoidance of obstacle. A designation of “0” indicates a failure to avoid the obstacle. Stair detection with the device was considered successful “1” if the audio command correctly identified the stair in the users path.

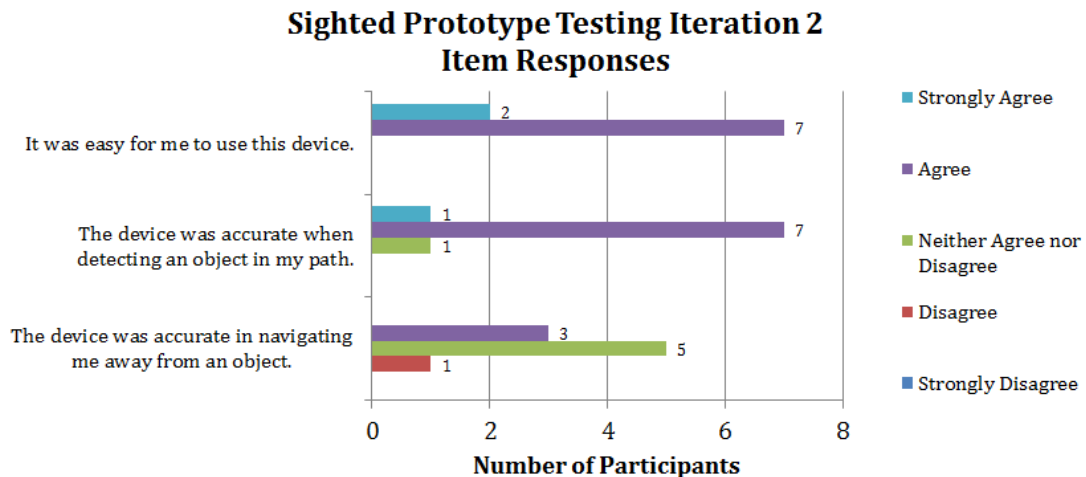


Figure 7.4: Sighted participant responses after one trial with the device.

7.4 Blind Testing

For blind participant testing, the test course was moved back to the original testing room that was used for the first iteration of sighted prototype testing instead of the hallway that was used for the second iteration. Due to unfavorable reactions

from sighted participants from the second iteration of testing, the devices varying intensity of vibrations were disabled for these tests. Additionally, the stair detection algorithm was vastly improved and verified via internal testing. The presence of a stair was communicated to the user by an audio cue which announced, “Stair ahead.”

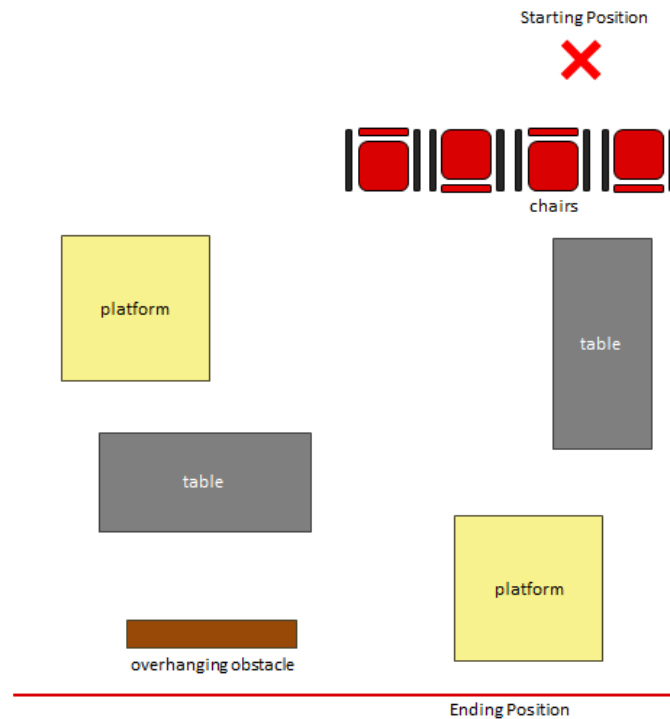


Figure 7.5: Configuration A Test Course Layout for Blind Prototype Testing

Similar to the second iteration of sighted testing, the testing process for blind participants first involved a run-through of the primary test course with only the white cane. This was followed by a trial run with the device in a fixed pre-test course. Blind participants were allowed more time to familiarize themselves with the device in this dedicated pre-test room where they heard a script with standardized instructions on using our device. Experimenters ensured that each subject had a sufficient

understanding of the device and answered clarifying questions. Participants then navigated the test course twice with the device and the cane to reduce the learning curve and increase their familiarity with the device. There were two configurations of the test course which were randomly assigned to each participant prior to testing in either an ABA pattern or a BAB pattern (Figure 7.7). To determine the qualitative effectiveness of the final system, the PIADS survey was administered. The survey was developed specifically to assess the psychosocial impact of assistive devices on the user, which includes the users feelings of functional independence, well-being, and quality of life when using the device [8].

7.4.1 Blind Testing Results

Blind subjects assessed our device using the Psychosocial Impact of Assistive Devices Scale (PIADS). This 26-item survey categorizes items into three subscales: competence, adaptability, and self-esteem. Each item is ranked on a scale of -3 to +3 (-3, -2, -1, 0, +1, +2, +3) according to their level of agreement with the item in terms of the perceived impact the device would have on their life. The competence subscale included questions concerning productivity, usefulness, performance, and independence. The adaptability subscale questions the user on their ability to participate, willingness to take chances, eagerness to try new things, and their ability to take advantage of opportunities. The self-esteem subscale assessed the users feelings of security, sense of power and control, and self-confidence when using the device. Overall, all four blind subjects felt more positively about their compe-

tence and adaptability when using our device (Table 7.4). Across all participants on average, they indicated positive impact scores for all three subscale measures of competence (1.31), adaptability (1.50), and self-esteem (0.63) out of a possible score of 3.00.

	Blind Participant 1 (seconds)	Blind Participant 2 (seconds)	Blind Participant 3 (seconds)	Blind Participant 4 (seconds)
Run #1 (without device)	55	32	38	31
Run #2 (with device)	136	109	66	32
Run #3 (with device)	44	42	33	36
Run #4 (with device)	-	-	-	33

T-Test between Run without device and Run # 2	0.047754911
T-Test between Run without device and Run # 3	0.484358336
T-Test between Device Run # 2 and Device Run # 3	0.044243966

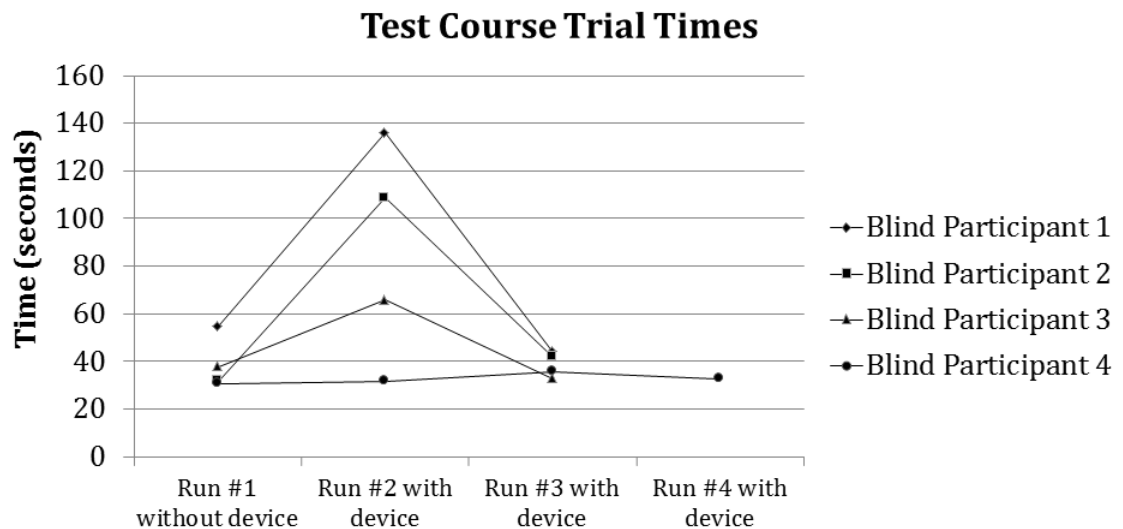


Figure 7.6: Test Course Times

	Overhanging Obstacle Detection				Stair Detection			
	Without Device	With Device Trial 1	With Device Trial 2	With Device Trial 3	Without Device	With Device Trial 1	With Device Trial 2	With Device Trial 3
Blind Participant 1	0	0	0	-	1	1	1	-
Blind Participant 2	0	0	0	-	1	0	0	-
Blind Participant 3	0	0	1	-	1	1	0	-
Blind Participant 4	1	1	1	0	1	1	0	1
Total Avoidance Incidence:	1	1	2	0	4	3	1	1

Table 7.4: Summary of Object Detection Results for Blind Prototype Testing. A designation of “1” indicates successful avoidance of obstacle. A designation of “0” indicates a failure to avoid the obstacle. Stair detection with the device was considered “1” / successful if the audio command correctly identified the stair in the users path.

There were mixed results when observing the incidence of obstacle avoidance for overhanging obstacles and stairs. In our limited sample of blind participants, when equipped with our device, 1 participant was successful in detecting the overhanging obstacle during the first trial with the device, and 2 participants were successful during the second trial with the device (Table 7.4). For stair detection, 3 out of the 4 participants were successful in avoiding the platform on the first trial with the device while 1 participants was successful in stair avoidance on the second trial (Table 7.4). These relatively low rates of success may be explained in part due to the individual differences we had to adjust for per participant. For example, Blind Participant 1 had a naturally slouched and tilted body position. Thus, before each of his trials, it was necessary to adjust for this abnormal body stance by calibrating to a greater degree of vertical adjustment of the Kinect and a tilt of the device horizontally so that the sensor could accurately detect the floor as parallel

to the device.

An objective look at the results show that the time it takes for a blind user to complete our test course significantly increases from baseline (Run #1) after their initial trial with our device (Run #2), and then there is a significant decrease in time from Run #2 to their second trial with our device (Run #3), traveling in a similar amount of time compared to their baseline run (Figure 7.6). The baseline was established by taking the amount of time the subject took for the first test using just the white cane (Run #1). Specifically, the results show that there is a significant difference between the runs without the device (Run #1) and the initial run with the device (Run #2) ($p = 0.048$). There is also a significant difference between the first run with the device (Run #2) and the second run with the device (Run #3) ($p = 0.044$). These results indicate that the user takes a longer time and is more careful while navigating when first using the device, as was expected. No significant difference was found between the run without the device (Run #1) and the second run with the device (Run #3) ($p = 0.48$). This non-significant result shows that after only one full test with our device, the user is able to reach their baseline time again, signifying that they are more comfortable with our device, and the learning curve significantly decreases with increasing trials with our device.

Chapter 8: Discussion

8.1 Future Work

Having created a successful prototype that can assist the blind in indoor navigation, we want to improve upon our success. The next step is to create a custom mount for the Kinect to rest on, instead of using the GoPro mount. This would provide greater stability while ensuring the viewing angle remains constant and allow us to automate the angle calibration by using the Kinects internal tilt motor and gyroscope.

Advances in hardware have also made more capable products available to the consumer market. A newer version of the Kinect has been released which is smaller and has an improved camera. These improvements will increase the portability of our device and allow it to scan a wider area for obstacles. There are also other similar sensors on the market that cut out certain features that we did not utilize like the microphone to decrease cost and bulk. The Surface Pro has been improved twice with the current model, the Surface Pro 3, having significantly better performance and battery life which will allow us to process images with greater resolutions at real time or utilize that power for other features.

Additionally, we would like to incorporate object recognition into our proto-

type, as suggested by users. Object recognition differentiates between obstacles, like a car, and objects that the user may want to approach, like a mailbox. We have already explored this feature using the kernel descriptors algorithm described by Bo, Ren, Fox [1]. This approach relies on RGB data, available through the Kinects API, and identifies objects in real time. We successfully tested this algorithm using Kinect data, but did not integrate it in order to start with a simpler prototype. In the next iteration of the project, we want to merge kernel descriptors with the prototype while also expanding the number of objects the algorithm can identify.

Another avenue we would like to pursue is to provide more user interaction with the device. Instead of having simply three motors (front, left, and right), we would like to include more motors on the mounting system to provide a better way to localize nearby obstacles. We already have the information about nearby obstacles, so we simply want to provide more channels of information for the blind. We also want to add an audio cue for detecting stairs going downwards.



Figure 8.1: The device identifying a banana using the kernel descriptors algorithm

8.2 Conclusion

For the sighted, it is trivial to walk across a hallway or go from one room to another no matter how cluttered or empty it is. For the blind, however, such a simple task is fraught with unknowns. White canes, guide dogs, and electronic travel aids can only partially uncover these potential threats. Canes and guide dogs can miss overhanging obstacles and cannot convey the presence of stairs. ETAs often rely on precomputed maps or expensive sensors. Our device addresses these problems through its ability to augment the canes functionality by searching for obstacles and communicating them to the user with haptic and audio feedback using fairly inexpensive consumer hardware. Through this project, we have taken the potential of a recreational gaming device, and transformed it into a tool that can enhance the lives of a disadvantaged population.

Our interviews with blind individuals uncovered a consensus of preferences for a proposed electronic travel aid in order to develop a device that would be useful and effective. The results from testing our device with the blind revealed several measures of success in its ability to detect hanging obstacles and stairs. With our unique integration of computer vision algorithms contained in our software package and novel mounting mechanism for the Kinect sensor, our prototype offers the blind user a heightened awareness of his or her surroundings. By detecting obstacles before their cane can reach them, our device truly strives to act as a haptic eye, seeing objects beyond what they were previously capable. With further development, there is the potential in our device to ultimately provide independence in mobility for blind

individuals. We hope future iterations of our device will continue to help expand the wealth of visual information one can communicate to the blind.

Appendix A: TABULATED RESULTS FROM BLIND SURVEYS

Gender:

Male	16
Female	11

Household Income:

\$0-\$19,000	4
\$20,000-\$39,000	6
\$40,000-\$59,000	6
\$60,000-\$79,000	5
\$80,000-\$99,000	1
\$100,000-\$149,000	4
\$150,000+	1
Prefer not to answer	0

Race:

American Indian/Alaskan Native	1
Black or African American	6
Asian or Pacific Islander	2
Hispanic/Latino	0
White	17
Other or Not Reported	1

Education (Highest degree obtained):

Some High School	1
High School Diploma/GED	3
Some College	3
Associates	0
Bachelors	9
Masters	9
Doctorate/Professional School	2
Other	0

Age:

2	0, 2, 4, 8
3	2, 5, 8, 8
4	0, 1, 3, 3, 4, 4, 6, 7, 8
5	1, 7, 9, 9
6	0, 2, 5, 7
7	
8	0, 1
9	

Born or Developed Blindness?:

Born	9
Developed	18

Age	Description
81	developed at age 80
38	born visually impaired, became blind at 7
47	developed at age 15
38	developed in high school
67	developed at age 2
59	started late 20s and all sight ended age 50
51	developed at 11 months old
44	developed at age 2
43	developed at age 33
40	developed glaucoma
41	developed at age 19

Cause of Blindness:

Macular Degeneration	1
Retinoblastoma	2
Retinal Detachment	1
Retinal Degeneration	1
Glaucoma	3
Optic Nerve Damage	2
Juvenile cataract and premature birth	2
Glaucoma and Cataracts	1
Cataracts	1
Retinopathy Prematurity	3
Retinal Pigmentosis	1
Retinal Detioration	1
Retinal detachment and cataracts	1
Conginetal Cataracts	1
leberis congenital amorosis	2
Shooting accident	1
Conginetal Glaucoma	3

What do you struggle most with when navigating through your surroundings?

- In an unfamiliar place, it is difficult to navigate
- Knowing exactly where I am
- Sign poles, hanging too low, on the ground is fine most of the time, above ground is difficult
- Being updated on how far from destination (outdoor). Wants a more accurate GPS.
- Missing landmarks and identifying where I am
- People that are not paying attention, hazards like bikes and skateboards, and loud environmental sounds which are distracting
- Figuring out where I am and what I am trying to do, especially if I havent been there before
- wide open spaces where he doesnt have reference point (like parking lots) and also loud sounds are distracting
- Unexpected obstacles and knowing the layout of certain places like consistent variables (ex. train stations)
- Unfamiliar environments
- In buildings, trying to figure out correct doors and places to go when theres nothing to show you, and the unknown in general
- Knowing the destination, like when youre walking to a room, where the room is...people dont give you direction, they panic and rab you...it would be good to get something to tell you how far and which direction...my cane already tells me things I need to avoid

- Difficulty with rever sing routes
- Uncertainty and changing environment
- Overhanging objects
- Unfamiliar areas
- Knowing the names of streets in an unfamiliar area
- 2 things difficulty reading signs, difficulty finding doors to buildings
- I dont really struggle that much. Probably with loud areas...noise is difficult, cant hear traffic as well
- Dont really have anything in particular that I struggle with. Maybe with open spaces, its harder to find things in a big open space (but not that much struggle for me)
- Not real good at walking in straight line. I hug the sides with my cane

Do you use any assistive devices (not including white cane)?

Yes	16
No	11

Have you used any other devices in the past (not including white cane)?

Yes	18
No	9

Reasons for abandoning assistive devices:

- apps were complicated
- sonic cane, trekker breeze, device that vibrated when you were 4ft from something. Prefers cane
- trekker breeze, got it recently, doesn't know much about using it
- tried out glasses with earpieces with different sounds for different directions and stopped using it. Considered sounds a distraction
- past devices were not reliable, or useful
- guide dog died, in the process of getting another one
- stopped using cane because not as confident with it as with dog
- dogs and neck boxes that werent mine to keep
- gps, but dont allow to hear traffic patterns, and use the white cane from time to time but I like the freedom of the dog better
- uses dog. psychologically, feel less alone with dog than cane
- sporadically uses prototype ultrasonic electronic device

How important is it to you to have a navigational aid that allows you to identify objects and people in your path?

Not Important	3
Neutral	5
Important	5
Very Important	11
Only for Face / Object Identification	3

We plan on creating a navigational device to assist the blind to recognize objects and humans in daily travel. Would you be open to using such a device?

Yes	20
Depends	6
No	1

What do you think would be the best way of communicating the information taken from the external environment to the user?

Audio	6
Tactile	2
Both	15
Both, mostly tactile	3
Auditory or Braille	1

This device will incorporate the Microsoft Kinect (a motion sensor system that is 12"x3"x2.5"), a backpack (in order to potentially strap the Microsoft Kinect to the user and carry hardware), and either a smartphone or a laptop (to process the data). Where do you feel would be the best place to put the Kinect on your body? For example, head, chest, or waist.

Chest	7
Waist	11
Side	3
Neck	2
Other	4

How comfortable would you be wearing this device on your body?

Comfortable	12
Not Comfortable	7
Depends	8

Do you think that this device would efficiently complement your cane, or do you feel that it would be a hindrance?

Complements	15
Doesn't Complement	4
Depends	8

Do you have any other comments or suggestions regarding the development of this device?:

- Obstacle avoidance is not that important. It is all about finding landmarks, and object identification. Obstacle avoidance is not what blind people want to do. Avoiding things is almost never the immediate goal for blind people. You want to know what is in your environment, and collect as much information as possible.
- Wants a battery charger so that it would be easier to charge device, and on/off switch.
- Wants something that tells him where to turn, like a GPS.
- The device should hone in on large crowds of people, lines to stand in, and obstacles
- Wants to know distance from an object: the closer he is, stronger vibration. He wants to know if the object is on right or left side. If the device is auditory, he doesn't want it to talk too long. He wants to be able to turn it on/off (vibrate in restroom). There should be earbuds to cancel out other noises. Mall navigation (ex. good to know how far you are from an escalator).
- It would be good if it detected people that are coming.
- Sounds like it would be a hassle, sounds like it would make a blind person uncomfortable about their appearance, there are devices that are improving, and cane would do job.
- Ways to change settings maybe to have different sound options or different purposes for the sounds
- Maybe not try putting it in both ears for the auditory because blind rely on hearing.
- Not a fan of the audio, people don't want things in ear. I prefer braille.
- Sometimes there's resistance from the blind community, because there were all these ideas before but they did not take off because they did not have a massive appeal. (Just telling us to be cautious).
- I think there if there was a way to put the device on a bicycle, that would be amazing, because I like riding bikes.

Would you avoid or go toward a vibration made by

Complements	15
Doesn't Complement	4
Depends	8

Appendix B: TRANSCRIPTS FOR BLIND PARTICIPANT INTERVIEWS

Subject 1

PARTICIPANT: Hello?

INTERVIEWER: Hi, [name redacted], this is Yolanda Zhang from the University of Maryland calling to interview you for our study?

PARTICIPANT: Mhm

INTERVIEWER: Okay, so, we're going to start off with some basic questions about yourself, like your demographics and such, and I just want to remind you that all your responses will be held confidentially. So, first, would you identify your gender as male, female, or other?

PARTICIPANT: I'm a female.

INTERVIEWER: Yes, okay. Your household income; Is it between 0-19,000 dollars?

PARTICIPANT: About right.

INTERVIEWER: It's about right? Okay.

PARTICIPANT: Yes I have to pay the taxes and the service in about 18,000 dollars

INTERVIEWER: Okay, Thank you. And your race? What would you identify as?

PARTICIPANT: White

INTERVIEWER: White? Okay. White, Hispanic or Latino?

PARTICIPANT: No I'm white from New York. I'm white, and I have no mix bred into me.

INTERVIEWER: And your education? What was the highest education that you received?

PARTICIPANT: I was two years in college

INTERVIEWER: Was that some college or did you get a associate's degree?

PARTICIPANT: I would say Some College

INTERVIEWER: Some College, okay. And how old are you?

PARTICIPANT: 81

INTERVIEWER: 81? Okay. And next, were you born blind or did you develop your blindness during your life?

PARTICIPANT: I developed my blindness about 9 months ago.

INTERVIEWER: Okay.

PARTICIPANT: I was told in '56 I would have macular degeneration. [inaudible] and everything went fine. And then 9 months ago, one morning I woke up, and that was the end; everything went black. And then the doctor told me that mine was considered macular degeneration, there was another name for it, I cannot remember, but mine was not due to old age, mine was [incomprehensible]. So I had such bad eyesight all my life, and that's what brought it on.

INTERVIEWER: I'm sorry to hear that. So during these past 9 months, what do you struggle most with when navigating through your surroundings?

PARTICIPANT: Well, I see shadows and I get around in my own place, when I use a cane. If I go into an unfamiliar place, I usually see shadows and I can go around furniture. If someone is with me, they just grab my arm and lead me to where I need to go.

INTERVIEWER: Do you currently use any assistive device to navigate besides your cane?

PARTICIPANT: No

INTERVIEWER: Have you ever used any assistive devices in the past?

PARTICIPANT: I have ordered the right cane, but nobody ever really showed me how to use it. So I don't know how I'm going to manage, I need my cane to walk with. In case there's a way I can fasten the cane unto my regular cane I don't know.

INTERVIEWER: I see, so you have 2...2 canes essentially?

PARTICIPANT: Yeah I have the right cane but so far I cannot use it because I need to have my cane in my right hand.

INTERVIEWER: Right, right that must be difficult. How important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: Not that you know, as long as I see you know. I lately the doctor gave me shots in my eye. That had helped some, and I can see a little cleared but I don't know right now if I'm going to do everything I can by myself.

INTERVIEWER: Mhm okay, so you can kind of see shadows and edges of certain things?

PARTICIPANT: Yes, I could go grocery shopping or something and I would go into the store, and I see shelves and whatever you call it but I cannot tell what's on them. So, somebody has to really, you know, guide me through it. I can find the milk carton. That I can recognize, but nothing else.

INTERVIEWER: Well, our team plans on creating a navigational device to assist the blind to help recognize objects and humans in their daily navigation. Would you be open to using such a device or do you feel like you don't really need something like that?

PARTICIPANT: I could use it if it would help me. I would use anything that's going to help me. But it all depends on what it is, and how I use it.

INTERVIEWER: Right, yeah out next few questions are going to go into more details about how you can use it. So, what do you think would be the best way of communicating the information, like objects or humans in your path? How do you think we can communicate that to you? Through touch or through hearing, like auditory instructions or a combination of both.

PARTICIPANT: Depends on what I'm looking for in the touch. I can identify, like I said, I have the shadows. Sometimes if I stand there long enough to identify what it is and I can realize what it is and what it can be. Well in my own place, since I've lived here since '67, I can find myself blindfolded. [Incomprehensible]. And I don't let anybody move something, and then I would know it's not there. Everything has to stay in place.

INTERVIEWER: Right so, for example, how would you feel if you were trying to get to some destination and you were wearing a belt kind of device that maybe vibrates, like on your left if it wants you to go towards the left, or vibrates on your right if it wants you to go to the right? How do you feel about vibrations?

PARTICIPANT: That probably would help, If somehow I was walking on the sidewalk, it would let me know if there was some object in my way. [Incomprehensible]. Can I put you on my speakerphone? I have very bad reception.

INTERVIEWER: Yeah. Sure

PARTICIPANT: I hope we don't get disconnected. Hold on.

INTERVIEWER: Okay sure.

PARTICIPANT: Okay I got you on that.

INTERVIEWER: Okay can you hear me now?

PARTICIPANT: Yes I can hear you better.

INTERVIEWER: Okay cool. So also, for example, how would you feel if there were some auditory directions given to you through an earpiece? Like a voice would tell you certain directions like go this many...

PARTICIPANT: That sounds good, haha. Good!

INTERVIEWER: That sounds good? Okay

PARTICIPANT: Going someplace and somebody says turn right or left or cross the street.

INTERVIEWER: Right right. Yeah something like that.

PARTICIPANT: Yeah

INTERVIEWER: Mhm, okay next questions then. So our device will probably be using: do you know what a tablet is?

PARTICIPANT: A tablet?

INTERVIEWER: Yeah. Tablet, a kind of mini-computer.

PARTICIPANT: Yeah I don't have a computer or anything.

INTERVIEWER: Yeah you wouldn't need one; we would give it to you. It's part of the device, and it might also come with a backpack, maybe not. We're still working on some designs. And it also comes with a sensor

that's about a foot long and 2-1/2 inches thick. Where do you feel like would be the best place to put this kind of sensor on your body? Like on your head? On your chest or your waist? A belt maybe? Around your belt area?

PARTICIPANT: I think it wouldn't be my back right?

INTERVIEWER: Yeah I think it would have to be somewhere in the front of your body, because it has to detect where you're going to go.

PARTICIPANT: Then it would have to be no my left wrist somewhere left arm somewhere on the left side. The right hand I'm using constantly with a cane.

INTERVIEWER: So you're right side will probably be moving around a lot. Okay so maybe towards your left side?

PARTICIPANT: Yes.

INTERVIEWER: Okay, how comfortable do you feel like wearing this kind of device on your body?

PARTICIPANT: I would certainly choose, but I would have to get used to it, like I have to get used to my new life now. Everything has totally changed.

INTERVIEWER: Mhm Yeah. Do you think this kind of device would efficiently complement your cane, the cane that you use now? Or do you feel like it might get in the way more?

PARTICIPANT: No, it looks like it would complement it. I might get around better.

INTERVIEWER: Mhm okay. Do you have any comments of suggestions regarding the development of our device?

PARTICIPANT: No I don't know enough about it. I cannot talk about it.

INTERVIEWER: Right

PARTICIPANT: It's that now, I can't read no newspaper, or the news or what it finds. I can't get the advertisement what it's saying on groceries or something;. I cannot see it anymore.

INTERVIEWER: Do you regularly go to Columbia Lighthouse? I'm sure they have a lot of people researching and stuff.

PARTICIPANT: Yeah. I wait for somebody. He went on vacation. He's supposed to call me back and then I saw the [incomprehensible] doctor three weeks ago. He had written him a lot of information what he wants to see if he can get it before he comes. It has a lot to do with how light comes from a direction or something so that I can see better. I don't know. I'm just waiting for him to call me back when he's back from his vacation. He's from Columbia (Clines?)

INTERVIEWER: Well I hope that you can receive the help that you need, and If we need to contact you further we will in the future or soon, and I will mail you the consent form for our study. So hopefully you can fill that out and send it back to us.

PARTICIPANT: I will. I'll get somebody to help me. They tell me what it says, then I tell them what to write down. At the end I sign it myself. Anybody can read. The next thing I know I'm writing my name as signed.

INTERVIEWER: Okay. Thank you very much for your time.

PARTICIPANT: Thank you for contacting me.

INTERVIEWER: Okay. Have a nice day!

PARTICIPANT: You too.

INTERVIEWER: Okay bye.

PARTICIPANT: Bye Bye

INTERVIEWER: Uhmhhh..

Subject 2

PARTICIPANT: Yes? Who is this?

INTERVIEWER: This is Yael Osman calling from the University of Maryland.

PARTICIPANT: Oh hi! Hi.

INTERVIEWER: Hi! How are you doing today?

PARTICIPANT: Good! Sorry I didn't grab the phone in time.

INTERVIEWER: No! Don't worry about it! Don't worry! I was wondering if you would actually be available now to conduct the interview.

PARTICIPANT: I am actually. Are you on a speakerphone?

INTERVIEWER: Yes I am. Can you not hear me?

PARTICIPANT: Would you mind picking the phone up and talking to me?

INTERVIEWER: The only thing is that I need to record the responses. So I need to have it on speakerphone, but if I hold the phone closer to my mouth can you hear me better?

PARTICIPANT: Are you doing that now?

INTERVIEWER: Yes

PARTICIPANT: Yeah the [incomprehensible] was gone. It's gone away so.

INTERVIEWER: Perfect, so I'll hold it like this.

PARTICIPANT: Okay that's good.

INTERVIEWER: Great, okay so we're going to start now and if you have any questions along the way just feel free to ask.

PARTICIPANT: Sounds good, and you have my form, I submitted that today.

INTERVIEWER: Yes we got it. Thank you so much for doing that.

PARTICIPANT: Yeah no problem.

INTERVIEWER: Okay so, how would you identify yourself? As a male? Female? Or Other?

PARTICIPANT: I would be male.

INTERVIEWER: Male. Okay great. And just as a reminder all of these questions are confidential, so nobody's going to get ahold of them besides for us.

PARTICIPANT: Okay

INTERVIEWER: Okay so what would your household income be? 0-19,000 dollars, 20,000- 39,000, 40,000-59,000, 60,000-79,000, 80,000....

PARTICIPANT: 20 to 39

INTERVIEWER: 20 to 39? Okay great. And what would your race be?

PARTICIPANT: I guess I'm white.

INTERVIEWER: White? Okay great. And what was your highest education reached?

PARTICIPANT: I have a B.S.

INTERVIEWER: Sorry could you repeat that? Oh a B.S. Okay a Bachelors? Great. Thank you so much. And how old are you?

PARTICIPANT: I'm, good question, I am 38.

INTERVIEWER: 38? Okay great. And were you born blind or did you develop it during your life?

PARTICIPANT: I was always visually impaired, and I became blind at about age 7.

INTERVIEWER: About age 7 okay and what caused your blindness?

PARTICIPANT: I was born with retinoblastoma.

INTERVIEWER: Okay. And what did you or what do you struggle most with when navigating through your surroundings?

PARTICIPANT: Can you repeat that please?

INTERVIEWER: What do you struggle most with when navigating through your surrounding?

PARTICIPANT: Knowing exactly where I am.

INTERVIEWER: Okay knowing where you are. Got it. And do you currently use any assistive devices to navigate? And if so, what?

PARTICIPANT: Sure. I use a white cane.

INTERVIEWER: Okay.

PARTICIPANT: That is my primary assistive technology. I use GPS mostly on my phone.

INTERVIEWER: Okay

PARTICIPANT: That's pretty much it.

INTERVIEWER: Okay great. In the past have you utilized any other assistive devices? And if so, what were they and why did you stop using them?

PARTICIPANT: It's interesting that you ask. I actually have a prototype ultrasonic electronic device that was built for me by some local engineers that I've been trying out over the last year. And I use that sporadically.

INTERVIEWER: Right

PARTICIPANT: And so I sort of use it. It's sort of a testing thing, but I do use it from, you know on and off. Not as a constant basis.

INTERVIEWER: Oh okay

PARTICIPANT: That's all I've used. I've used other GPS solutions over the years as they evolved but that's about it.

INTERVIEWER: Okay. Got it. So next question is how important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: That's very important. In fact I'd say it's critical.

INTERVIEWER: Okay so, critical. So what we plan on doing is creating a navigational device to help assist the blind to recognize objects and humans in daily travels. So would you be open to using such a device?

PARTICIPANT: Sure!

INTERVIEWER: Okay great. And in the next few questions I'm going to be asking you questions more related to our device. So we'll have a better sense of what we're developing. So in order to communicate the information taken from the external environment to the user, we were debating either doing tactile feedback, auditory feedback or possibly a combination of both. So what would you prefer?

PARTICIPANT: I guess my preference would be for both, and weighted towards tactile.

INTERVIEWER: Okay weighted towards tactile. How come? If you don't mind me asking.

PARTICIPANT: Because hearing is a necessary part of navigation. And having additional stimulus is distracting if not downright interfering.

INTERVIEWER: Right, okay perfect. Thank you so much. Okay so the next question relates to... so basically for the device, in order, we have to have a sensor system in order to pick up on the external information from the environment. So it would be... sorry one second. [What were the exact measurements?] YZ [Off mic]: Like 12 inches long and 3 inches thick.

INTERVIEWER: So it would be around 12 inches long and 3 inches thick. Also, possibly, we're still working on developing it, but possibly you need to have a backpack also to hold the device that would be working it. So, where exactly would you prefer to have this sensor placed? On your chest? On your waist? On your head? Where would be most comfortable to have this sensor?

PARTICIPANT: Well it kind of depends on how it works. If you want it to be a sensor oriented kind of pointed forward sort of thing probably chest.

INTERVIEWER: Chest okay.

PARTICIPANT: If you want it to be a little more maneuverable, I don't know maybe arm.

INTERVIEWER: Right okay. We were actually considering that but I think that we'd want it to be somewhere more stable that doesn't move as much.

PARTICIPANT: The size of the thing you were describing would be ludicrous if not completely impossible to attach to someone's head.

INTERVIEWER: Right, right so yeah. Haha. We just thought we'd have that as an option just in case somebody did prefer that. But okay so you said chest just to clarify.

PARTICIPANT: Yes.

INTERVIEWER: Okay great. And how comfortable do you think you'd be wearing this device on your body.

PARTICIPANT: It sounds pretty uncomfortable. Obviously for testing services and all that. But I mean if you're talking about using and employing a production-style device, it sounds pretty encumbering.

INTERVIEWER: Right okay, that's part of the reason that we're trying to get your feedback along with other participant's so we can develop something that is most comfortable just because based on what the device is, it's hard to make it completely out of the way.

PARTICIPANT: Well currently, and that's not true because in a year and a half it'll be a third of the size that you're describing.

INTERVIEWER: True true, you're right, but I'm talking about for terms, like for now and for what we're capable of developing.

PARTICIPANT: Right

INTERVIEWER: Okay, and do you think that this device would efficiently complement your cane? Or do you feel that it would be a...or do you think it would hinder it?

PARTICIPANT: I don't know anything about what it's really going to do, so that's really hard for me to answer.

INTERVIEWER: Okay so basically just an overview of what it would do is it would help you...it would do a lot of object recognition, so it would help identify objects in your pathway to help you avoid them. So it would give you prior knowledge that the cane would not be able to offer you.

PARTICIPANT: As long as it did it in a real-time fashion.

INTERVIEWER: Yes it would.

PARTICIPANT: Then yeah! That could be really useful. I would have to try it to really see what it did for me but yeah it sounds very potentially very useful.

INTERVIEWER: Okay great. And just lastly, do you have any comments or suggestions regarding the development of this device?

PARTICIPANT: I only have one, and that's from reading the little abstract that you send me.

INTERVIEWER: Okay

PARTICIPANT: So sighted people seem to think that object avoidance is a thing, and that that is a goal. And that is almost never the case. Most orientation ability is all about finding landmarks and object identification, and not about avoiding obstacles like you usually want to find an obstacle not avoid an obstacle.

INTERVIEWER: Right.

PARTICIPANT: And I think that is a perspective thing, like the way that it's...oh sorry that's...Sorry my phone is jabbering at me, okay now it's stopped.

INTERVIEWER: Don't worry.

PARTICIPANT: That is a sort of...maybe it's a language thing, I mean it's a way you look at the situation, but there are lots of devices or approaches that have been all about object avoidance. So that's almost never what blind people want to do. You want to know what's in your environment and collect as much information as possible, and you know, sure there's some things that you don't need to engage with, but actually avoiding things is almost never the immediate goal.

INTERVIEWER: Okay so more focus on....

PARTICIPANT: Yeah, so this whole idea of object avoidance is probably not right way to look at it.

INTERVIEWER: Okay

PARTICIPANT: It's not that you're not doing the right thing, but it's not the game you want to be playing

INTERVIEWER: Right, that's actually very helpful feedback.

PARTICIPANT: Yeah, this is kind of what happens to a lot of people over the years. A lot of different scientists and engineers, and the other blind people that I've talked to who have used the technology seem to agree that object avoidance is never what you want to do because to avoid something, you haven't necessarily identified it, and you're more lost because objects are what you navigate by.

INTERVIEWER: Right.

PARTICIPANT: Landmarks and such.

INTERVIEWER: Okay got it. And that's very helpful, and I appreciate that extra feedback.

PARTICIPANT: Sure.

INTERVIEWER: Okay so thank you very much for your time in taking this interview. My team and I greatly appreciate it. And if we have any further questions we will contact you in the future if that's okay.

PARTICIPANT: Okay I do have one specific question.

INTERVIEWER: Yes Of course!

PARTICIPANT: There's a mention of an obstacle course or something in your facility.

INTERVIEWER: Yes

PARTICIPANT: I do live in Baltimore so I am available for that if you want to hit me up.

INTERVIEWER: That's perfect. Awesome! Yeah we're actually going to be conducting that hoping next fall.

PARTICIPANT: Okay

INTERVIEWER: So soon after the summer ends. So I will definitely be in touch with you, probably towards the end of the summer, if not early fall to give you more information about that.

PARTICIPANT: Okay so I am in the area and I will be delighted to help you out.

INTERVIEWER: Great! Thank you so much for helping! I really appreciated. You've been a great help.

PARTICIPANT: No problem.
INTERVIEWER: Okay. Have a great day!
PARTICIPANT: You too! Thanks a lot, bye.
INTERVIEWER: Bye.

Subject 3

PARTICIPANT: Hello
INTERVIEWER: Hi [name redacted], this Yael Osman calling from the University of Maryland.
PARTICIPANT: Hi. How are you?
INTERVIEWER: I'm good. How are you doing today?
PARTICIPANT: Fine
INTERVIEWER: I was wondering if you are available now to do the interview? Is that still okay?
PARTICIPANT: Yeah that's fine.
INTERVIEWER: Okay that's perfect. So I'm going to start by just...just a reminder that when you are answering everything, all of your answers are being kept confidential And if you have any questions along the way please feel free to ask.
PARTICIPANT: Okay
INTERVIEWER: Okay so, just how would you identify? As male, female or other?
PARTICIPANT: Female.
INTERVIEWER: Female. Okay. What would your household income be? 0-19,000 dollars, 20,000-39,000, 40,000-59,000, 60,000...
PARTICIPANT: 40,000-59,000
INTERVIEWER: Okay so 40,000-59,000. Perfect. Okay and what would your race be?
PARTICIPANT: Let's put to Asian.
INTERVIEWER: Okay. Asian. Okay.
PARTICIPANT: Yeah
INTERVIEWER: Perfect. And what is your highest education level reached or highest degree obtained?
PARTICIPANT: I have Bachelor's degrees from College Park
INTERVIEWER: Okay Bachelor's Degree. Great. And how old are you?
PARTICIPANT: 47
INTERVIEWER: 47. Okay were you born blind or did you develop it during your life?
PARTICIPANT: I became blind when I was 15.
INTERVIEWER: 15. Okay and what caused your blindness?
PARTICIPANT: [incomprehensible] attachment.
INTERVIEWER: Sorry would you mind repeating that again?
PARTICIPANT: Retinal Detachment

INTERVIEWER: Okay. And what do you struggle most with when navigating through your surroundings?

PARTICIPANT: Well, [incomprehensible] to most, I use a white cane.

INTERVIEWER: Okay

PARTICIPANT: But mostly signposts with have posts on either side and in between there's nothing. So basically my cane can go underneath the signpost.

INTERVIEWER: Okay.

PARTICIPANT: Or [incomprehensible] if they're hanging too low.

INTERVIEWER: Right

PARTICIPANT: If anything is on the ground, I can navigate and figure it out with my cane. Most of the time I can figure it out with my cane.

INTERVIEWER: Right so anything that's not on the ground per-say is difficult.

PARTICIPANT: Yeah

INTERVIEWER: Okay got it. Okay so do you currently use any assistive devices to navigate? If so what?

PARTICIPANT: I mean other than my cane I don't use anything.

INTERVIEWER: Okay. In the past have you utilized any other assistive devices?

PARTICIPANT: No

INTERVIEWER: No? Okay

PARTICIPANT: No just the cane.

INTERVIEWER: Just the cane? Got it. So how important it is to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: It is very important, especially if I'm going into a crowd, or a crowded place, or anywhere around town or just to find the obstacles in my way, and also in the workplace. Sometime people put things in the middle of the hall and they don't tell me.

INTERVIEWER: Right and then so that can become an issue.

PARTICIPANT: Yeah

INTERVIEWER: Got it okay. So we plan on creating a navigational device to assist the blind in recognizing objects and humans in daily travel. So would you be open to using such a device?

PARTICIPANT: Yes

INTERVIEWER: Yes okay great. So in the questions to follow, I'm just going to be asking you questions related to the development of our device.

PARTICIPANT: Mhm

INTERVIEWER: Okay. Basically in order to community the external information to the user, we're deciding in using either tactile feedback or auditory feedback or a combination of both. So what would you most prefer?

PARTICIPANT: For me, auditory is fine.

INTERVIEWER: Okay

PARTICIPANT: But I know that there are a lot of deaf/blind people who won't benefit from this, so tactile or vibration.

INTERVIEWER: Okay.

PARTICIPANT: Will be good for them.

INTERVIEWER: Okay but for you personally you would prefer the auditory?

PARTICIPANT: Yes, in a response that's all in front of you.

INTERVIEWER: Right exactly. Exactly. Got it. And is it because it's just clearer for you and easier for you to understand?

PARTICIPANT: Mhm

INTERVIEWER: Okay perfect. So part of our device is creating a motion sensor system that basically is able to identify these objects in the external environment. So this system would be about 1 foot long and about 3 inches thick. So where would you, I guess, most like to have this place? Either on your head, on your chest, on your waist? What do you think would be most comfortable for you?

PARTICIPANT: I would put it around my neck in front of me so if I'm using my cane, it can sense and let me know what is coming in front of me.

INTERVIEWER: Okay

PARTICIPANT: Because a hanging thing and I can put it around my neck, and I can put it around my chest in a sense.

INTERVIEWER: So on your chest in a sense?

PARTICIPANT: [incomprehensible]

INTERVIEWER: Okay Got it. Got it. And how comfortable would be wearing such a device?

PARTICIPANT: I would be okay. There would be a lot of other things.

INTERVIEWER: Okay. Got it. And do you think that this device would efficiently complement your cane or do you think it would hinder your ability to use the cane?

PARTICIPANT: I think it would complement my cane use.

INTERVIEWER: Okay great. And just lastly, do you have any comments or suggestions regarding the development of this device?

PARTICIPANT: I mean it will probably be using batteries?

INTERVIEWER: Yes

PARTICIPANT: With a battery charger that you can plug in to charge the device. That will be easier.

INTERVIEWER: Oh okay oh easier than using batteries?

PARTICIPANT: Yeah

INTERVIEWER: Okay. Got it. Okay and any other feedback?

PARTICIPANT: And if it can turn on and off if I'm not using it and it can fit in a turn off situation/position so I don't run out of battery all the time.

INTERVIEWER: Right. Great okay.

PARTICIPANT: You know a lot of other people have that problem with cell phones.

INTERVIEWER: Oh yeah. Yeah that's such a good point. Thank you. Okay and anything else?

PARTICIPANT: Nope that's all.

INTERVIEWER: Okay great. Thank you so much for taking the time to do this interview. I really appreciate it.

PARTICIPANT: Okay

INTERVIEWER: Alright. Have a great day!

PARTICIPANT: Yael? I need to let you know a piece of information.

INTERVIEWER: Yes?

PARTICIPANT: You probably...you are at College Park, at the adaptive technology lab?

INTERVIEWER: Sorry could you repeat that? The Adaptive Technology Lab?

PARTICIPANT: Yes. [Incomprehensible]

INTERVIEWER: No I haven't heard about that.

PARTICIPANT: Well if you go there, my friend [name redacted] goes there every year for the Maryland Day.

INTERVIEWER: Okay

PARTICIPANT: So, because I am an alumni at Maryland, and [name redacted], who is the coordinator of that lab. He has other students who are really interested or may be interested.

INTERVIEWER: Oh! Great, okay perfect. Okay Great I really appreciate that feedback. I'll definitely look into that and see if we could get other participants from there.

PARTICIPANT: Okay

INTERVIEWER: But thank you so much and if we have any further questions we'll contact you in the future if that's okay.

PARTICIPANT: Okay

INTERVIEWER: Great.

PARTICIPANT: That'll be fine.

INTERVIEWER: Thank you so much. Have a wonderful day!

PARTICIPANT: Okay thank you.

INTERVIEWER: Okay bye.

Subject 4

PARTICIPANT: Hello

INTERVIEWER: Hi. This is Yael Osman calling from the University of Maryland.

PARTICIPANT: Yes

INTERVIEWER: Hi, How are you today?

PARTICIPANT: Good. Very Good

INTERVIEWER: Are you still available to do the interview right now?

PARTICIPANT: Yes. Absolutely yeah.

INTERVIEWER: Okay, great. So I just wanted to remind you that all of your responses are confidential, and if you have any questions along the way, please feel free to ask. Okay great, so I'm just going to start the interview. So how would you identify yourself: male, female, or other?

PARTICIPANT: Male

INTERVIEWER: Male? Okay great, and what would your household income be: either 0-19000 dollars, 20,000-39,000, 40,000-59,000, 60,000-79,000, 80,000.

PARTICIPANT: Is this household or individual?

INTERVIEWER: Sorry could you repeat that?

PARTICIPANT: For individual or total household?

INTERVIEWER: Household

PARTICIPANT: 50,000 plus

INTERVIEWER: Wait sorry could you say that one more time?

PARTICIPANT: Say what the last category you said. 50,000 to?

INTERVIEWER: Oh, uhm I said 60,000-79,000.

PARTICIPANT: Yeah that's [incomprehensible]

INTERVIEWER: That's correct? Okay great. And what is your race?

PARTICIPANT: Asian indian

INTERVIEWER: Asian indian, okay perfect. What is your highest level of education reached? Or your highest degree obtained?

PARTICIPANT: I have 2 masters degrees

INTERVIEWER: Two masters degrees. Okay. And how old are you?

PARTICIPANT: I'm 24

INTERVIEWER: 24. And were you born blind or did you develop it during your life?

PARTICIPANT: I developed it within my life.

INTERVIEWER: Okay, and what caused your blindness?

PARTICIPANT: Hockey

INTERVIEWER: Okay. And do you currently use any assistive devices to navigate? And if so, what?

PARTICIPANT: I use certain apps on my iPhone.

INTERVIEWER: Okay. Could you expand on that a little?

PARTICIPANT: Yes, the GPS...uhh...the GPS apps and the apps for macs and linuxes. Those are the apps that I use.

INTERVIEWER: Okay great. And do you use anything else? Such as a cane?

PARTICIPANT: Well I do use a accessible technology from Point of View, Yes I do use JAWS

INTERVIEWER: Okay.

PARTICIPANT: Which can get me there faster, and also I use AccessPlay as well as I use BookFans, I don't know if you know that.

INTERVIEWER: Okay.

PARTICIPANT: And few of the devices [incomprehensible] combination of voice recorders and skinny disks on different platforms.

INTERVIEWER: Okay great. Okay so in the past have you utilized any other assistive devices? And if so why did you stop using them?

PARTICIPANT: Yes I have, and was compelled there was one particular the [incomprehensible], I think it was called the, I forget what the name is. It's called the Plectalk. And I think I stopped using it because it was a little bit too complicated to [incomprehensible]

INTERVIEWER: Okay got it. So it was just a little too complicated.

PARTICIPANT: Yes

INTERVIEWER: Okay.

PARTICIPANT: And I forgot this big one which I stopped using it.

INTERVIEWER: Okay great. What do you struggle most with when navigating through your surroundings?

PARTICIPANT: Being update or if I need to know status where I'm at that I don't know. Or if I need to know how far I am at from my destination, things like that.

INTERVIEWER: Right okay

PARTICIPANT: And of course there are two different things. If you're talking about indoor navigation and outdoor navigation I am mostly referring to outdoor navigation right now.

INTERVIEWER: Okay. Outdoor navigation. Got it.

PARTICIPANT: Could be more accurate, It's getting better but it could get more accurate.

INTERVIEWER: Okay. Got it. And how important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: People in my what's the last part?

INTERVIEWER: Identify objects and people that are in your path.

PARTICIPANT: People in my...

INTERVIEWER: In your path, so for example if you were walking and a person was in front of you.

PARTICIPANT: That would be very important actually

INTERVIEWER: Yeah okay great. So what we plan on doing is creating a navigational device to assist the blind in recognizing objects and humans in daily travel. So would you be open to using such a device?

PARTICIPANT: Yes absolutely, especially if a friend I know is walking by or [incomprehensible] ahead of me. I wish there was an alert which would give me "okay such and such x y which friend is walking by you and would you like to say hello or just you know"

INTERVIEWER: Right okay. Perfect. Got it. Okay so part of developing the device requires us to find a way to communicate the information taken from the external environment back to the user. So right now we're deciding between either using tactile feedback, auditory feedback, or a combination of both. So what would you prefer?

PARTICIPANT: I think a combination would be better. It's good to have alternative forms because let's say if it's a noisy situation, then I would definitely move to tactile.

INTERVIEWER: Right

PARTICIPANT: And if I, you know tactile sometimes be somewhat more cumbersome or needs more battery power or you know, something else can happen I can backup to auditory you know?

INTERVIEWER: Right so depending on the situation. One or the other.

PARTICIPANT: They're suppose to be independent of each other, information independent of each other or some information in auditory and some information in tactile. I think it should be all information in both.

INTERVIEWER: Okay got it. Okay so the device that we're creating is going to incorporate/is incorporating a motion sensor system that basically identifies the information in the external environment. So this system it will be around one foot long and three inches thick approximately.

PARTICIPANT: Tell me your [incomprehensible]

INTERVIEWER: So the dimensions were a foot long and three inches thick.

PARTICIPANT: Okay

INTERVIEWER: So where would you most like, I guess, to have this device on your body. For example, on your head, on your chest, on your waist?

PARTICIPANT: So, I know I mean the last thing you want to look like is to look like a Martian you know?

INTERVIEWER: [Laughter] Yeah

PARTICIPANT: And I mean I know this because when we were developing the reading machine for the blind, it got wild. We were doing similar kind of testing and people didn't want to carry a briefcase-like device to do something simple and mundane you know?

INTERVIEWER: Right

PARTICIPANT: So definitely, if it can be avoided at all, if it can blend into my clothing. Ideally that would be the best thing. I can put it into my pocket or you know, it's a small thing you're speaking of: as part of my belt, as part of my button or something.

INTERVIEWER: So okay, so if...okay

PARTICIPANT: Yeah so that will be important. So if the whole device doesn't need to be out, it should not be out. That's what I would prefer you know?

INTERVIEWER: Okay got it, so least obtrusive as possible.

PARTICIPANT: Right if the camera needs to be out then that's fine, so the camera will just look out. It can be part of my hat or something, but nothing.... it should blend into my clothing or my whatever.

INTERVIEWER: Okay got it. So how comfortable would you be wearing this device on your body?

PARTICIPANT: I can wear it for testing purposes and I don't know if I would wear such a device on a day-to-day basis, on a regular kind of thing. For testing that's fine but in a prototype.

INTERVIEWER: Okay so you would feel comfortable wearing this?

PARTICIPANT: Yeah I would feel comfortable yeah.

INTERVIEWER: Okay. Got it. And do you think this device would efficiently complement your cane or do you think it would hinder your ability to use the cane?

PARTICIPANT: I think there's two aspects to this. One is that cane by itself should be left independent you know? Of course they both can complement but uh [incomprehensible] They can use cane if there's [incomprehensible] technology. But if it's good I get more information. Cane will not tell me who's walking by or what you're... I really don't care....for obstacle, for obstacle within the next 5 feet.

INTERVIEWER: Right.

PARTICIPANT: I don't expect any other device to catch anything, like I don't want to know whether there's a pole approaching me or there's a tree in front of me.

INTERVIEWER: Right okay. Got it

PARTICIPANT: So unless the device is 100% safe, and 100% accurately tells me every time there's a pole coming or not, then I can rely on it.

INTERVIEWER: Okay.

PARTICIPANT: I don't think there's a reliable device which will say there's a pole is coming by or I don't want to be [incomprehensible] too much information sometimes you know?

INTERVIEWER: Okay I got it. Okay great thank you. So do you have any other comments or suggestions regarding the development of this device? Or anything else?

PARTICIPANT: Who is putting this project? Is this part of a PhD, Masters program? Or a company?

INTERVIEWER: It's actually an undergraduate honors program at the University of Maryland.

PARTICIPANT: Okay

INTERVIEWER: So yeah [laughter] it's a research program.

PARTICIPANT: How many students are involved?

INTERVIEWER: 14 students.

PARTICIPANT: 14 students?

INTERVIEWER: Yes.

PARTICIPANT: And how long is the project last? What is the end time goal time to achieve your goal?

INTERVIEWER: So we have to...our goal is to write a thesis paper about it, and I'd say like two year around? So probably we'll be working on this for another two years.

PARTICIPANT: I see, and if Microsoft or any other company involved? Google or...?

INTERVIEWER: No I mean the company....we're using a Microsoft Kinect, but the company itself is not involved in the development of the product. [long pause] Hello? [long pause] Hi are you still there?

PARTICIPANT: Yeah I'm here yeah.

INTERVIEWER: Okay sorry. Did that answer your question?

PARTICIPANT: Yeah so tell me one last question I have what's the next step?

INTERVIEWER: Okay so our next step after conducting the interviews is we're going to give our feed back to members of our team who are working in developing this product. And hopefully in the fall of next year we're going to start doing product testing. And so that would require participants coming in and actually testing our product and giving us feedback on how they liked the product and I guess advice they have in order to improve it and stuff along those lines.

PARTICIPANT: Okay

INTERVIEWER: So, is that something you think you would be interested in doing in the future?

PARTICIPANT: Absolutely, yeah yeah.

INTERVIEWER: Okay great. So I will probably be in touch with you either towards the end of the summer or beginning of next fall to give you more information about the product testing stage of everything.

PARTICIPANT: Sure. That sounds great.

INTERVIEWER: Okay. Great. Great thank you so much for doing this interview. I really appreciate it.

PARTICIPANT: Thank you yes yeah.

INTERVIEWER: Okay have a great day!

PARTICIPANT: You too. Buh-bye

INTERVIEWER: Bye.

Subject 6

Filled out a form.

Gender	Female
Household Income	\$150,000+
Race	White
Education	Masters
Age	32
Born / Developed Blindness	Developed
Cause of Blindness	Unknown and Sudden
Difficulties Navigating	Pedestrians not paying attention and loud environments
Assistive Devices in Use	Guide dog, GPS on phone, and cane
Assistive Devices Abandoned	None
Importance of Having Assistive Devices	Important
Open to Using New Devices	Yes
Audio, tactile, etc. preference	Both
Kinect Placement	Waist
Comments	None

Subject 7

PARTICIPANT: Hello?

INTERVIEWER: Hi. Is this [name redacted]?

PARTICIPANT: Yes.

INTERVIEWER: Hi this is Yolanda Zhang from the University of Maryland about the blind study.

PARTICIPANT: Hi how are you today?

INTERVIEWER: Hi Im good how are you?

PARTICIPANT: Alright.

INTERVIEWER: Alright so this interview will take about 10-15 minutes.

PARTICIPANT: Okay

INTERVIEWER: And Im just going to be asking you basic, like first basic question about demographics, and then like more specifics about our actual project.

PARTICIPANT: Okay

INTERVIEWER: And all your responses will be held confidential.

PARTICIPANT: Okay

INTERVIEWER: Okay so, I have to ask, [Chuckle], but its a very standard question, but would you identify your gender as male, female, or other?

PARTICIPANT: Female.

INTERVIEWER: Female. Okay. Is your household income between 0-19,000 dollars, 20,000 dollars to 39,000 dollars, 40,000... sorry what?

PARTICIPANT: Oh no. You...you faded out.

INTERVIEWER: Oh sorry, is it between 0-19,000 dollars?

PARTICIPANT: Its that right there.

INTERVIEWER: Okay

PARTICIPANT: Okay

INTERVIEWER: What is your race?

PARTICIPANT: African American.

INTERVIEWER: Okay. And what is the highest level of education or degree that youve attained?

PARTICIPANT: Eleventh-grade.

INTERVIEWER: Okay so some high school?

PARTICIPANT: Yes in high school.

INTERVIEWER: Okay. And how old are you?

PARTICIPANT: Im 38.

INTERVIEWER: 38. Okay. Were you born blind or did you develop it during your life?

PARTICIPANT: I developed it in high school.

INTERVIEWER: Mhm. What caused your blindness?

PARTICIPANT: How can I put it, I had optic nerve damage, so pressure from...pressure put on my optic nerve.

INTERVIEWER: Mhm. Okay so what do you struggle most with when navigating through your surroundings?

PARTICIPANT: Really just orient...just orient....how can I put this. Really just to figure out where I am or what Im trying to do especially because I havent been here before.

INTERVIEWER: Mhm right so, just knowing where you are?

PARTICIPANT: Right.

INTERVIEWER: Right, so do you currently use any assistive devices to navigate?

PARTICIPANT: A cane, white cane.

INTERVIEWER: White cane. Mhm.

PARTICIPANT: Mhm

INTERVIEWER: In the past have you used any other types of assistive devices?

PARTICIPANT: No

INTERVIEWER: No okay. How important is it to you to have a navigational aid indoors that allows you to identify objects and people in your path?

PARTICIPANT: I mean its very important.

INTERVIEWER: Mhm. Okay. So our team plans on creating a navigational device to assist the blind to recognize objects and humans in their daily travel in an indoor environment. Would you be open to using such a device?

PARTICIPANT: Yeah.

INTERVIEWER: Okay. So what so you think would be the best way of like communicating the information taken from the external environment to the user? For example it could be tactile, auditory, or a combination of both.

PARTICIPANT: Im not really sure about what tactile is. Do you have any information on that?

INTERVIEWER: Right thats just like touch. Its usually like vibrations or like maybe like on a belt. It would either vibrate on your right or left side. And maybe give you directions that way. Or.

PARTICIPANT: Oh no I would like the voice.

INTERVIEWER: The voice? Okay.

PARTICIPANT: Mhm.

INTERVIEWER: And would you mind explaining why you prefer the auditory?

PARTICIPANT: Because it seem like it would give you basic directions that you could just listen to and follow. As oppose to vibrating or moving and that would just be distractive for me.

INTERVIEWER: Right. Right it might not be as clear or something.

PARTICIPANT: Right.

INTERVIEWER: Okay. So our device will incorporate a type of sensor and maybe a backpack and also a tablet. So the actual sensor that is like sensing the objects in front of you. Where do you feel like would be the best place to put it on your body? Its about 12 inches long and 3 inches thick. For example you can put it on your head, your chest or your waist or any other places?

PARTICIPANT: So okay. Let me get a better understanding. Okay you said 12 inches long and about how...2 inches thick?

INTERVIEWER: Right

PARTICIPANT: So describe something that has that dimension to me so I can understand what it will be like.

INTERVIEWER: Right so, [mutter]. So maybe like a school textbook, but not as...not as wide like that or as heavy. Its more like a bar-like kind of thing.

PARTICIPANT: Okay. Okay like a bar. I think that would go good on the waist.

INTERVIEWER: It would go good on the waist?

PARTICIPANT: Mhm. Or the side. Like you know how you....you know like how officers carry a nightstick on the side?

INTERVIEWER: Right. Right.

PARTICIPANT: Yeah like that.

INTERVIEWER: Okay. How comfortable would you be wearing this device on your body?

PARTICIPANT: Pretty comfortable as long as its not like right there, like on your head. On your chest where it just sticks out more than you do.

INTERVIEWER: Yeah. Yeah I understand. Do you think this device will efficiently complement your cane or do you feel like it would be a hindrance; it would get in the way?

PARTICIPANT: I would think if it tells things that your cane cannot. I think it will be helpful when used with the cane.

INTERVIEWER: Mhm. Right. Do you have any other comments or suggestions regarding the development of this device?

PARTICIPANT: No not really

INTERVIEWER: Okay so, so this is the end of the interview. Thank you very much for your time and we really appreciate your input.

PARTICIPANT: Okay yeah. Good luck and I hope you all get it together. So do you know when the device will be ready...up and ready?

INTERVIEWER: Right. It would probably be ready this fall. Thats also the time we will begin product testing/prototype testing. So, we could contact you in the future if youre interested in doing that.

PARTICIPANT: I hope so. I will be very interested in using it, and just to see you know how it develops and everything.

INTERVIEWER: Right. Right okay. Thats great thank you.

PARTICIPANT: Okay. Good luck.

INTERVIEWER: Thank you. Bye.

PARTICIPANT: Bye-bye.

INTERVIEWER: Have a nice day.

PARTICIPANT: Alright

Subject 8

PARTICIPANT: Hello.

INTERVIEWER: Hi [name redacted]?

PARTICIPANT: Hi Yolanda how are you?

INTERVIEWER: Im good how are you?

PARTICIPANT: Im good.

INTERVIEWER: Okay good. Are you available right now to do the interview?

PARTICIPANT: Yeah

INTERVIEWER: Okay. So this will take maybe about less than 10 or maybe 10 to 15 minutes.

PARTICIPANT: Okay.

INTERVIEWER: And all your responses will be held confidential. So, Im going to begin with some basic, like demographic questions. Would you identify your gender as male, female, or other?

PARTICIPANT: Female.

INTERVIEWER: Female, okay. Is your household income 0 to 19,000 dollars, 20 to 39,000 dollars, 40,000 to 59,000 dollars, 60,000 to 79,000 dollars, 80,000 to 99,000 dollars, 100,000 to 149,000 dollars, or more than 150,000 dollars?

PARTICIPANT: Im going to say the 40 to 50 something.
INTERVIEWER: 40 to 59,000?
PARTICIPANT: Yeah. Thats what Im going to say.
INTERVIEWER: Okay. What is your race?
PARTICIPANT: I am black.
INTERVIEWER: Okay and what is the highest education or degree that youve obtained?
PARTICIPANT: I have a bachelors from the University of Maryland, College Park.
INTERVIEWER: Oh nice.
PARTICIPANT: Yeah
INTERVIEWER: Okay how old are you?
PARTICIPANT: I am 40.
INTERVIEWER: 40. Okay. Were you born blind or did you develop it during your life?
PARTICIPANT: I was born...my blindness was due to...because I was a premature baby.
INTERVIEWER: Okay. So
PARTICIPANT: You could say that I was basically. You could say that it was a result of me being born early.
INTERVIEWER: Right. Right because you have no memory of...
PARTICIPANT: [Chuckle] Right. Right.
INTERVIEWER: Okay. What do you struggle most with when navigating through your surroundings?
PARTICIPANT: Lets see. I guess I want to say like with the cane, sometimes when you dont have the right cane and youre still walking outside, you cane will get stuck in places.
INTERVIEWER: Oh really?
PARTICIPANT: Yeah. Or itll...yeah itll get stuck in cracks, in stuff and may jolt you a little bit.
INTERVIEWER: Right. Right are there differences in the challenges between outdoor and indoor environments?
PARTICIPANT: I think it just depends. I think it really just depends.
INTERVIEWER: Do you currently use any assistive devices to navigate?
PARTICIPANT: Yeah. I have a cane.
INTERVIEWER: Right. So just the white cane?
PARTICIPANT: Yeah
INTERVIEWER: In the past have you used any other assistive devices?
PARTICIPANT: Well, like Ive used Monoculars.
INTERVIEWER: Mhm.
PARTICIPANT: If you want to consider that.
INTERVIEWER: Okay. Sure
PARTICIPANT: To look at stuff. Thats all I can think of right at this moment.
INTERVIEWER: So, why did you stop using the binoculars or whatever?

PARTICIPANT: Monoculars? Because the cataract got stuck in my left eye.
And I couldnt use that particular one anymore.

INTERVIEWER: Mhm. Okay. How important is it to you to have a navigation aid that allows you to identify objects and people in your path in an indoor environment?

PARTICIPANT: I think it would be really important. I still have some of my sight. Im not completely blind, so I think that would be a good think to have a device like that if youre going to make a device for no-vision blind people.

INTERVIEWER: Mhm.

PARTICIPANT: So I just think it would be good.

INTERVIEWER: Mhm. So what types of things can you see? Like how limited is your eyesight?

PARTICIPANT: Okay Im going to describe it the best way I can when people ask me that. What I see is like if someone put Saran wrap over my eye. You see the overall picture, but you may not see detail unless youre really right up on it. But you see the overall picture.

INTERVIEWER: Right. So its not like you cant, its not corrective at all?

PARTICIPANT: No. Not at this point. Only with like certain visual aids and stuff. But thats the best way I can describe it that people can kind of...kind of get an idea.

INTERVIEWER: Uh-huh. Yeah thats interesting. So our team; we plan on creating a navigational device to assist the blind or visually impaired to recognize objects and humans in daily travel in an indoor environment. Would you be open to using such a device?

PARTICIPANT: Yes

INTERVIEWER: Okay. So what do you think would be the best type of way to communicate the information taken form the outside...like the environment to the user? For example, it could be tactile, auditory, or a combination of both.

PARTICIPANT: I would think...for me I would like auditory, but I think a combination of both would be beneficial.

INTERVIEWER: Mhm. So for you personally, why would you like auditory better?

PARTICIPANT: Well the auditory because I can hear. [laughter] So its like I can hear like oh like a dog or oh thats this that or the other. So but I think overall I think if you can kind of combine the two, so people who arent necessarily auditory who might have a deaf-blind person who uses it. They might have the option to have the tactile.

INTERVIEWER: Right. Okay. But for you personally you would prefer auditory?

PARTICIPANT: Yeah, if possible, but like I said if it can have options to it.

INTERVIEWER: Okay yeah. So the device that we plan on creating incorporates a type of sensor, maybe a backpack and a tablet that controls it. And the sensor is about a foot long and maybe 3 inches

thick. Its kind of like a bar kind of thing. Where do you feel like would be the best place to put this sensor on your body? For example, like the head, chest or waist?

PARTICIPANT: Oh goodness, maybe on your waist?

INTERVIEWER: Yeah like a belt-kind of think?

PARTICIPANT: Yeah! Thats what Im thinking. Maybe on your waist.

INTERVIEWER: Yeah. So its...so it doesnt look as....sticks out as much.

PARTICIPANT: Right, exactly.

INTERVIEWER: Right. Yeah. How comfortable would you be wearing this device? On your body.

PARTICIPANT: Well. If its not as...as long as its small, I think it would be okay. But, nobody wants a bulky thing. You know, hanging off their pants or whatever.

INTERVIEWER: Right. For sure. Yeah. So do you think this kind of device would efficiently complement your cane or do you feel like it would get in the way?

PARTICIPANT: Well I think it would just be an added benefit.

INTERVIEWER: Right. Okay. Do you have any other comments or suggestions regarding the developments of this device?

PARTICIPANT: No. Not at this time.

INTERVIEWER: Okay. So thats the end of our interview. Thank you very much for your time. And...

PARTICIPANT: No problem.

INTERVIEWER: We really appreciate your input.

PARTICIPANT: Oh no problem. I remember when you came to the advisory board meeting at The Lighthouse.

INTERVIEWER: Yeah yeah yeah. That was us. [Chuckle]

PARTICIPANT: Yeah. Yeah. So just let me know where else I can help out.

INTERVIEWER: Mhm yeah we would probably...did you indicate that you were interested in obstacle course testing?

PARTICIPANT: I think I did. I agreed to a couple of things yeah.

INTERVIEWER: Yeah that would probably begin this fall, so we could contact you around the fall about that.

PARTICIPANT: Yeah. I did sign a couple of agreements so....

INTERVIEWER: Mhm. Yeah I saw that actually.

PARTICIPANT: Okay.

INTERVIEWER: Yeah we got that. Okay thanks you

PARTICIPANT: No problem.

INTERVIEWER: Have a nice day.

PARTICIPANT: You too Yolanda.

INTERVIEWER: Okay bye

PARTICIPANT: Bye-bye.

Subject 9

INTERVIEWER: Are you ready for the interview?

PARTICIPANT: Im sorry?

INTERVIEWER: Oh are you ready for the interview?

PARTICIPANT: Yes I am.

INTERVIEWER: Okay. Before we get started, I just want to let you know that all of your answers will be confidential. And I will be recording this conversation as well as writing down the gist of your answer so if I ever take a little while to respond back that might be why.

PARTICIPANT: Okay alright.

INTERVIEWER: Alright.

PARTICIPANT: And you said this...this will probably take about....

INTERVIEWER: 15 minutes probably.

PARTICIPANT: 15 minutes? Okay.

INTERVIEWER: Okay. Alright so the first question. Were obligated to ask this but are you male, female, or other?

PARTICIPANT: I am male.

INTERVIEWER: Okay. Household income: would you say its from 0 to 19,000, 20 to 39 thousand, 40 to 59 thousand, 60 to 79 thousand, 80 to 99.

PARTICIPANT: 50 to...

INTERVIEWER: Oh sorry. Go ahead.

PARTICIPANT: 50 to 79. Is that combined or....

INTERVIEWER: Household...your entire house.

PARTICIPANT: Pardon?

INTERVIEWER: Your entire house.

PARTICIPANT: Oh okay. Alright. So I would say the 80 to...59 to 79 thousand.

INTERVIEWER: Okay so one of the options is 60 to 79 and the next is 80 to 99.

PARTICIPANT: Oh. Okay gotcha. 60 to 79.

INTERVIEWER: Okay.

PARTICIPANT: Okay.

INTERVIEWER: Alright. So what is your race?

PARTICIPANT: African American.

INTERVIEWER: Okay. Your education: have you gone to some high school, got a high school diploma, some college, associates, bachelors, and so on?

PARTICIPANT: Got a high school diploma.

INTERVIEWER: Okay. How old are you?

PARTICIPANT: I am 67.

INTERVIEWER: Alright. Were you born blind or did you develop it during your life?

PARTICIPANT: I was developed it during my life, even though it was very early. I was around when I was 2 years old.

INTERVIEWER: Okay.

PARTICIPANT: Mhm

INTERVIEWER: [muttering]. And what caused your blindness?

PARTICIPANT: Juvenile cataracts and premature birth.

INTERVIEWER: Oh okay. [muttering]. What do you struggle most with when navigating through your surroundings?

PARTICIPANT: Oh thats a good one. What do I struggle with. I would say wide open spaces.

INTERVIEWER: Just not know how to navigate around that right?

PARTICIPANT: Well not you know not having a reference point. You know. Its really wide open. Like parking lots and stuff. Also, loud sounds will distract me too, but mostly wide-open spaces.

INTERVIEWER: Okay. Do you currently use any assistive device to navigate? If so, what?

PARTICIPANT: I use a white cane.

INTERVIEWER: Alright. In the past have you utilized any other assistive devices and if so why did you stop using it or them?

PARTICIPANT: Ive never used another specific device as a regular...you know regular basis.

INTERVIEWER: Okay. Was there anything you ever tried out and then decided it wasnt for you?

PARTICIPANT: Ive tried out some assistive devices...I tried out...someone had a thing where you wear glasses and it has an earpiece in it. Different sounds for different...you know for different levels and different directions and things like that. So...but even then I never tried it that often. You know different testing with it.

INTERVIEWER: What was it that you didnt like about it?

PARTICIPANT: Well I didnt like it because you had to....there was a learning a curve that you have to learn...you know you have to interpret what sound meant, what and also being that Im totally blind, and dependent on my hearing, it was distracting more than really helpful.

INTERVIEWER: Okay. Give me one second to record this down

PARTICIPANT: Sure. Absolutely

INTERVIEWER: [Chuckle]. Alright so how important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: I would say the importance from a scale from 1 to 10. Probably 7.

INTERVIEWER: Okay. We plan on creating a navigational device to assist the blind to recognize objects and humans in daily travel. Would you be open to using such a device?

PARTICIPANT: Id be willing to give it a try, yes

INTERVIEWER: Alright. What do you thin would be the best way in communication information taken from the external environment to the

user? For example would you like an auditory, tactile, or a combination of both?

PARTICIPANT: I would like tactile.

INTERVIEWER: Okay.

PARTICIPANT: As I mentioned before. Being that I am totally blind I tend...on

INTERVIEWER: Hearing

PARTICIPANT: On my hearing mainly

INTERVIEWER: Yeah

PARTICIPANT: I wouldnt want anything to...really to distract from that.

INTERVIEWER: Okay. This device will incorporate the Microsoft Kinect. Its a motion-sensor system that is 12 inches by 3 inches by 2.5 inches. And then it will also...there will also be a backpack in order to potentially strap the Microsoft Kinect to the user and carry the hardware. And either a smartphone or laptop to process the data. And where do you feel would be the smartest place to put the Kinect on your body? For example, chest, head, or waist?

PARTICIPANT: I think back for me ...that would the least distraction...or the least disruptive part. On my body.

INTERVIEWER: Wait. Which...?

PARTICIPANT: On my back.

INTERVIEWER: Your back?

PARTICIPANT: Yes.

INTERVIEWER: So the device would have to see whats in front of you, so...

PARTICIPANT: Oh. Oh! I see. Okay.

INTERVIEWER: But yeah the back is definitely...

PARTICIPANT: Yeah. It would be...Ill say maybe the chest area. Well let me figure this out. I would say the chest area. Yeah. The chest area, yeah.

INTERVIEWER: Okay. How comfortable are...would you be wearing this device on your body?

PARTICIPANT: I would...I would be comfortable with it yeah.

INTERVIEWER: Okay.

PARTICIPANT: Very comfortable.

INTERVIEWER: Do you think that this device would efficiently complement your cane or do you feel that it would be a hindrance?

PARTICIPANT: Well I would want it to be a complement obviously other than a hindrance. Potentially it would be a complement. Thats what I pictured this as.

INTERVIEWER: Okay. Yeah we definitely didnt want to take the classic white cane away from the user because we know that everyones very comfortable with it.

PARTICIPANT: Correct.

INTERVIEWER: So we wanted something to go along with it rather than replace it.

PARTICIPANT: Correct.

INTERVIEWER: Do you have any comments or suggestions regarding the development of this device or just questions in general?

PARTICIPANT: One thing that I would suggest is that you have some way of telling the distance or you know telling the relative distance from us. For example, when you get closer to an object...for example one of the things I would want it to be, like for example if it was tactile, that it would be...

INTERVIEWER: Some type of extreme vibration maybe?

PARTICIPANT: Yes. In other words, vibration will be stronger.

INTERVIEWER: Yeah yeah yeah.

PARTICIPANT: And weaker as you get away from it.

INTERVIEWER: Definitely. Yeah well look into that. [muttering]

PARTICIPANT: And also one thing that I would recommend is that you have some way of telling independently what side something is on. In other words, if its to your left....

INTERVIEWER: Side okay.

PARTICIPANT: That would be the left side of your hand for example.

INTERVIEWER: Okay.

PARTICIPANT: Itll be you know closer or it would be your left. You know if it was...if it was to your right, it would be on on the right side of your hand or on your right hand.

INTERVIEWER: The vibration or the....

PARTICIPANT: The vibration.

INTERVIEWER: Okay

PARTICIPANT: Another comment that I have is that if there is an auditory, that it not be too long in length. In other words, that would have to depend on listening to it too long. That would also interfere with your you know what youre hearing and your location of things. So thats one thing that would be a recommendation.

INTERVIEWER: Okay yeah thats definitely some great advice. Any other questions you have? Or suggestions?

PARTICIPANT: Would...is there....is there thought of when you approach, lets say you....would this be a something that you issue on demand as needed? I would recommend then that you have an on demand mode. And if you are in a familiar place, that you dont need it.

INTERVIEWER: That you can just turn it off right?

PARTICIPANT: Yeah that you can just turn it off? You could put it on a different mode, but is it on demand? And the reason Im thinking Agnes is lets say you didnt have some kind of speech output that would tell you for example if youre at a restroom. Okay, and it would yell and this is something that you could put on demand and it would. Say you push a button or you could put it on either vibrate or needed a speech output temporarily. You know what Im saying?

INTERVIEWER: Yeah

PARTICIPANT: So like lets say what room or what dorm am I at here, so let me press this button.

INTERVIEWER: Okay.

PARTICIPANT: And it would say some kind of or yell some kind of you know restroom or closet or you know front door or something like that.

Door-knob side or something like that. You know. Or it would say...one of the issues I have is that what Im on the platform.

INTERVIEWER: The platform?

PARTICIPANT: Finding the escalators. When Im on the platform of the metro.

INTERVIEWER: Oh Okay okay.

PARTICIPANT: ITs finding the escalator.

INTERVIEWER: Okay

PARTICIPANT: Okay. Now. Especially the situation where there is...where there are other noises also. So if you could have some kind of something that you could put like something like ear buds or something like that where you would push a button and you would say you know say escalator or it would indicate some kind of you know that youre getting close...close to the escalator.

INTERVIEWER: Okay. So this

PARTICIPANT: Yeah.

INTERVIEWER: Because this is a project were working on in our undergraduate career.

PARTICIPANT: Sure.

INTERVIEWER: Yeah. Were currently working on indoor navigation.

PARTICIPANT: Okay

INTERVIEWER: And well try to get to outdoor if we have time but thats more of a...but Im just....thank you for the advice on the outdoor. Well try to get to that if we have extra time but we have to focus on indoor first given the amount of time that we do have.

PARTICIPANT: Oh yeah, that could be

INTERVIEWER: Indoor/Outdoor that could be anywhere yeah.

PARTICIPANT: Yeah. That could be applicable to lets say, another big issue that we have, the reason I say open space is an example. Its very important to do independent navigation in a mall.

INTERVIEWER: Mhm. Yeah.

PARTICIPANT: You know what Im saying? In a mall where its open. Theres no...theres very few landmarks. Theres no...theres very few you know permanent landmarks. And theyve very....but its all open so you cant follow a sure line, or you cant...its very difficult to follow a wall or something like that.

INTERVIEWER: So what would you like in that type of setting?

PARTICIPANT: Im sorry?

INTERVIEWER: Are you looking for anything specific out of something like the mall setting?

PARTICIPANT: No yeah yeah something like this, this is where you could, this will be good to know where you know how far you are from an escalator for example.

INTERVIEWER: Okay.

PARTICIPANT: How and what as you go along...when you come to a doorway. Its kind of hard to tell you know that youve come to a doorway you know what Im saying? And normally in...normally when youre in an enclosed area you can tell just by the sound of your footsteps that youve come to a doorway, because you know its closer, but when youre in an open space, like a mall or a hotel lobby. Like one day we went to a convention, you know it was in this big huge hotel in Dallas, it was all open, oh you couldnt tell...

INTERVIEWER: Not the perfect place? [Chuckle]

PARTICIPANT: Yeah. You couldnt tell exactly It was hard to really follow a landmark so that type of thing...this kind of device you know I could conceive of something like that working in a situation like that.

INTERVIEWER: Okay. Okay. Yeah well definitely look into...so were going to gather all the feedback that weve been getting from the participants and develop a device eventually probably around the fall. And when we are ready to start doing the product testing through an obstacle course or something to see if the participants are comfortable with the device. You indicated that you would be willing to do that so well definitely try to...well you know stay in contact with you then.

PARTICIPANT: Absolutely.

INTERVIEWER: And were trying to do it at you know NFB and CLB so the participants are...so at CLB so the participants are...[muttering]

PARTICIPANT: Yeah in a familiar area to start off with yeah. Sure!

INTERVIEWER: So you wouldnt have to do any extra-difficult travel or anything like that

PARTICIPANT: Right. Right.

INTERVIEWER: Yeah so...

PARTICIPANT: Okay

INTERVIEWER: Oh I just had a quick other.. CUTOFF

Subject 10

PARTICIPANT: Hey Agnes.

INTERVIEWER: Hi did you find the consent form okay?

PARTICIPANT: I did. Did my approval come through?

INTERVIEWER: Im actually not the one that handles the papers but Ill ask...Ill ask the...

PARTICIPANT: What happened was when I pressed the button to confirm, it kept bringing me back to that page so I just assumed that it went through. If theres any questions Ill do it over again but if you want to

see what the or if you can or if you must have confirmation first then you let me know how you want me to proceed.

INTERVIEWER: Okay. I think were fine to go ahead and Ill just check with the person that handles it later and let you know if anything needs to be done, but you agree to the conversation being recorded and also...

PARTICIPANT: Absolutely.

INTERVIEWER: To a possible call back for the obstacle course right?

PARTICIPANT: Correct.

INTERVIEWER: Okay okay. Then youre fine. So besides being recorded Im going to be writing down the answers so if I take a while to respond to anything thats probably going to be the reason why if you dont mind.

PARTICIPANT: No problem.

INTERVIEWER: Okay so the first question, sorry were required to ask this but are you male, female or other?

PARTICIPANT: Male.

INTERVIEWER: Okay. Second question. Household income: would you say its from 0 to 19 thousand, 20 to 39 thousand, 40 to 59 thousand, 60 to 79 thousand, 80 to 99 thousand, 100 to 149 thousand, or 150 thousand and plus. This is household income.

PARTICIPANT: 40 to 59

INTERVIEWER: Okay. The next question is your race.

PARTICIPANT: Im African American.

INTERVIEWER: Okay. Education: Have you done....

PARTICIPANT: I have a [incomprehensible] degree

INTERVIEWER: What do you have?

PARTICIPANT: I have two masters degree.

INTERVIEWER: Okay. How old are you?

PARTICIPANT: 35

INTERVIEWER: Alright. Were you born blind or did you develop it during your life?

PARTICIPANT: Born blind

INTERVIEWER: Actually I think youre one of the first people that weve gotten that was born blind. Most people developed it, so its good to have more variety. What caused your blindness?

PARTICIPANT: Glaucoma and cataracts.

INTERVIEWER: Okay. What do you struggle most with when navigation around your surroundings?

PARTICIPANT: What do I struggle with? When getting around?

INTERVIEWER: Yeah

PARTICIPANT: The unexpected obstacles, I dont want to go too in depth but Im not from here so I am learning the area in terms of navigating, learning what some of the consistent variable are in an environment. Lets say knowing how train stations are laid out typically, escalators and stairs and how they might be, you know how they might be arranged.

INTERVIEWER: Okay

PARTICIPANT: Yeah but the unexpected obstacles are one of the biggest challenges.

INTERVIEWER: Okay. Do you currently use any assistive devices to navigate? If so what?

PARTICIPANT: Of course I use a long cane, and I also on occasion will use any number of navigation system

PARTICIPANT: applications if you will. I am an iPhone user, so yeah.

INTERVIEWER: Oh okay.

PARTICIPANT: There are some app I use to help me navigate.

INTERVIEWER: Alright. In the past have you utilized any other assistive devices? If so, why did you stop using them?

PARTICIPANT: Well Im an assistive technologist specialist, so the caveat to this answer is that.

INTERVIEWER: [chuckle]

PARTICIPANT: Now, I have used a number of devices because I have either been on a team to develop the devices or been one of the beta testers for devices. So the sonic cane, the Trekker Breeze., and the Trekker system from Humanware. I dont know the name of this particular device, but if you watch Covert Affairs, you remember that Auggie had this handheld device that what the uninformed viewer didnt know is that it was vibrating in his hand when he got like 4 feet from an obstacle. Right so everybodys like how come he doesnt use a cane, and whats this blind man doing on TV not using a cane. That was, I actually was a tester for that device back in the summer of 10. Yeah.

INTERVIEWER: So why were...why would you...yeah why...

PARTICIPANT: Why I dont use it yeah thats the next part.

INTERVIEWER: Yeah. [chuckle]

PARTICIPANT: Because in one sense I am pretty much a traditionalist. Needless to say Ive been using my cane since I was five, so I have decent traveling skills. I havent fallen into any holes. Certainly not falling into any because I was not using my cane. But I find that all those tools are options and they are options for people that might choose them and I think its good to have a number of options. Because were not all cut the same and we dont all travel the same, our needs are not the same for information. So I think having all of those options are good. For me though, give me a cane and most of those answers are maybe an app as I look at what you talk about in developing...I like the concept...I like it....so well hash it out some more.

INTERVIEWER: Okay. So how important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: You know, interesting enough, again with one of my major travel concerns, I like that...and I like that you have it as objects and people, and I hope its not much so that the issue of facial recognition so much, and Im going to tell you why I say that. You didnt ask me

but here it goes. One of the biggest things that travelers who are blind people or visually impaired especially in say a metropolitan area like this aren't concerned about is when they're traveling in areas where there aren't a whole lot of people, and sometimes you get the shady character. If the device had a security feature that alerts them to the presence of an actual human whether that be some kind of advanced heat sensor, or you know everything gives off heat. If it's to say this is not a statue of a person, but somebody, then that would let them, you know the coward they want to use what they think is the element of surprise and all that kind of crap so, I thought that was kind of interesting when I saw it. I don't know what your intention for it is, but that is my piece.

INTERVIEWER: That's definitely a good thing to think about. But yeah so you're more interested in knowing a person is coming rather than facial recognition. Just knowing that someone is coming is more important to you?

PARTICIPANT: Coming or even just there. Even just standing on a platform and you know, they just do a quick scan. You know and yeah.

INTERVIEWER: Alright, that's definitely something good to think about. Alright, we plan on creating a navigational device to assist the blind to recognize objects and humans in daily travel. Would you be open to using such a device? [Chuckle]

PARTICIPANT: I would. Yeah. I would. I would.

INTERVIEWER: Alright. What do you think would be the best way of communicating information taken from the external environment to the user. For example would you like tactile, auditory, or a combination of both?

PARTICIPANT: Well, when you say tactile, are you thinking maybe haptics? or something....

INTERVIEWER: I guess it would be something along the lines of the...I mean we're not sure yet and opinions are welcome but I think we're thinking along the lines of vibrating belt or something like that.

PARTICIPANT: Okay okay. I'm saying a lot. But yeah, a combination, a combination.

INTERVIEWER: Okay. This device will incorporate the Microsoft Kinect, which is a motion-sensor system that is 12 inches by 3 inches by 2.5 inches. There will also be a backpack in order to potentially strap the Microsoft Kinect to the user and carry the hardware. And either a smartphone or a laptop to process the data. So where do you feel would be the best place to put the Kinect on your body? For example the head, the chest or the waist?

PARTICIPANT: I would, the Kinect is a wand right? If I recall it right.

INTERVIEWER: Say it one more time sorry?

PARTICIPANT: The Kinect is a wand right? We're talking about three pieces right?

INTERVIEWER: Okay so the backpack would of course go on your back.

PARTICIPANT: Sure.

INTERVIEWER: And the laptop, what were trying to do is scale-down from a laptop to a smartphone, but I think the least we can do is get it down to the size of a tablet for all the information that we need to. And the Microsoft Kinect, which will probably be the size of a textbook I guess? Not in...well yes its 12 inches by 3 inches by 2.5 inches, wait what did you mean by wand?

PARTICIPANT: Okay thats what I was starting to see. So you got two large items of sorts, and would they both go in the backpack?

INTERVIEWER: No the Kinect would just...the way it would be...it would be strapped to the backpack but it would be on your chest or your head or your waist or whatever were trying to see what people prefer, but it would not be in the backpack no.

PARTICIPANT: Okay

INTERVIEWER: Because it has to be able to use its motion sensor capabilities, and in order to do that it has to see out.

PARTICIPANT: Im not averse to wearing something around my waist.

INTERVIEWER: Okay. Okay. How comfortable would you be with wearing this device on your body?

PARTICIPANT: I have to be honest, there would...its one of those it would have to depend answers. Obviously when you think of traveling and catching busses and trains, well its going to get hot so you would consider what kind of material are we talking about? Something breathable? Of course you are considering weight and size and not adding additional risk concerns and you know all that kind of stuff to the person. So, yeah I would be okay wearing something just as long as it doesnt....

INTERVIEWER: Impede you too much?

PARTICIPANT: Right. Yeah.

INTERVIEWER: Okay.

PARTICIPANT: And I mean even if I want to use this to navigate at the airport to get through security and I have to take my shirt off to take it off thats not going to be good, so we have to think of how we can do this such that you know something to clip on to the outside, or...

INTERVIEWER: Yeah it would be the outside, I dont think you would have to take your clothes off to do it. It would be on the outside. [laughter]

PARTICIPANT: Alright

INTERVIEWER: Do you think that this device would efficiently complement your cane or do you feel that it would be a hindrance. So this is something that would be used in addition to the cane we dont want to take that away from anyone.

PARTICIPANT: Yeah and I wouldnt...I wouldnt walk with just the device. Because the device wont alert to change in the terrain or stuff like that, to travel at a speed that would be able to keep you at pace with the you know your normal strategy, so I would say Im very open to seeing

if it would. Im also an OMMer, Orientation and Mobility Specialist, what I can tell you is both the instructional piece and the end user piece is if we can keep it to being something that gives information either upon request or in increments that can be processed, followed through, and the machine is intelligent enough to determine that that last set of instructions have been completed. The thats fine. What you dont want is information overload.

INTERVIEWER: Okay. So do you have any other comments or suggestions regarding the development of this device?

PARTICIPANT: My comment is that I am so thrilled as a person with legal blindness all my life to know that an independent group of individuals is taking up the cause of developing something that could potentially increase the independent and safety of mobility of individuals who are living with blindness.

INTERVIEWER: Thank you.

PARTICIPANT: So keep working at it. Keep working with all of the stakeholders, consider including in your research Orientation and Mobility Specialist, there are basically two groups. Those that have their NOMC, National Orientation and Mobility Certification, those individuals are typically individuals who have come through the graduate program at Louisiana Tech, and the National Federation of the Blind is a big supporter of that program, and that cane technique, it was developed by an individual who is blind back in the 60s. And then your classical tradition Orientation Mobility Specialists, who are certified through the academy for the certification of rehabilitation and education professionals. You want to have conversations to those individuals too. Just so you get a representation from all the stakeholders. I can tell you as an OMM, I would if I believed that the traveler was at an advanced travel stage, and could use a tool like that. Especially someone like me coming to a new area, you know that would be pretty good, I would use it.

INTERVIEWER: Alright oh thank you. Can you tell me the name of the first group again? Not the classic....

PARTICIPANT: Oh so NOMC is the National Orientation and Mobility Certified

INTERVIEWER: Oh Okay.

PARTICIPANT: Yeah. And I saw that you all have someone from the National Federation and the Columbia Lighthouse who contact individuals, so you probably already been in contact with people like [redacted] who are OMCs in the area. So I would just encourage you all to get some feedback from those stakeholders as well...

INTERVIEWER: The name said was [redacted]? Okay.

PARTICIPANT: Discussion of [redacted] and more [names redacted]

INTERVIEWER: Thank you so much for taking part in this I really appreciate it.

PARTICIPANT: No doubt no doubt.

INTERVIEWER: Well try to follow up in a couple of months as were developing the device and need participants for the obstacle course portion. If you have anyone else thats interested in participating just shoot me an email and Ill try to get to them too. And Ill be calling your friend [name redacted] in a couple of minutes. Thank you for that contact.

PARTICIPANT: No doubt no doubt.

INTERVIEWER: Alright thank you. Have a good rest of the day.

PARTICIPANT: Okay. Alright good luck to you all Agnes and to your group there.

INTERVIEWER: Thank you so much.

PARTICIPANT: Okay.

INTERVIEWER: Bye.

PARTICIPANT: Bye.

Subject 11

INTERVIEWER: Alright are you ready?

PARTICIPANT: Uh huh

INTERVIEWER: Okay so first question, sorry we have to ask this. Are you male, female, or other?

PARTICIPANT: Female.

INTERVIEWER: Household income: Would you say its from 0 to19 thousand, 20 to 39 thousand, 40 to 59 thousand, 60 to 79 thousand, 80 to 99 thous....

PARTICIPANT: I am in the 40s.

INTERVIEWER: Oh in the 40s? Okay.

PARTICIPANT: Yes.

INTERVIEWER: What is your race?

PARTICIPANT: Im white.

INTERVIEWER: Okay. What is your highest level of education?

PARTICIPANT: A masters.

INTERVIEWER: Okay. How old are you?

PARTICIPANT: Im 28

INTERVIEWER: Alright. Were you born blind or did you develop it during your life?

PARTICIPANT: I was born that way.

INTERVIEWER: Alright. What caused your blindness?

PARTICIPANT: Basically a syndrome.

INTERVIEWER: Im sorry could you say that one more time?

PARTICIPANT: A syndrome. [incomprehensible] retinal detachment and had a cataract.

INTERVIEWER: Okay. What did you say the name of this syndrome was again?

PARTICIPANT: [incomprehensible] syndrome that caused eye problems.

INTERVIEWER: Okay. What do you struggle most with when navigating through your surroundings?

PARTICIPANT: Probably [incomprehensible] unfamiliar environments.

INTERVIEWER: Unfamiliar environments?

PARTICIPANT: Yes.

INTERVIEWER: Do you current use any assistive devices to navigate? If so, what?

PARTICIPANT: A cane, and sometimes the navigating app that I have on my iTunes.

INTERVIEWER: Okay. In the past have you utilized any other assistive devices and if so, why did you stop using them?

PARTICIPANT: Because they didnt work that well, I mean werent reliable.

INTERVIEWER: Okay. Do you know any names of the ones you used before?

PARTICIPANT: I like used [incomprehensible] that one time actually. And it even it keep on telling me to walk down, and then all of a sudden I realize that it seems [incomprehensible] and the numbers just kept on getting higher, and thats when I realized, I am totally walking the opposite way, so I stopped using it.

INTERVIEWER: You said it was called the Navi-Derm?

PARTICIPANT: It just the name is Navi-Derm.

INTERVIEWER: Oh okay. How important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: It would be cool or it would be nice, but Im not, you know its nothing that I have to have.

INTERVIEWER: Yeah

PARTICIPANT: Its something that Ive never had before.

INTERVIEWER: Okay. So were planning on creating a navigational device to assist the blind to recognize objects and humans in daily travel, but would you be open to using such a device?

PARTICIPANT: Yeah.

INTERVIEWER: What do you think would be the best way of communicating the information taken from the external environment to the user? So for example, would it be tactile, auditory or a combination of both maybe?

PARTICIPANT: Probably auditorial or braille. Like something that would be able to pop up and [incomprehensible]

INTERVIEWER: Something that would be able to what?

PARTICIPANT: That like.... it would be able to transfer to some kind of braille display.

INTERVIEWER: Okay.

PARTICIPANT: Like a Brailleman or a [incomprehensible]. I can read Bluetooth too but whatever you guys can create or whatever.

INTERVIEWER: Okay. So youre saying you would want tactile or...?

PARTICIPANT: Not necessarily because tactile can mean so many things.

INTERVIEWER: Yeah yeah. T; So probably auditorial or braille.

INTERVIEWER: Okay. So the device that were creating will incorporate the Microsoft Kinect, which is a motion sensor system that is 12 inches by 3 inches by 2.5 inches. And there will also be a backpack in order to potentially strap the Microsoft Kinect to the user, and the theres either a smartphone or a laptop to process the data. So where do you feel...if it were a laptop it would be in your backpack, but were trying to scale down from a laptop to a smartphone and just put all the information to a smaller device. But where do you feel would be the best place to put the Kinect on your body? For example, your head, your chest, or your waist?

PARTICIPANT: I think my wrist.

INTERVIEWER: Head, chest, or waist? What did you say?

PARTICIPANT: I said my wrist, but would it be only these three places?

INTERVIEWER: So, its actually 12 inches by 3 inches by 2.5 inches, so its pretty big.

PARTICIPANT: Oh.

INTERVIEWER: Yeah

PARTICIPANT: I mean I would change [incomprehensible] but I guess my waist.

INTERVIEWER: Okay. How comfortable would you be with wearing this device on your body?

PARTICIPANT: I wouldnt do it.

INTERVIEWER: Do you think that this device would efficiently complement your cane or do you feel that it would be a hindrance?

PARTICIPANT: Itd get in the way, thats what it sounds like.

INTERVIEWER: So do you have any other comments or suggestions regarding the development of this device?

PARTICIPANT: From the way that you described it, I think it would be more of a hassle, and it would make a [incomprehensible] about their appearance feel uncomfortable and not confident in wearing the device. Especially with you know the other connection, the laptop. Thats just too much stuff. And theres a lot of navigational tools that are, you know, improving nowadays, that you know they can use Siri even though. I know that your device cant generate that [incomprehensible] the navigational tool to go around objects and you know things like that? You have a cane, one who has a cane is a cane-user, then you know they can get the job done and they can use the advocacy to get the job done too.

INTERVIEWER: Okay. Alright. Well thank you so much for all your feedback I really appreciate it. Oh yeah, remember to please sign the consent form too.

PARTICIPANT: Okay I will. Its saved in my email and everything so...

INTERVIEWER: Okay. Thank you so much.
PARTICIPANT: Alrightie. Take care.
INTERVIEWER: You too. Have a nice day.
PARTICIPANT: Alright.
INTERVIEWER: Bye.
PARTICIPANT: Bye.

Subject 12

PARTICIPANT: Hello
INTERVIEWER: Hi. Is this [name redacted]?
PARTICIPANT: It is
INTERVIEWER: Hi. This is Yael Osman calling on behalf of Team
NAVIGATE from the University of Maryland.
PARTICIPANT: Yes.
INTERVIEWER: Hi, I was wondering if this was a good time for you to do
your interview?
PARTICIPANT: Yes this is the scheduled time we have yes.
INTERVIEWER: Okay. Wonderful wonderful. So I just wanted to remind you
before the interview starts that all of your answers will remain
confidential. So...
PARTICIPANT: Okay. Thats fine.
INTERVIEWER: Okay great. Okay just to begin with a few questions, can you
just state your gender please?
PARTICIPANT: Male
INTERVIEWER: Male okay great. And what is your household income? Is it
between 0 to 19,000, 20,000 to 39,000, 40,000 to 59,000, 60,000 to
79,000, 80,000 to 99,000, 100,000 to 149,000, or 150,000 plus?
PARTICIPANT: Combined income youre saying?
INTERVIEWER: Yes
PARTICIPANT: Yeah so what was the one you said? It was 70 something?
INTERVIEWER: It was 60,000 to 79,000.
PARTICIPANT: And the one above that?
INTERVIEWER: And the one above that is 80,000 to 99,000
PARTICIPANT: And above that?
INTERVIEWER: 100,000 to 149,000.
PARTICIPANT: Thats probably the one.
INTERVIEWER: And can you clarify your race for me?
PARTICIPANT: I guess I would be Caucasian.
INTERVIEWER: Caucasian, great thank you so much. What was your highest
achieved education? Some high school, high school diploma, some
college, associates.
PARTICIPANT: Some College
INTERVIEWER: Some College? Okay wonderful. And how old are you?

PARTICIPANT: I am 48
INTERVIEWER: 48 okay great. And were you born blind or did you develop it during your life?
PARTICIPANT: I guess its not really clear, but I had congenital cataracts. So thats probably as close to being born blind as you can get.
INTERVIEWER: Okay.
PARTICIPANT: [incomprehensible] so probably...
INTERVIEWER: did the blindness progress in your life? Or..?
PARTICIPANT: It did, yeah.
INTERVIEWER: Okay. Got it, so that answers our next question, what caused it? And what do you struggle most with when navigating through your surroundings?
PARTICIPANT: Well, [cough]
INTERVIEWER: Sorry?
PARTICIPANT: Sorry no its just...let me think. I guess knowing the names of streets in an unfamiliar area.
INTERVIEWER: Okay. And do you current use any assistive devices to navigate, and if so, what?
PARTICIPANT: I use a long white cane
INTERVIEWER: Okay.
PARTICIPANT: Not sure if thats what you had in mind
INTERVIEWER: No yeah thats great.
PARTICIPANT: And I experiment with this GPS app on my iPhone.
INTERVIEWER: Okay wonderful. And do you find that those help?
PARTICIPANT: I tend to use them to do comparison, I use them in areas I am familiar with, and I have relied on them more than not so I do find them helpful.
INTERVIEWER: Okay great. And how important is it...
PARTICIPANT: Im sorry, its different than relying on them.
INTERVIEWER: Okay so you wouldnt strictly rely on them but you do use them as an aid.
PARTICIPANT: Correct.
INTERVIEWER: Great. And how important is it to you to have a navigational aid that allows you to identify objects and people in your path?
PARTICIPANT: Can you repeat the question?
INTERVIEWER: How important is it to you to have a navigational aid that allows you to identify objects and people in your path?
PARTICIPANT: Identify objects and people in my path.
INTERVIEWER: So in other words, it would let you know for example if youre approaching a certain object and it would let you know what that is and it would let you know if youre approaching a person.
PARTICIPANT: Yeah I mean I guess for the most part I can predict those things.
INTERVIEWER: Okay. And you would say through using your cane?

PARTICIPANT: Well right my cane and also what I call multi-sensory information gathering.

INTERVIEWER: Okay. Can you just expand on that?

PARTICIPANT: Sure. Blind people, especially been blind a long time, will get to gather environmental sensory information through auditory, tactile, olfactory and all that. And echolocation as well, for example which would tell me theres a person or object Id be in danger of running into and that combined with my cane will find, will tell me then about 3-10 feet around ahead or back of me.

INTERVIEWER: Interesting. Okay. Great, so just a little bit about what we plan on doing. We plan on creating a navigational device to assist the blind in recognizing objects and humans in daily travel. So, would you be open to using such a device? So this would be something that ideally would use auditory cues to tell you if youre approaching something, what you are approaching...

PARTICIPANT: Mhm. Yeah.

INTERVIEWER: So you would be open to such a device.

PARTICIPANT: Would I be interested? I would be absolutely curious to know how such a device works and how it might be working. For disclosure, Im an Orientation Mobility Instructor.

INTERVIEWER: Oh okay. I do remember that actually from our emails.

PARTICIPANT: Yeah. I mean I look at these things quite broadly at how it might benefit my students, or how it might benefit people who may travel with some maybe sensory deficits for example.

INTERVIEWER: Definitely. So well lets continue the interview but after Id be happy to talk more with you about the device. What do you think would be the best way to communicate the information taken from the external environment to the user? For example, tactile, auditory, or a combination of both?

PARTICIPANT: And it depends on the platform. Those are important, but I would caution that with saying that, so, if Im walking with just my white cane, I am taking in all that information, like auditory, tactile, olfactory, all that. But if Im getting that information through a device, it might be difficult to, so think about that as an extra thing, so if I have something Im listening to, you know, on the device or something like that. Id have to integrate that with whatever else is happening with the environment so, which I can do, you know, I can do, but if it was that and tactile, unless it was an either/or thing that I can maybe select. To have both though tactile and auditory, it seems like it would take my attention and my focus away from other environmental cues I should be paying attention to.

INTERVIEWER: Right so definitely it would be something that you would want to have. I guess at the same time you wouldnt want to have both of those.

PARTICIPANT: [incomprehensible]

INTERVIEWER: But to have the option: select auditory sometimes and tactile at others.

PARTICIPANT: Yeah that makes sense. Okay great. So this device will incorporate the Microsoft Kinect, which is a motion sensor that is around 12 inches long about 3 feet, oh 3 inches tall, and about 2.5 inches wide. Have you ever come in contact with a Microsoft Kinect?

PARTICIPANT: No I have not.

INTERVIEWER: Okay. And also it will incorporate a backpack. Okay right now, so originally we were planning on using a laptop, but now we are, I think, going to be using a tablet. So, were trying to find currently something like a pouch or something you can hook on and put the tablet inside you dont necessarily have to carry the tablet around the backpack. So our question for you is where you do feel would be the best place to put this Kinect on your body? So where essentially would you want this sensor to be place on the front of your body? So you could say like a head, chest, waist.

PARTICIPANT: If I put the tablet right?

INTERVIEWER: Well no the tablet would be the technology part of it. Thats where it would like the system would function. That would be the hardware part of it. But the sensor is what would be taking information from the external environment.

PARTICIPANT: Its the input device then right?

INTERVIEWER: Yes.

PARTICIPANT: Okay. Where that sensor should be...

INTERVIEWER: So like chest, head, waist typically is what we found people would...would desire.

PARTICIPANT: Yeah. The information that....I mean [incomprehensible] the notoriously challenging for a blind person and that goes back to your earlier question. My cane can pick up most objects from say from the waist down that kind of thing will bump you know mid-torso down.

INTERVIEWER: Right.

PARTICIPANT: Not so good at detecting overhead objects. So, that would be the area that I think would be beneficial to have information about.

INTERVIEWER: Okay. So, okay so probably like chest region

PARTICIPANT: And up.

INTERVIEWER: And up okay. And how comfortable would you be wearing something like this on your body?

PARTICIPANT: So personally, probably not very... it would have to be pretty extraordinary for me to consider wearing something extra like that. I think traveling light is best.

INTERVIEWER: Yeah

PARTICIPANT: For me, it would be perfect. So yeah Im not going to say, depending on how...

INTERVIEWER: How helpful

PARTICIPANT: The information can be. Actually for an [incomprehensible] there are a lot of things to think about. You know if Im traveling under weather conditions where this is something that can get wet, something thats going to function the same in all weather conditions.

INTERVIEWER: Yeah thats a really good point. Honest this has been really helpful so far so I really appreciate it. Just....

PARTICIPANT: I mean wearing something like that how bulky or how intrusive or whatever would it actually be. I mean would it be on my clothing, or would it be half over my clothing that kind of thing. Frankly what would I look like wearing it.

INTERVIEWER: Yeah. No I mean thats completely a legit thing to say. So we definitely understand that and are considering that. So do you think that this device will efficiently complement your cane or do you think that it would be a hindrance to your cane?

PARTICIPANT: If it were attached to the cane?

INTERVIEWER: No, just...I mean it wouldnt be attached to the cane, but it would be a separate device from the cane, but do you think that it would hinder your ability to use the cane or hinder the canes ability or do you think that it would complement it? And I guess just add to the cane more than it would take away from it.

PARTICIPANT: You know again it would be difficult for me to say without hands-on experience with it. But ideally, it should complement information from the cane. If it took away from it then I would be not very [incomprehensible] toward using it, you know me personally.

INTERVIEWER: Got it. Okay. And then last question for you is were currently in the process of determining where to place the vibration, and were trying to see how people interpret certain vibrations. In terms of if you feel a vibration what do you do if you know that you are trying to avoid an object? So do you prefer to feel a vibration telling you which side either left or right to avoid because of an obstacle in the way, or do you prefer vibration telling you which side you want to go towards based on a destination. So like in other words, if you felt a vibration would you interpret it as this is where the object is or this is the direction I want to go towards?

PARTICIPANT: Probably the former.

INTERVIEWER: Okay

PARTICIPANT: Because that allows me greater judgment. It allows me greater...okay so...

INTERVIEWER: So you would like it if it vibrated it on your right that would mean to you like I should go to my right.

PARTICIPANT: No no no. Thats the alter I thought

INTERVIEWER: Oh youre right sorry.

PARTICIPANT: It would indicate theres an obstacle there. Because that allows me freedom to make certain choices.

INTERVIEWER: Right

PARTICIPANT: Oh theres an object to my right, let me go around it or, use my cane to investigate, see what that is. Maybe I was looking for something.

INTERVIEWER: Oh thats a really...

PARTICIPANT: [incomprehensible]

INTERVIEWER: Thats a really good point, we never thought of it.

PARTICIPANT: Instead of you know...oppose to you know okay so its vibrating on my right, thats where I should go. The question thats running through my mind is why? And [incomprehensible] on that. Thats the rationale for it.

INTERVIEWER: Okay that was great. We actually never thought about that insight before, so really appreciate that. So I guess just to conclude do you have any comments or suggestions regarding the development of this device? Or questions.

PARTICIPANT: Encourage you for your investigation I think every step of the way that you can include other blind people. I guess theres later future [incomprehensible]. Find people with actual designs of the product, thats awesome you should consult with people like me. But I encourage you in taking this further, but sometimes theres resistance in the blind community on these kinds of new things because you have to know that from how should I say history is littered with all these great ideas from before, you know they didnt take off because they didnt have a further mass appeal. The brilliance of the long white cane is in its simplicity.

INTERVIEWER: Okay yeah.

PARTICIPANT: [incomprehensible] I dont want to discourage. I want to encourage, so our community will be awesome to get involved in testing and looking at it and offering ideas about how to change the object and what have you.

INTERVIEWER: Thatd be awesome. So we plan on actually, were in the process of just figuring out algorithms and designing the hardware for it. But ideally I want to say by next semester, wed like to start testing. Is this something youd be interested in participating in?

PARTICIPANT: Yeah. I would add another thing if I could. I know Im leveraging your time here, but when you first mentioned something that would detect objects and people, my mind immediately went to shape recognition or object, is it going to take a photo of it and identifying exactly what it is or is there just an object there. In other words...

INTERVIEWER: Right so, yeah sorry go on.

PARTICIPANT: Okay. I mean this would go back to the very first question. The information that I dont have access to, it would be helpful to are: [incomprehensible], what store am I now, what is the address, of some place I mean some GPS will do that. With some accuracy. Not only [incomprehensible] but who is that person thats there. An object some distance away but is that a parked semi or is it another kind of thing.

INTERVIEWER: Right so actually, so this team has been kind of...so this is the third team that has been conducting research like this, so the first team actually did work on facial recognition, so were not necessarily going in that direction, but we are trying to I guess develop an algorithm that will allow the device to recognize an object and then relay that information back to the user. So if for example you were approaching a chair, it would tell you that.

PARTICIPANT: Okay, so thats kind of cool. I like that kind of...

INTERVIEWER: Okay great ,so I guess does that kind of maybe change your mind a little? Do you think that maybe you would be willing to use such a device if it were able to give you that depth of information?

PARTICIPANT: Yeah, yeah. I mean I dont want to leave the impression now because there isnt anything out there that provide that kind of accurate information. [incomprehensible] If a device is developed that can do all that kind of stuff, I really am open to [incomprehensible]

INTERVIEWER: Okay. Awesome. Thats really great, and well definitely be in touch with you when we are in the process of starting testing, because we definitely would like to have your feedback more. This has been really helpful.

PARTICIPANT: That will be fun.

INTERVIEWER: Okay well thank you so much for taking the time out of your night for helping us out. We really appreciate it.

PARTICIPANT: Its my pleasure. [Incomprehensible]

INTERVIEWER: Okay have a wonderful night!

PARTICIPANT: Okay, and the name of your team is NAVIGATE?

INTERVIEWER: Yes Team NAVIGATE

PARTICIPANT: Team NAVIGATE and [incomprehensible] came out?

INTERVIEWER: Yes

PARTICIPANT: Yeah [discussions about institutions and researchers]

INTERVIEWER: Okay thank you so much and have a great night!

PARTICIPANT: You too, bye-bye

INTERVIEWER: Bye

Subject 13

PARTICIPANT: Hello.

INTERVIEWER: Hi, [name redacted] this is Agnes from Team NAVIGATE.

We were wondering if we could interview you right now?

PARTICIPANT: Yes this is a good time.

INTERVIEWER: Okay great. So before we begin the interview, we just want to let you know that I have someone with me here thats recording down your answers to your questions, and also this will be kept private and confidential.

PARTICIPANT: Alright.

INTERVIEWER: Okay so, first question. Your gender: just for purposes of this survey, is it male, female, or other?

PARTICIPANT: male.

INTERVIEWER: Your household income, is it 0 to 19 thousand, 20 to 39 thousand, 40 to 59 thousand, 60 to 79 thousand, 80 to 99 thousand, 100 to 149 thousand or 150 thousand?

PARTICIPANT: I dont want to answer that one.

INTERVIEWER: Okay. Race would you say is American Indian, Black or African American, Asian or Pacific Islander, Hispanic of Latino, White, or other?

PARTICIPANT: White

INTERVIEWER: Okay what is your education? Some high school, high school diploma/GED, some college, associates, bachelors, masters, or doctorate in professional school or other?

PARTICIPANT: Doctorate.

INTERVIEWER: Okay. How old are you?

PARTICIPANT: 40

INTERVIEWER: Okay. Were you born blind or did you develop it during your life?

PARTICIPANT: Developed it during my life.

INTERVIEWER: So what caused your blindness?

PARTICIPANT: Glaucoma

INTERVIEWER: Okay. What do you struggle most with when navigating through your surroundings?

PARTICIPANT: I think 2 things, one is difficulty reading signs, and the other is difficulty finding doors to buildings.

INTERVIEWER: Okay okay so do you currently use any assistive devices to navigate, and if so what?

PARTICIPANT: I use a white cane/long cane.

INTERVIEWER: Okay. In the past have you utilized any other assistive devices? And if so why did you stop using them?

PARTICIPANT: No I havent used anything else in the past.

INTERVIEWER: So youve been working with the white cane all your life? Or as long as youve had blindness?

PARTICIPANT: As long as Ive had blindness, right.

INTERVIEWER: Okay. How important is it to you to have a navigational that allows you to identify objects and people in you path?

PARTICIPANT: Very important, extremely important.

INTERVIEWER: Okay, we plan on creating a navigational device to assist the blind to recognize objects and humans in daily travel. Would you be open to using such a device?

PARTICIPANT: Well the cane already does that. So it already recognizes....it already sort of gives me information about objects in my path, people, and sort of tells me if theres stairs, if theres a curb, or you know if Im on grass, or a sidewalk, gravel, or...So the cane provides that.

INTERVIEWER: Okay okay so what do you....With the device that were trying to create, what do you think would be the best way of communication. Even if youre not planning to use, just your advice would be great to hear. What do you think would be the best way of communicating the information taken from the external environment to the user? For example through a tactile method, or auditory, or a combination of both?

PARTICIPANT: Oh thats a good question. It kind of depends how you would do it I think. If it was auditory, then youd have to use, you know, an earphone or headphone or something, because you dont want to have it, like talking to everybody when youre in a crowd you know? Youd want to use a headphone or earphone or something. The problem with that is youre really needing your ears to listen for cars and traffic when youre out and about, so some audio would be a little bit of a problem if its going to distract you form traffic. I mean thats your major danger. You know, cars. Then, you know, making sure youre not going to get into trouble. So, I think probably tactile will be better. I heard about a project, and maybe this is something you guys have heard as well where it tend to be with a glove, and some think thats very good because you would want to have your hand available cuz I use braille for reading, I know only about 10% of blind people do, but I do, and so you dont want to have a glove on because you cant read with a glove on!

INTERVIEWER: So what exactly would this glove do?

PARTICIPANT: [Talks about the glove] So, the nice thing about the cane is, you know the information comes straight through your fingers, and sort of convenient that way. I think the key is that it should not be something that would cover your fingers because you would need those, and it shouldnt be something that looks sort of bulky and weird, and you know kind of strange. [talks about another project]. Things that are convenient are nice, like for example, you know I use a smartphone. Many blind people use a smartphone, thats actually a nice thing. Its a convenient little thing that you put in your pocket, you know?

INTERVIEWER: Yeah definitely.

PARTICIPANT: So...you know stuff like that.

INTERVIEWER: So, Im not going to lie, our device is definitely not the smallest, but we do want to work on in the future, you know, scaling down the size, but can I just explain what it would look like to you?

PARTICIPANT: Oh Im very interested. Yeah.

INTERVIEWER: So its going to incorporate the Microsoft Kinect, which is a motion sensor system, which is 12 inches by 3 inches by 2.5 inches. And...

PARTICIPANT: 12 by 3...

INTERVIEWER: Yeah yeah yeah. Sorry, go ahead.

PARTICIPANT: 12 by 3 by 2.5, so its like a, so its like the size of maybe a coke bottle or something or taller than that maybe.

INTERVIEWER: Its about the length of a ruler, but its deep as well and wide.

PARTICIPANT: Okay, okay I got it.

INTERVIEWER: So in addition to that there would be some kind of case or backpack where you can put in a tablet. We were originally going to use a laptop to store the actual information you would need, but now weve scaled it down to a tablet. Maybe one day in the future we can scale it down further than that to a smartphone size. But for now it would be a backpack that would contain that....the tablet. And then...what we want to know is where do you feel would be the best place to put the Kinect on your body? So the actual 12 by 3 by 2.5 that I described earlier. Do you think the best place is the head, the chest, the waist. Things like that?

PARTICIPANT: So is this 12 by 2 by 3 thing, is this going to make a sound or vibrate or whats it going to do?

INTERVIEWER: Okay so, it doesnt make any sounds or anything like that. It just senses the environment around you and then relays the information from it to you.

PARTICIPANT: Oh okay, so its just sort of like an antenna or sensor or something.

INTERVIEWER: Yeah.

PARTICIPANT: Lets see, I would probably like, Im not a big fan of backpacks, just because sometimes theyre uncomfortable. I kind of have a sort of a messenger style bag that I like.

INTERVIEWER: Yeah yeah yeah. Were definitely thinking about doing that. Yeah.

PARTICIPANT: Over the shoulder kind of deal, Im thinking its probably better.

INTERVIEWER: But what about the actual device tho? Would you....because the bag would to place the tablet in.

PARTICIPANT: Oh okay.

INTERVIEWER: But the actual device has to be in front of you so that it can sense the external environment. So do you think a place like your head, or your chest, or your waist would be the best place to place that?

PARTICIPANT: So this thing is heavy or not so heavy?

INTERVIEWER: Its like less than 5 lbs.

PARTICIPANT: Okay less than 5 lbs. So I think thats sort of too heavy for your head, you know?

INTERVIEWER: Yeah yeah definitely.

PARTICIPANT: So, Im thinking of something heavy like that, make me think of waist probably. Sort of the natural place to have something heavy.

INTERVIEWER: Okay

PARTICIPANT: Well I mean not something super heavy but something bulky and having some weight to it. I cant imagine having that on your head.

INTERVIEWER: Okay, so how comfortable would you be wearing this device on your body?

PARTICIPANT: So I get that I still have to ask a question before I can answer that. Im still not sure kind of what it would do. So like its sensing the environment, but what sort of information is it providing?

INTERVIEWER: Okay so it basically, itll detect objects and itll identify them for you, and people.

PARTICIPANT: Okay so like if Im wearing this thing, and lets say Im on a metro rail for example. Itll do a lot. There will be a lot of people. The platforms are jammed, lets say Im at metro center. Whats it going to be telling me about all those people?

INTERVIEWER: So thats another thing about this device. It is for indoors and not for outdoors, and for the people aspect....so for the people aspect it just identifies that people are there, so this is for indoors only. We havent gotten to the outdoor aspect yet.

PARTICIPANT: Okay okay so its indoor. Lets say Im in an indoor space with a lot of people, lets say Im, I dont know, at a restaurant or something. You know theres lots of people there walking around, sitting at tables, milling around, eating, whatever. And walking around in there. So what would it....could you just walk me through what it would do?

INTERVIEWER: Okay so, it can basically detect objects that you have in your path. I guess youre saying your cane already helps you with that. Also, it would be able to...so if theres a human youre coming near, it would tell you that theres a human in front of you or beside of you.

PARTICIPANT: Uh-huh. Okay. And then lets say its a restaurant and Im walking around and there a table, and theres a chairs, and theres people sitting, and theres booths, and people sitting, and people standing, people walking, so it would say like theres table in front of you with 4 people, theres a person walking to your right, and theres a...that kind of stuff? Im just trying to get a picture in my head.

INTERVIEWER: So, it can tell you which side, maybe, and just one at a time it can tell you.

PARTICIPANT: Huh. Okay. Okay so yeah so what Im struggling with is understanding the kind of information it would give me. Like could you maybe give me an example? And its okay if you dont know yet, I mean I understand, its a process developing thing, but what, lets say Im at a restaurant, what kind of information would it say to me?

INTERVIEWER: So I have one more person here with me, and maybe she can tell you a little bit as well. Her name is Yolanda.

PARTICIPANT: Okay.

INTERVIEWER: Hi [name redacted], Okay yeah so we are still in our developing stages with our device. Ideally I guess what we would want our device to do is within one or two meters of you, it can identify like...Itll tell you through audio feedback like what the object is. Like if theres a chair in front of you, Itll just say theres a chair. Maybe like one meter ahead of you, and it might vibrate on your left side if its on

your left side. And yeah, I guess it'll go through the progression of those objects one by one what is near you in your path.

PARTICIPANT: Okay okay. I think I have an understanding now. So Im sorry I have to cycle back to your question, which now I forgot because I asked you all those questions that you asked me a question but I dont know what it was. Im sorry.

INTERVIEWER: Okay so I was just asking how comfortable would you be wearing this device on your body.

PARTICIPANT: I would probably be uncomfortable wearing it. It would be uncomfortable yeah.

INTERVIEWER: Alright. Do you think this device would efficiently complement your cane or do you feel that it would be a hindrance?

PARTICIPANT: Oh can you say that one more time I didnt hear it.

INTERVIEWER: Oh sorry. Do you think this device would efficiently complement your cane or do you feel that it would be a hindrance?

PARTICIPANT: I think it would be a hindrance because you now the cane already tell you this kind of information, so to have it coming sort of twice, and have it coming in the way that Yolanda described it, I think it would be a hindrance.

INTERVIEWER: Just to let you know this would be able to detect overhead objects, which is something the cane typically cant do.

PARTICIPANT: Oh okay so that is good. So like, like I know this is indoor only, but like an example of an indoor object thats a problem is like if youre at a clothing store where youre at a rack of close where the rack bar extends above the base of it. Those are dangerous because your cane does not tell you that theres a head-level thing. This head-leveled bar straight ahead of you. Yeah its a problem with tree branches as well, so something that is head-level, face level thing with nothing below that the cane wont tell you, those are trouble. So thats the kind of thing one would enjoy hearing about, or having a sense about that theres something in the path. Things like theres a chair there or theres a person there.

INTERVIEWER: You can already do that with you cane?

PARTICIPANT: The cane will already tell you that.

INTERVIEWER: Yeah.

PARTICIPANT: If its a person and theyre talking, youll hear it anyway.

INTERVIEWER: Yeah yeah. So if we were to develop this device, we want it to have vibrations to tell you in which direction to go or which direction to avoid. So for example, lets say you felt a vibration on your left. Would you take that to mean oh I need to go to the left to avoid this obstacle in front of me, or I need to go the opposite way in order to avoid the obstacle? Like if you felt that vibration, what would you...

PARTICIPANT: I would think that theres the object on the left. Like you could vibrate it on the left, I would think theres an object on the left.

Because similar to the cane, if you felt something on the cane on the left, then you would think theres like a thing there.

INTERVIEWER: Oh exactly, exactly yeah.

PARTICIPANT: That would be, I think, intuitive.

INTERVIEWER: Okay that makes a lot of sense. Do you have any other comment and suggestion regarding the development of this device?

PARTICIPANT: Yeah I mean the question is what kind of problem is the device intended to solve?

INTERVIEWER: [muter]. Okay so besides the whole overhead objects part, it would actually identify the objects in your path. Maybe the cane would tell you that theres an object there but we would be able to identify what object it is.

PARTICIPANT: Okay so...

INTERVIEWER: So the Kinect sensor is better at detection than cane...or previous devices that have been built to attempt this.

PARTICIPANT: Have you been able to experiment with that yet? Do you know that the device is better at distinguishing objects than the cane? Im just wondering...

INTERVIEWER: Im sorry I didnt mean cane. I just meant better than devices that have been used before.

PARTICIPANT: Oh other things that....

INTERVIEWER: Other...Other electronic travel aids.

PARTICIPANT: Yeah yeah. I mean its interesting, because I know a lot of blind people. I dont know any blind people that use an electronic travel aid. I mean you see them in catalogues, like that wand thing, are you familiar with that?The problem with the wand thing is that it doesnt really detect further, and the advertising even said it doesnt

INTERVIEWER: Did you say wand thing?

PARTICIPANT: It looks like a wand.

INTERVIEWER: A wand gotcha.

PARTICIPANT: Like W-A-N-D wand. And so idunno if [name redacted] uses ultrasound or something, and it detects objects and things, but it doesnt detect drop off, because you need to be able to detect drop offs, you have to have the cane and then you have something in each hand. You got the cane in one hand and the wand thing in the other hand, and thats sort of ridiculous because then you cant carry anything. So, Im sure that theres much improvement to be made over those other devices. But what I would encourage getting into artistic prototypes and things like that to see if you can figure out if it is better at detecting objects quickly and accurately in a sort of natural way than the cane. And I sort of think the cane is really the competition to this device. You know what Im saying?

INTERVIEWER: Well what we want to do is not take the cane away at all, because the typical blind person that is their natural go-to. We just wanted to complement it. We dont want to take away the cane at all.

PARTICIPANT: Oh okay. So this is the case.
INTERVIEWER: Yeah this is the case.
PARTICIPANT: So then I guess the question would be if the new device adds to what the blind person cant figure out with the cane or if its you know distracting from what theyre already able to figure out, because with the cane, and I agree, no one wants to take a way the cane because its also a symbol. But with the cane, youre sort of able to tell whats going on, whats where. And if the device doing the audio is talking to you, itll be interesting to see when you prototype it...when you test it with blind people and sighted people, if its sort of distracting and information overload, and out of the way, or if its telling people something that they find useful in addition to what the cane is telling them.
INTERVIEWER: Yeah we definitely work on that and making the device as simple as possible and cut down on how bulky it will be. But when we test our prototypes, would you be open to be one of our participants for the testing?
PARTICIPANT: Sure!
INTERVIEWER: And just let us know how you feel about the device?
PARTICIPANT: Yeah Ill do that.
INTERVIEWER: So thank you so much for interviewing with me today, you gave me a lot of good feedback that I can take back to the team.
PARTICIPANT: Sure. Well good luck with your project.
INTERVIEWER: Thank you and well hopefully be in contact with you in the future.
PARTICIPANT: Okay
INTERVIEWER: Okay thank you so much [name redacted].
PARTICIPANT: Bye
INTERVIEWER: Bye
PARTICIPANT: Youre welcome. Bye.

Subject 14

PARTICIPANT: Hello
INTERVIEWER: Hi [name redacted] This is Agnes, from...
PARTICIPANT: Hi Im [name redacted]
INTERVIEWER: Hi yeah Im from Team NAVIGATE and I was calling to you about doing the blind interview questions?
PARTICIPANT: Okay
INTERVIEWER: Okay hello. Before we get started I just wanted to let you know that your answers are all confidential and also Ill be recording them down on a word document, so there might be some pauses between questions.
PARTICIPANT: Okay

INTERVIEWER: Okay. Thank you for agreeing to participate. My first question, just for purposes of recording, what is your gender? Male, female, or other?

PARTICIPANT: female.

INTERVIEWER: Okay. Your household income: would you say its from 0 to 19 thousand, 20 to 39 thousand, 40 to 59 thousand, 60 to 79 thousand, 80 to 99 thousand, 100 to 149 thousand or over 150 thousand?

PARTICIPANT: Itd be about 0 to 19 thousand.

INTERVIEWER: Wait Im sorry say it again?

PARTICIPANT: 0 to 19 thousand.

INTERVIEWER: Okay. And your race. Is it American Indian, Black or African American, Asian or Pacific Islander, Hispanic or Latino, Caucasian, or other?

PARTICIPANT: Caucasian.

INTERVIEWER: Okay. Your education: Would you say its some high school, high school diploma/GED, some college, associates, bachelors, masters, doctorate...

PARTICIPANT: Masters.

INTERVIEWER: Masters? Okay. How old are you?

PARTICIPANT: 24

INTERVIEWER: Alright. Were you born blind or did you develop it during your life?

PARTICIPANT: I was born blind.

INTERVIEWER: Alright. What caused your blindness?

PARTICIPANT: Its a genetic condition. Called Leber Congenital Amaurosis..

INTERVIEWER: Could you say that to me one more time? Sorry.

PARTICIPANT: Its a genetic condition called Lebers Cogenital Amaurosis. I do not know how to spell amaurosis.

INTERVIEWER: Okay was the first word laborious?

PARTICIPANT: [Spells Leber]

INTERVIEWER: Okay

PARTICIPANT: Thats how you spell it.

INTERVIEWER: Thank you. What do you struggle most with when navigating through you surroundings?

PARTICIPANT: Thats a good question. I dont really struggle that much. Probably with things that are...huh I dont know. Let me think about that for a minute.

INTERVIEWER: Okay sure.

PARTICIPANT: Probably like if Im in a really loud area.

INTERVIEWER: Okay.

PARTICIPANT: Where there a lot of noise that can be a little difficult because I cant hear traffic as well. Besides that, thats really all I can think of.

INTERVIEWER: Do you currently use any assistive devices to navigate, if so what?

PARTICIPANT: I use a cane.

INTERVIEWER: A cane? Okay.

PARTICIPANT: Yeah.

INTERVIEWER: In the past have you utilized any other assistive devices, if so why did you stop using it or them?

PARTICIPANT: No actually I havent.

INTERVIEWER: So youve used nothing else in the past? Okay.

PARTICIPANT: uh uh .

INTERVIEWER: You dont even use any phone apps or things like that?

PARTICIPANT: I mean I use GPS to help me get directions, but I dont use it to actually sync with it.

INTERVIEWER: Okay. Okay how important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: Honestly, I think it would be cool. It would definitely be really neat. But I dont know how much I would actually use it. Now it would be kind of neat if you could put it on, I dont know if you could do this or not, it would be pretty cool if Im running, Im going running.

INTERVIEWER: Okay.

PARTICIPANT: That would work out pretty well because then it could probably help me react...I could probably react faster to it than a cane, maybe or maybe not I dont know Ive never tried it before. I was also thinking could you also put it like in the front of a bike?

INTERVIEWER: Okay. So you live a very active lifestyle?

PARTICIPANT: Yeah. [Chuckle]

INTERVIEWER: Good to know. So we plan on creating a navigational aid system to recognize objects and humans in daily travel. Would you be open to using such a device?

PARTICIPANT: Sure. I think it would be cool to try it out.

INTERVIEWER: You said your preference would be if it helped you in your active travels right?

PARTICIPANT: Yeah.

INTERVIEWER: Okay. Alright. What do you think would be the best way of communicating information take from the external environment to you, the user? So for example do you think tactile, auditory, or a combination of both maybe?

PARTICIPANT: I think tactile would be my preference. Auditory could work too but I think tactile can be better because if its noisy around, its better to...you might not hear the audio so...

INTERVIEWER: Okay. So the device that were making is going to incorporate the Microsoft Kinect. Its a motion sensor system thats 12 inches by 3 inches by 2.5 inches. And theres going to be a backpack to strap the Microsoft Kinect to the user and carry the hardware. Were thinking...Were trying to get to a smaller scale right now. Were using something called a GoPro mount. Using that we can strap the Microsoft Kinect to the person. And then we were going to have a laptop at first that the person would carry in a backpack. But now

were scaling down to a smaller size and we got it down to a tablet size now so you may not have to carry a bag, maybe just a satchel or something like that. And then, so where do you think would be the best place to put the Kinect on your body? For example, your head, your chest, or your waist?

PARTICIPANT: I would say probably your.... It depends. It depends on how the tactile thing works, so probably your chest or your waist.

INTERVIEWER: Okay. So, yeah were trying to scale down the technology were using to a smaller size. So hopefully, maybe one day its not a tablet and we can maybe get it to a smartphone size. Also, current direction were going right now, were thinking about maybe...you know the GoPro mount were talking about it has straps on it and possible we can put vibration motors on those straps, and then...

PARTICIPANT: That would be cool.

INTERVIEWER: Yeah so, were trying to scale it down as much as possible, because at first we were thinking of belts. Like a tactile belt so you can feel the vibrations but were trying to make it make it less heavy. Yeah how comfortable would you be wearing this device on your body?

PARTICIPANT: It depends on where I am, but yeah, thatd be fine.

INTERVIEWER: So, do you think that this device will efficiently complement your cane or that it will be a hindrance?

PARTICIPANT: I dont know. I couldnt say that until Ive actually tried it. I mean I hope that it would be a complement to my cane, but you know it could...I dont know.

INTERVIEWER: Because were not looking to take away the cane from anyone at all because we know thats what the natural inclination to use is. We just want to add to it.

PARTICIPANT: Yeah I mean I think that some people. I dont know personally is it would ... I know to me it would... I like just using my cane, because its not...it might be too much to pay attention to all the time. To have that device, I think sometimes it would be beneficial but I dont know if I would use it all the time. But I mean some people might really like it in addition to the cane, and I can see that really benefitting some people.

INTERVIEWER: Okay. Alright so one other thing were exploring right now is so say you were traveling with this device, and you felt a vibration on your right side. Would that tell you that you should move to the right side or that you should avoid the right side? What would you think if you felt that vibration?

PARTICIPANT: I would think to avoid it.

INTERVIEWER: Okay.

PARTICIPANT: That would be my inclination.

INTERVIEWER: Okay. Alright. Do you have any more comments or suggestions regarding the development of the device, or any questions like that?

PARTICIPANT: I think the only thing is I think if there was a way to put this device on a bicycle so that it could be somehow get to the front of a bike. That would be amazing, because I like riding bikes. I dont know many other blind people that do, but it would be really nice if that could maybe be sort of used to navigate on a bicycle. I dont know if you can do it or not.

INTERVIEWER: So, just for my curiosity, how do you navigate while biking now currently?

PARTICIPANT: [Talks about biking]

INTERVIEWER: Alright well, anything else?

PARTICIPANT: No. I think thats good.

INTERVIEWER: Okay, thank you so much. And well have a phase where we try out this product on people in the future, and maybe we can contact you in the future for it?

PARTICIPANT: Okay sounds good.

INTERVIEWER: But I think you live in California? Is that right?

PARTICIPANT: Yeah I live in California now so I dont think that I will...

INTERVIEWER: Yeah that might be difficult. Alright well thank you so much for participating. I appreciate all your feedback.

PARTICIPANT: All right. Thank you

INTERVIEWER: Okay bye.

PARTICIPANT: Okay bye.

Subject 15

PARTICIPANT: Hello this is [name redacted]

INTERVIEWER: Hi this is Agnes Varghese from Team NAVIGATE at the University of Maryland. We arranged an interview for today.

PARTICIPANT: Yeah

INTERVIEWER: Hi. How are you?

PARTICIPANT: Alright. How are you?

INTERVIEWER: Good. So, I just wanted to let you know beforehand that your answers will be confidential and...

PARTICIPANT: Okay

INTERVIEWER: Also Ill be writing down...Ill be typing up the answers while youre talking so if theres a pause between questions, thats what it is.

PARTICIPANT: Okay cool

INTERVIEWER: Alright. So first question, just for statistical purposes, would you define yourself in gender as a male, female, or other?

PARTICIPANT: Male.

INTERVIEWER: Okay.

PARTICIPANT: Male

INTERVIEWER: Your house hold income: would you say its from 0 to 19 thousand, 20 to 39 thousand, 40 to...

PARTICIPANT: 20 to 39.
INTERVIEWER: Okay. What is your race?
PARTICIPANT: Caucasian.
INTERVIEWER: Okay. And education: would you say some high school, high school diploma or GED, some college, associates degree...
PARTICIPANT: Some college
INTERVIEWER: Okay, do you have an associates or bachelors from college or...
PARTICIPANT: Working on my bachelors.
INTERVIEWER: Okay. Gotcha. How old are you?
PARTICIPANT: 22.
INTERVIEWER: Okay. Were you born blind or did you develop it during your life?
PARTICIPANT: I was born blind.
INTERVIEWER: Okay. What caused your blindness?
PARTICIPANT: I have a eye condition called Lebers Congenital Amaurosis.
INTERVIEWER: [muttering]. Okay. What do you struggle most with when navigating through your surroundings?
PARTICIPANT: Is this an open-ended question?
INTERVIEWER: Yeah
PARTICIPANT: Oh thats good. Its hard to say....what I struggle with most, I mean because I dont really think theres anything in particular that I struggle with.
INTERVIEWER: Okay.
PARTICIPANT: Maybe with big...big open spaces. [Incomprehensible] Its a little hard to find something in a really really big open space, but even then it wouldnt be a struggle. Its...I guess it would be the hardest thing.
INTERVIEWER: Okay
PARTICIPANT: Does that make sense?
INTERVIEWER: Yeah yeah yeah it makes sense. So...
PARTICIPANT: Yeah okay.
INTERVIEWER: Youre saying that if you had to pick something itd be that but its not something that, but its not something thats that much of a struggle for you.
PARTICIPANT: Yeah. Nothing is really much of a struggle. Its just that I guess I pick that yeah: The big open spaces and finding things in that.
INTERVIEWER: Okay do you currently use any assistive devices to navigate, if so what?
PARTICIPANT: I use a white cane.
INTERVIEWER: Okay
PARTICIPANT: And I use a white phone with GPS software.
INTERVIEWER: Okay in the past, have you utilized any other assistive devise, if so why did you stop using it or them?
PARTICIPANT: No I havent used really anything in the past.

INTERVIEWER: Okay

PARTICIPANT: [incomprehensible]

INTERVIEWER: How important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: I guess not terribly. What I have right now is pretty good, but Id be open to trying, you know, the new device if its....but its not like....its not something I desperately need.

INTERVIEWER: Okay, but how are the...just in general the...okay so your devices do that for you, they help you identify objects and people in your path? Or...

PARTICIPANT: Well, what my cane does...you know, is I find objects and people with my cane. You know...to some degree the cane...you know....I can get an idea of what object there is. You know tapping it with the cane, you know the sound it makes, you know I can find people and hear where people are, and find you know...if I tap them with my cane, I go around them.

INTERVIEWER: Okay.

PARTICIPANT: Uhm...And then the GPS. It just tell me, it give my like turn-by-turn directions. And like you know streets and stuff. Sometimes I use it if I, you know, if Im in a...in a new area. But, and as afar as a device that...I guess vibrates or give me audio feedback for people or things I dont really use anything like that.

INTERVIEWER: Okay.

PARTICIPANT: And...I dont really feel like...like a pressing need for it, but Im open to, you know, trying one if there was something that is out there.

INTERVIEWER: Alright. So...yeah so, I understand, I guess the next question would just be for us to get feedback about the product that were thinking about creating, so what were planning on is creating a navigational device that assist the blind in recognizing objects and humans in daily travel, and would you be open to using such a device? And you said youd be...

PARTICIPANT: Yeah!

INTERVIEWER: Okay.

PARTICIPANT: Id be open to...Id be open to using it. Id be open to, you know, test it or...if you need testers [laughter].

INTERVIEWER: Okay.

PARTICIPANT: For...for sure.

INTERVIEWER: What do you think would be the best way of communicating the information taken from the external environment to the user, for example, tactile means, or auditory, or a combination of both?

PARTICIPANT: I like combination of both.

INTERVIEWER: Okay.

PARTICIPANT: But a little more tactile than audio so, you know, I can still hear my surroundings.

INTERVIEWER: Right now, in the phase we are, we are thinking that wed make a setting where a user can make audio setting or someone can do tactile, or one where theres a combination and one thats like predominately tactile and auditory would just be like for the necessary times. But, this device is going to incorporate the Microsoft Kinect , which is a motion sensor system thats around 12 inches, by 3 inches, by 2.5 inches. And, were going to have something called the GoPro Mount, and itll allow us to strap the Microsoft Kinect to the user, and either a tablet or if we can size it down to a smartphone one day thatd be nice, to process the data. So, where do you feel would be the best place to put the actual Kinect on your body: for example, your head, your chest, your waist?

PARTICIPANT: By my waist.

INTERVIEWER: Okay.

PARTICIPANT: But yeah, the chest or waist, not my head.

INTERVIEWER: Okay. How comfortable would you be wearing this device on your body?

PARTICIPANT: Thats hard to say. I mean how much would it weight...I dont know how much it would weight. Sounds like it would be kind of big, kind of wide right?

INTERVIEWER: Okay, yeah yeah.

PARTICIPANT: Like a big....Honestly, its....might not...I dont think I would be very comfortable, you know...

INTERVIEWER: Its...Its about...

PARTICIPANT: Sounds like it would be kind of big....

INTERVIEWER: Yeah its about a foot wide...

PARTICIPANT: ...to use everyday.

INTERVIEWER: Yeah, okay.

PARTICIPANT: Yeah it sounds like its something that would be cumbersome to use on a day to day basis and probably kind of inconvenient, but, you know, if it were smaller, once its smaller, obviously you know the smaller it is, the more convenient it is.

INTERVIEWER: Mhm.

PARTICIPANT: But, uhm, Id be open, you know, obviously you gotta start somewhere.

INTERVIEWER: Yeah. [chuckle] Okay so, do you think this device would efficiently complement your cane or do you feel that it would be a hindrance?

PARTICIPANT: Mmm...

INTERVIEWER: Because were not looking...

PARTICIPANT: Thats a...

INTERVIEWER: Yeah were not really looking to...

PARTICIPANT: Thats a good question.

INTERVIEWER: Yeah. Were not looking to take away the cane; we just want to add to it.

PARTICIPANT: Well..I mean then it should, you know, complement it, but its hard to say til I, you know, actually try it to say whether it would or would not...the hope...I guess my hope is think its...of course it would. But it has...you know....depends on what kind of information is trying to bide. I mean it could, it could in a way, you know, complement it, or it could be, you know, too much.

INTERVIEWER: Yeah.

PARTICIPANT: Its just hard to answer that definitively.

INTERVIEWER: Okay.

PARTICIPANT: ...without trying it.

INTERVIEWER: Alright, so this is another question we have: lets say you felt a vibration on, say, your right side while youre wearing this device. Would you natural inclination be to avoid the right side or go towards the right side when you feel that vibration?

PARTICIPANT: Id turn towards the right side and use my cane to investigate what it was.

INTERVIEWER: Okay

PARTICIPANT: At least at first. Until I get an idea of you know, what messages were being sent you know? Like what does the right side mean

PARTICIPANT: obstacle, or not.

INTERVIEWER: Okay. So do you have any other questions or comments or suggestions regarding the development of this device?

PARTICIPANT: I mean I guess...are you....so youre still working on this, I assume? And, you know, do you need testers?

INTERVIEWER: Yeah, but when I was calling you I saw that youre located in [location redacted]?

PARTICIPANT: Say again?

INTERVIEWER: Are you located in [location redacted]. When I was calling you?

PARTICIPANT: Actually Im....actually Im not, its just a [state] number.

INTERVIEWER: Oh okay.

PARTICIPANT: Im actually about to discontinue this number because I live in [city redacted]

INTERVIEWER: Oh. Okay thats great then, yeah so when we start testing, then we can contact you to be one of the people we try it out with.

PARTICIPANT: Yeah, because Id be interested in testing it, because I live close.

INTERVIEWER: Oh okay. Are you going to school here right now? In [city redacted]?

PARTICIPANT: Yeah I go to [school redacted]

INTERVIEWER: Okay, okay thats good.

PARTICIPANT: I live downtown and Ive been there about a year and a half so...

INTERVIEWER: Alright youre originally from [state redacted].

PARTICIPANT: all over the place...so...
INTERVIEWER: Oh okay. Yeah then you'd definitely be a candidate to try it out because you're in the area, so yeah in the future when we develop it, we'll definitely contact you.
PARTICIPANT: Yeah.
INTERVIEWER: Okay. Thank you so much
PARTICIPANT: Totally
INTERVIEWER: For participating today.
PARTICIPANT: Thank you so much. Thank you.
INTERVIEWER: Okay have a nice day! Bye.
PARTICIPANT: Okay. You too, bye.

Subject 16

PARTICIPANT: [muttering off phone] Hello?
INTERVIEWER: Hi, This is...
PARTICIPANT: Okay. I'm ready.
INTERVIEWER: Oh okay. Alright so before we get started, I just want to let you know that all your answers will be confidential, and...
PARTICIPANT: Okay
INTERVIEWER: I'm typing up your answers as well so if there's a pause in between the questions that's why.
PARTICIPANT: Okay
INTERVIEWER: Okay. Alright so, we just have to ask for survey purpose
PARTICIPANT: would you define your gender as male, female, or other?
PARTICIPANT: Male
INTERVIEWER: Okay. Your household income: is it between 0 to 19 thousand, 20 to 39 thousand, 40 to 59 thousand, 60 to 79 thousand, 80 to 99 thousand, 100 to 149 thousand, or 150 thousand plus?
PARTICIPANT: 100 to 49 thousand.
INTERVIEWER: Okay. Alright, your race: is it American Indian, Black or African American, Asian or Pacific Islander, Hispanic, Caucasian, or other?
PARTICIPANT: Black
INTERVIEWER: Okay. Education: some high school, high school diploma or GED, some college, Associates, Bachelors, Masters, Doctorate or Professional School, or other?
PARTICIPANT: Masters and I'm a Terp!
INTERVIEWER: Oh okay [chuckle]
PARTICIPANT: Mhm.
INTERVIEWER: [unrelated] How old are you?
PARTICIPANT: I am 41.
INTERVIEWER: 41? Okay.
PARTICIPANT: Yup

INTERVIEWER: Were you born blind or did you develop it during your life?
PARTICIPANT: I lost my sight at 19.
INTERVIEWER: Okay. [muttering] and what caused this blindness?
PARTICIPANT: [incomprehensible]
INTERVIEWER: Can you repeat that for me?
PARTICIPANT: A shooting accident, I accidentally got shot.
INTERVIEWER: Oh okay...wait Im sorry what type of accident was this?
PARTICIPANT: Shooting. Shooting. I got shot.
INTERVIEWER: Shooting...oh okay okay okay. Ugh Im sorry to hear that.
PARTICIPANT: no worries
INTERVIEWER: What do you struggle most with when navigating around
your surroundings?
PARTICIPANT: Thats a good question. Im not real good at walking in a
straight line. AV :Okay
PARTICIPANT: Im not a straight-line walker. Pretty bad at it though. I
always..kinda...what you call it...cradle the side, like the wall like that.
INTERVIEWER: You do what with the sides?
PARTICIPANT: I kinda hug the sides, like with my cane.
INTERVIEWER: Oh okay okay.
PARTICIPANT: Yeah.
INTERVIEWER: Okay. Alright do you currently use any assistive devices to
navigate? If so, what?
PARTICIPANT: Oh just a regular white cane.
INTERVIEWER: Okay. In the past have you utilized any other assistive
devices? If so, why did you stop using it or them?
PARTICIPANT: You mean in terms of mobility?
INTERVIEWER: Yeah...or anything...
PARTICIPANT: Okay I do not.
INTERVIEWER: Yeah. Go yeah.
PARTICIPANT: Okay no, Ive always used a white cane.
INTERVIEWER: Okay so you havent used anything like applications on a
phone...or
PARTICIPANT: Oh you saying....oh navigate like a iphone or...
INTERVIEWER: Yeah yeah yeah.
PARTICIPANT: Oh actually no, no I never used the iPhone to navigate
anything.
INTERVIEWER: Okay. Okay. How important is it to you to have a
navigational aid that allows you to identify objects and people in your
path?
PARTICIPANT: Its not extremely important to be honest.
INTERVIEWER: Okay. We plan on creating a navigational device to assist the
blind to recognize objects and humans in their daily travel. Would you
be interested in such a device?
PARTICIPANT: Sure!

INTERVIEWER: What do you think would be the best way of communicating the information taken from the external environment to the user, for example: tactile, auditory, or a maybe combination of both?

PARTICIPANT: Auditory.

INTERVIEWER: Okay. Do you have your reasoning behind that?

PARTICIPANT: [incomprehensible] Auditory cues.

INTERVIEWER: Okay. This device is going to incorporate the Microsoft Kinect, which is a motion sensor system that is 12 inches by 3 inches by 2.5 inches, and maybe...were trying to size it down right now....right now we have tablet in which you can process all the data and itll contain all the information, and maybe you can hold it or have a satchel or bag that you can put it in, and we have something called the GoPro mount and that is going to hold the Microsoft Kinect. Its going to strap it you. What would you feel would be the best place to put the Kinect on your body? For example: the head, the chest, or the waist.

PARTICIPANT: Probably the chest.

INTERVIEWER: Okay. And how comfortable would you be wearing this device on your body?

PARTICIPANT: [Incomprehensible]

INTERVIEWER: Im sorry, say it one more time?

PARTICIPANT: I would not be uncomfortable.

INTERVIEWER: Okay. Do you think that this device would efficiently complement your cane or do you feel that it would be a hindrance?

PARTICIPANT: What do you mean? [Incomprehensible]

INTERVIEWER: Say it again?

PARTICIPANT: You mean walking with both canes? Or you just saying...?

INTERVIEWER: Okay, so what we want to do is just make a device that adds to your cane. We dont want to take the device...we dont want to take the cane away from you. So...

PARTICIPANT: Oh! Okay, no..okay..

INTERVIEWER: So would it...

PARTICIPANT: Alright. No it wouldnt be a hindrance at all.

INTERVIEWER: Okay. Do you have...so something else we want to test right now is...lets say you have this GoPro mount on you with the Kinect strapped to you, and you felt a vibration on your right side. So if you felt a vibration on your right side, would you take that to mean that you need to avoid the right side or you need to go towards the right side?

PARTICIPANT: Move towards the right, because somethings in my way.

INTERVIEWER: So if you felt a vibration on the right, you would move towards the right?

PARTICIPANT: Yes

INTERVIEWER: Okay. And what...what is your reasoning for that?

PARTICIPANT: Im assuming that somethings in my way.

INTERVIEWER: Okay. So do you take a...this is just something to understand, do you take a vibration on the right side to mean that there is something on the right side thats in the way, or do you take that to mean that something on the left side is in your way?

PARTICIPANT: I take it to mean that something on the right side is in the way.

INTERVIEWER: Okay, so you would...if something on the right side is in the way, are you saying that you would move away from that and not towards it?

PARTICIPANT: Correct.

INTERVIEWER: Okay. Do you have any other comments or questions or suggestions regarding our development of this device?

PARTICIPANT: No. AV :Okay. We might have a tested...when we create the product, we might have testing in the future, would you be open to being one of our participants?

PARTICIPANT: Sure

INTERVIEWER: Alright, good to know. Well keep in touch with you via email. Thank you so much for doing this with me today...

PARTICIPANT: Thank you

INTERVIEWER: Hope you have a good rest of the day. See ya.

PARTICIPANT: Mhm. Take care.

INTERVIEWER: You too.

Subject 17

PARTICIPANT: Hello

INTERVIEWER: Hi [Name redacted], this is Agnes, the one ... I was supposed to call you at 11 today.

PARTICIPANT: Yeah, how are you?

INTERVIEWER: Good, how are you?

INTERVIEWER: Hello?

PARTICIPANT: So, you're right on time.

INTERVIEWER: Oh, yeah; can you hear me?

PARTICIPANT: Yes, I hear you just fine.

INTERVIEWER: Ok, so, before we get started, I just want to let you know that all of your answers are completely confidential, and that we are recording it so that I can transcribe the notes from it later.

PARTICIPANT: Ok.

INTERVIEWER: But you'll just be tied to a participant number so your identity won't be revealed or anything.

PARTICIPANT: Yeah, I understand.

INTERVIEWER: So, we just have to ask: is your gender male, female, or other?

PARTICIPANT: Male.

INTERVIEWER: Ok.

PARTICIPANT: Let me plug in my phone real quick

INTERVIEWER: Ok. No problem

PARTICIPANT: We're gonna get disconnected. One second.

INTERVIEWER: Hm. [the phone call is stopped for a couple of seconds]

PARTICIPANT: Yes

INTERVIEWER: Ok, are you ready?

PARTICIPANT: Yes.

INTERVIEWER: Ok. So would you say your household income is from 0 to 19,000, 20 to 39,000, 40 to 59,000, 60 to 79,000, 80 to 99,000, 100 to 149,000, or above 150?

PARTICIPANT: 79.

INTERVIEWER: Ok. Um, your race, what is that?

PARTICIPANT: White, caucasian.

INTERVIEWER: Ok. Your education, is it some high school, high school diploma or GED, some college, associates, bachelors, masters, doctoral or professional school or other?

PARTICIPANT: Masters

INTERVIEWER: How old are you?

PARTICIPANT: 43

INTERVIEWER: 43 you said? Were you born blind, or did you develop it during your life?

PARTICIPANT: Born blind.

INTERVIEWER: And, what exactly caused your blindness?

PARTICIPANT: [unintelligible]

INTERVIEWER: Um, can you say that for me one more time?

PARTICIPANT: Yes. Retinopathy prematurity.

INTERVIEWER: Retinopathy prematurity, ok. What do you struggle with most when navigating through your surroundings?

PARTICIPANT: I guess the biggest thing is in new, unfamiliar areas, trying to figure out what's there. In buildings, it would be, trying to find the right door, the right places. In outdoor areas, of course it would be, knowing where you're supposed to turn, when there's really nothing to show you that [unintelligible] something new. And then of course there's always obstacles that aren't normally in your path that end up there; badly parked cars, other junk that's put out at different places. The unknown, I guess, is the best way to put the things that you just don't know what to expect.

INTERVIEWER: Can you say the part about what's most difficult in buildings again?

PARTICIPANT: In buildings?

INTERVIEWER: Yeah.

PARTICIPANT: Just finding the correct doors, the correct place you're supposed to go when there's nothing to really show you. I mean, there's nothing to tell you which door.

INTERVIEWER: Ok. Do you currently use any assistive devices to navigate and, if so, what?

PARTICIPANT: Umm, white cane

INTERVIEWER: Ok

PARTICIPANT: Had a guide dog, but not at the moment. That's pretty much it. I will use some apps for finding directions and things, but for actual navigation and walking, just the cane.

INTERVIEWER: Apps are from the iPhone, right?

PARTICIPANT: Right

INTERVIEWER: Ok. You said ... in the past, have you utilized any other assistive devices? If so, why did you stop using it or them?

PARTICIPANT: I had two guide dogs, and both of them passed away, and looking to get a third one, but the training hasn't happened yet.

INTERVIEWER: So, when you use your guide dogs, do you also use a cane?

PARTICIPANT: No.

INTERVIEWER: Ok, so what is your preference? The guide dog or the cane?

PARTICIPANT: Preference is the dog.

INTERVIEWER: Ok. So, right now, the cane is just a placeholder till you're able to train a new dog?

PARTICIPANT: Yeah, it may not be quite that simple, because there's so much involved in getting dog training and getting it set up, and just being ready to get a new dog. There have been a couple of year breaks between having my last dog. So yes I prefer the cane but other things to consider as to the timing of it and waiting to go get a new dog. But for just purely navigational purposes, a dog is better.

INTERVIEWER: Ok. Ok. So, I guess, you like dogs for navigation, but I just want to clarify, but the cane is easier to obtain, because obtaining a dog and training it is a process.

PARTICIPANT: It's a process, right, but [unintelligible] they're just ready to get another dog. They just have to do it, I'm just not that way.

INTERVIEWER: Ok. Hold on one second, sorry, problems. All right, how important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: On a scale, or just?

INTERVIEWER: Yeah, just how important is it to you. It doesn't have to be on a scale. If you want to say it on a scale, you can.

PARTICIPANT: Both of these are extremely important, because ... Now, you're asking who the people are, or just that there's a person there?

INTERVIEWER: Right now, just to know that a person is there.

PARTICIPANT: Yeah, because of safety issues, very important.

INTERVIEWER: So, you said very important?

PARTICIPANT: Yes.

INTERVIEWER: So, we plan on creating a navigational device to assist the blind to recognize objects and humans in daily travel. Would you be open to using such a device?

PARTICIPANT: Yes.

INTERVIEWER: What do you think would be the best way of communicating the information taken from the external environment to you the user? For example, do you want tactile feedback, auditory, or some kind of combination of both?

PARTICIPANT: Auditory, what was the first one?

INTERVIEWER: Tactile. So maybe like vibrations, some kind of touch.

PARTICIPANT: Ok. Probably a combination is best because there are deaf blind people too that would use it. And people have their different preferences. Maybe there's times where you can turn the sound on or off and just hear vibration that might be helpful for some people. But you need both.

INTERVIEWER: Ok, so for just the blind person, not a deaf blind person, you would also say a combination?

PARTICIPANT: Combination, right. But you have to extend it if its something that blind people will use that the deaf blind will want to explore too.

INTERVIEWER: So the device is going to incorporate the Microsoft Kinect, which is a motion sensor system that's 12 inches by 3 inches by 2.5 inches, and there's going to be some sort of satchel that you'll wear and in it will be an iPad or a tablet which will process all your data. Where would you feel would be the best place to put the Microsoft Kinect on your body? For example, your head, your chest, your waist?

PARTICIPANT: How will it be connecting? So, its not in the satchel, where does it go?

INTERVIEWER: Yeah, I'm asking you where you would prefer for it to go. Your head or your chest or your waist, maybe.

PARTICIPANT: Ok, but how does it hook on?

INTERVIEWER: So, right now, we were thinking well some kind of strap that would attach it. Right now, we are thinking that if we're doing the chest, we're gonna use the GoPro mount. To kind of strap it on to the person.

PARTICIPANT: Ok. So, using Velcro, something like the side, the hip or the waist would be good for that. Just depends on how its going to be hooked on.

INTERVIEWER: Yeah. It needs to be in the front of you, in a way, because it has to be able to pick up on what's in the environment in front of you.

PARTICIPANT: I'm not sure how it would fit on your head. I would try anything once, but I don't know how that would work

INTERVIEWER: Yeah, because right now the prototype we're building is, we're strapping it on to the chest.

PARTICIPANT: That probably would work fine

INTERVIEWER: How comfortable would you be wearing this device on your body?

PARTICIPANT: I'd be fine with it. I'd be comfortable with it, no problem.

INTERVIEWER: So, do you think this device would efficiently complement your cane or do you feel that it would be a hindrance?

PARTICIPANT: I think it would complement the cane.

INTERVIEWER: Because what we were aiming to do was create a device that works with the cane. We wouldn't want to take that, the usage of the cane, away from anyone. I have another question. Let's say that you're walking and on the device you feel a vibration on your left side. Would you take that to mean that hey, I should avoid my left side, or hey, I should go towards my left side?

PARTICIPANT: Well, since we don't know anything about the area and what we're actually looking for. Not knowing that, I would say the vibration on the left side would mean avoid the left side.

INTERVIEWER: Ok, I just wanted to know what your natural inclination would be.

PARTICIPANT: Yeah, I mean if you told me, if you would say, its going to vibrate when you find the door and then go that way, fine. But normally, instinct would say, if its vibrating, avoid it.

INTERVIEWER: Do you have any other comments or suggestions regarding the development of this device?

PARTICIPANT: It sounds like you've taking in consideration that you're going to use different tones and different vibrations for different things, right?

INTERVIEWER: Yeah, so if for the tactile part we would use vibrations that for example, with what you were saying: if you kept feeling more intense vibrations on your left side, that would mean to move away from the left side. So its like an obstacle avoidance kind of thing. And it would do the same thing with audio. You might have clicks that get faster and more intense to tell you to move away from something.

PARTICIPANT: Yeah, so that sounds good, and then if there are ways to maybe change some settings, so for instance, maybe I want the clicks to do something different than what they're initially set for; maybe I want a different sound, or

INTERVIEWER: To have options

PARTICIPANT: Different sound options, and, in my case, I have a little bit of hearing loss, so I might decide that I want a different type of sound that I hear better, I have certain pictures that I don't hear as well, so maybe offer some options as far as sound.

INTERVIEWER: Ok. Anything else?

PARTICIPANT: No, I think that would be it.

INTERVIEWER: Alright. What area do you live in, sorry?

PARTICIPANT: Louisville, Kentucky

INTERVIEWER: We're doing, probably in the fall when the device is developed, we're doing testing, but seeing that you live in Kentucky, and not in the DC Maryland Virginia area, that may be hard for you to come out. But thank you so much for participating in this interview,

and if you have any other feedback, you have my email address, so email me anytime.

PARTICIPANT: Yes, if anything happens with this, I'd be curious to know what ends up happening.

INTERVIEWER: Ok. As in with the testing, or

PARTICIPANT: Yeah, what's determined and how it proceeds and if it becomes available and so forth.

INTERVIEWER: If you just check back in with me maybe towards the end of this year, we should have developed the device and gone underway with testing to kind of get feedback on how well it works from blind users.

Alright, thank you so much... hello? Thank you.

PARTICIPANT: You're welcome, you have a good day.

INTERVIEWER: You too, bye.

Subject 18

INTERVIEWER: What is your gender [name redacted]?

PARTICIPANT: Male

INTERVIEWER: And what is your household income?

PARTICIPANT: One of the choices was 60-79?

INTERVIEWER: Yes

PARTICIPANT: Okay what would you say your race is?

INTERVIEWER: I guess Caucasian?

PARTICIPANT: Okay

INTERVIEWER: Education: would you say you had some high school high school diploma...

PARTICIPANT: Masters.

INTERVIEWER: Masters? Okay

PARTICIPANT: Cool what do you have a masters in?

INTERVIEWER: It is in...what is the...legislative studies.

PARTICIPANT: Oh okay. How old are you?

INTERVIEWER: 59

PARTICIPANT: Did you say 59 or 69?

INTERVIEWER: Five nine

PARTICIPANT: Five nine, okay

INTERVIEWER: Were you born blind or did you develop it during your life?

PARTICIPANT: Developed it over time

INTERVIEWER: That was there a certain age that this happened?

PARTICIPANT: It was.. no it was gradual

INTERVIEWER: Okay. What caused your blindness?

PARTICIPANT: Retinitis Pigmentosa. Or RP its commonly called.

INTERVIEWER: Alright. What do you struggle most with when navigating through your surroundings?

PARTICIPANT: Navigating? I actually think the most difficulty is...is knowing the destination, like when youre walking to a room, knowing where...first of all knowing where the room is. Ultimately where do I need to go. Is there somebody to tell me where the restrooms are. They dont give you any directions. They panic and then grab you, and they pull you. Instead of saying down the hall, you know, about 5 feet, go left. So knowing my destination I think is a difficult one to...a hurdle to cross.

INTERVIEWER: So youre saying that you would want something that tells you "oh. Five feet to the left?"

PARTICIPANT: Yes, exactly, exactly where I need to go. A lot of people say like watch out theres a chair in front of you. I have a white cane, I can avoid the chair! But I dont know exactly where I should go. I dont know the directions.

INTERVIEWER: Okay. Give me one moment Im writing all this down

PARTICIPANT: Sure. Sure, Im probably talking too fast.

INTERVIEWER: No, no, no. Youre completely fine. I just want to get this down is all. Do you currently use any assistive device to navigate? And if so, what?

PARTICIPANT: I use...well I use a white cane. Thats pretty much...it

INTERVIEWER: Okay.

PARTICIPANT: I...

INTERVIEWER: Oh sorry, go ahead.

PARTICIPANT: Go ahead please.

INTERVIEWER: Oh no. If you were going to say something else, go ahead. Hello?

PARTICIPANT: I didnt hear the last statement

INTERVIEWER: Oh I said if you want to say...add something else to that, go ahead.

PARTICIPANT: I was going to say I use a white cane only, what I do something is when Im taking, for example, a trip on a metro, Im able to go get some directions. You know, like walking directions from a metro to my destination, but as far as Im actually travelling, Im only using a white cane.

INTERVIEWER: Okay. Wait what is the source of these directions you get? Like is it on a phone, or...?

PARTICIPANT: On a computer. Actually on a metro you can do it both ways, but I can download directions. Almost like when you do a, you know, like a mapquest of a google maps. The from and to, and then you can get walking directions sometimes.

INTERVIEWER: Okay. Okay. In the past have you utilized any other assistive devices? If so, why did you stop using it or them?

PARTICIPANT: I cant think of anything else Ive used.

INTERVIEWER: So youve been using a cane...

PARTICIPANT: You're talking about for example, traveling from my house to an office building or something. Is that what you mean?

INTERVIEWER: Just like if you've used any other devices in the past, like app on a phone, or some other device that some company may have created in the past.

PARTICIPANT: Not for navigation. I mean I've used apps for information purposes but not really to help me navigate.

INTERVIEWER: Okay. Just curious about something from one of the above questions. When did you start gradually losing your sight with RP?

PARTICIPANT: My late 20s.

INTERVIEWER: Okay. And when were you completely blind by?

PARTICIPANT: [incomprehensible] no other vision about...I was about 50. At that point I was completely dependent upon the assistive technology to read anything.

INTERVIEWER: Okay.

PARTICIPANT: Any one letter on a computer.

INTERVIEWER: Okay. How important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: Well those are two different things, but that's extremely important. Both are extremely important.

INTERVIEWER: Okay.

PARTICIPANT: 10 out of 10

INTERVIEWER: Okay. All right. So we plan on creating a navigational device to assist the blind to recognize objects and humans in daily travel. Would you be open to using such a device?

PARTICIPANT: Absolutely! And I would be willing to test it.

INTERVIEWER: Okay. Where you from [name redacted]?

PARTICIPANT: I currently live in [residence redacted].

INTERVIEWER: Oh okay. So you are somewhat close enough to come to testing okay. [Irrelevant information about undisclosed information].

INTERVIEWER: In the fall we'll probably message people and see who's interested in possibly coming...

PARTICIPANT: I'm sorry, my cuckoo is cuckooing and I didn't hear what you just said.

INTERVIEWER: I'll wait until it stops. Okay. So I was just saying that in the fall, once the device is developed, we'll probably start contacting people and seeing if they're interested in testing the device with us.

PARTICIPANT: Fabulous.

INTERVIEWER: Were in College Park, MD.

PARTICIPANT: Okay.

INTERVIEWER: So, what do you think the best way of communicating the information from the external environment to the user would be? For example, do you want something that's tactile, maybe auditory, maybe a combination of both?

PARTICIPANT: Im afraid I didnt hear your options beside auditory? The last thing you said?

INTERVIEWER: I said: the three options were tactile, auditory, or a combination of both.

PARTICIPANT: Oh combination. Well my gut reaction is auditory so Id like to certainly be flexible. What Im thinking, and Ive had other, or had discussions about this issue before, is I dont see something being developed to replace the cane. My thought would be that I thought it would augment a cane or someone who uses a service dog.

INTERVIEWER: Which is...

PARTICIPANT: And...

INTERVIEWER: Go ahead.

PARTICIPANT: And that, because of that I think auditory is the best...approach in terms of delivering the information.

INTERVIEWER: Yeah. Our aim is definitely to augment the cane. We dont want to take that away from anybody. So it would just be a device that you would use in addition to the cane.

PARTICIPANT: Okay. Thank you.

INTERVIEWER: The device is going to incorporate the Microsoft Kinect, which is a motion sensor system and the measurement of the Microsoft Kinect are 12 inches by 3 inches by 2.5 inches, and also theres going to be a satchel youre going to wear, and in it is going to be a tablet which process the data. And where do you think, or where would you feel that the Microsoft Kinect system be the best place to put on your body. For example, your head, your chest, your waist?

PARTICIPANT: Boy thats a good one...

INTERVIEWER: Its 12 inches by 3 inches by 2.5 inches.

PARTICIPANT: Id have to...My thinking is that Id like to try all three, and see which one works the best, but obviously thats not an option right now. So Im kind of thinking the neck area, maybe shoulder. In the choices you gave, I think you said chest?

INTERVIEWER: Those are just suggestions. Whatever place you think would be best for you.

PARTICIPANT: Right...

INTERVIEWER: I said head, chest, and waist.

PARTICIPANT: Im thinking like your arm needs to be swinging the cane.

INTERVIEWER: Mhm...its not.

PARTICIPANT: So it wouldnt...like the forearm wouldnt be a good option. Perhaps the neck and shoulder, almost wearing it like a...you said the size, but depending on the size, ones neck like a backpack type item. Possibly the waist.

INTERVIEWER: Yeah the size is probably like the length of, across your...it would be across your....it would take the length of your chest. But it would protrude out like 3 inches or...something like that.

PARTICIPANT: Yeah that might be more cumbersome. I was thinking more like a fanny pack thing that would holster in your hip? I dont know if it needed to be distributed, but if, if one would wear around ones waist like a fanny pack or a belt...that style. Now the question in that is though since its auditory, one has to, you know, hear it, so I dont know if it would need to have a wireless connection to a ear bud, or something like that? It is now so difficult to... in traffic, on metro for example near my house, theres an audible pedestrian signal. But because of all the traffic, its sometimes so loud and literally you cant hear the signal. You would hear it after its too late. So, anticipating that in normal situations, walking in any kind of urban area, or suburban area, even if its around someones chest or waist, the device, I would think there would have to be some device in the ear, I dont know if thats something that you guys have already... concluded youre going to do or not.

INTERVIEWER: Yeah, so for our...if we had multiple modes for the auditory portion of it, we would have some type of earphones or headphones to be connected in so that you can hear the sounds to recognize objects and to...when to tell you to avoid an obstacle.

PARTICIPANT: Okay. Thats interesting. Im trying to picture this. But I think too you would want to not, unless absolutely necessary, cover both ears, because I know, most people I know blind and low vision are using every sound they hear walking down the street. Like if their cane happens to tap something. You know something like that but thats just a small example, but I.

INTERVIEWER: Yeah.

PARTICIPANT: Now you guys have probably thought of these things, I just wanted to mention them.

INTERVIEWER: Yeah. We want to try to make it as unobtrusive as possible, but yeah thats definitely a good point. Let me write that down. Okay, how comfortable would you be wearing this device on your body?

PARTICIPANT: On my body...I would be comfortable.

INTERVIEWER: Okay. Do you think that this device would efficiently complement your cane or do you feel that it would be a hindrance?

PARTICIPANT: Well based on what I know now, I think that it would be a complement. As with most devices Im sure do for some purpose. Im sure if you actually use it, there are complications you may not think about but in general I think it would definitely complement the cane.

INTERVIEWER: Okay. So another question: lets say that you are walking and while you are walking. I guess if you are to do the auditory version, youd hear a bunch of faster, heavy clicks, or if you were doing a tactile version, you would hear like a, I mean, youd feel a vibration on your left side; an intense vibration on your left side, or an intense audio on your left side. Would you take that to mean that you should avoid the

left side or you should go towards the left side? Whats your natural inclination when you feel that?

PARTICIPANT: I would say avoid.

INTERVIEWER: Okay. Yeah most people have been saying that. Do you have any other comments or suggestions regarding the developments of this device?

PARTICIPANT: Well, you know, I mentioned early on that auditory was my preference, but the question you just asked me mentioned vibrations. Vibrations certainly to me can be as valuable, in some cases, more valuable than auditory, so I hope I didnt...by saying auditory I didnt exclude...give the impression that I would exclude vibrations, because I think vibrations can be extremely important. In fact, if one thinks auditory is only words, I think thats not as quick a transfer of information because you literally have to translate the words, but if you feel something vibrate in a certain spot, thats a quicker...to me thats a quicker indicator of a message thats being sent.

INTERVIEWER: Yeah, you are completely fine for having a preference for audio. We just wanted to get an idea of what everyone leans towards, but for the final device, I think that were going to have all options available. Tactile...

PARTICIPANT: Oh really?

INTERVIEWER: Yeah: tactile, auditory, and combination.

PARTICIPANT: Okay. Because I do that that its...and this may be something I never understood myself until I started losing my eyesight. I often react to a sound before I understand what my reaction should be, if you know what I mean. Like Im just walking adown the street and I hear something, I might stop or if its on my right, I might just to the right. It may ultimately be nothing I need to worry about, but I react when I first hear a sound or feel something. I give an example is walking from...between my house and the metro station, after it rains, theres a lot of bushes and stuff, you know overhangs and tree, and after it rains they hang a little lower. So its not something Im expecting, but I like at least graze the top of my head or sometimes it might be something harder, like a branch, so because Im reacting to something I feel, that would be something I can picture this device helping with.

INTERVIEWER: Okay. Do you have any other comments or suggestions?

PARTICIPANT: I guess just a question: youre doing this survey...now youre with the University of Maryland, College Park?

INTERVIEWER: Mhm, and Im in a research...an undergraduate research program at the school, and my team specifically is working on creating a navigational aid for the blind: Team NAVIGATE. [Unrelated information redacted]

Subject 19

PARTICIPANT: Hello.

INTERVIEWER: Hi, is this [name redacted]?

PARTICIPANT: Yeah

INTERVIEWER: Hi this is [name redacted]. I contacted you about a study that were doing, and we had an interview scheduled today at 1?

PARTICIPANT: Yeah

INTERVIEWER: Hi how are you?

PARTICIPANT: Im fine, how are you?

INTERVIEWER: Good, good...before we get started, I just wanted to let you know that I am recording the conversation so that I can transcribe it later, and also that all your information is confidential and youre just tied to a participant number, so no one is going to know the information about you specifically.

PARTICIPANT: Okay

INTERVIEWER: Okay

PARTICIPANT: Not a problem.

INTERVIEWER: Alright, so first question, were just required to ask: are you male, female, or other?

PARTICIPANT: Female.

INTERVIEWER: Okay. Your household income, would you say is from zero to nineteen thousand, twenty to thirty-nine thousand, forty to fifty-nine thousand, sixty to seventy-nine thousand, eighty to ninety-nine thousand, one hundred to one hundred and forty-nine thousand, or above one fifty?

PARTICIPANT: The second one, whatever it was.

INTERVIEWER: Twenty to thirty-nine?

PARTICIPANT: Yeah

INTERVIEWER: Okay. Your race: what is your race?

PARTICIPANT: Caucasian.

INTERVIEWER: Caucasian okay, your education: did you have some high school, high school diploma, some college, Associates, Bachelors, Masters, Doctorate, other?

PARTICIPANT: I have a doctorate degree.

INTERVIEWER: Oh, okay. How old are you?

PARTICIPANT: 51

INTERVIEWER: Were you born blind or did you develop it during your life?

PARTICIPANT: I lost my sight when I was 11 months old.

INTERVIEWER: 11 months.

PARTICIPANT: Yeah, retinal blastoma.

INTERVIEWER: Okay, retinal blastoma. Alright, what do you struggle most with when navigating through your surroundings?

PARTICIPANT: Im sorry, what?

INTERVIEWER: What do you struggle most with when navigating through your surroundings?

PARTICIPANT: In terms of...what do you mean?

INTERVIEWER: So just when youre traveling day to day, what are the biggest issues you have when youre navigating?

PARTICIPANT: Im also partially deaf, so my biggest issue would be traffic noises/background noises.

INTERVIEWER: What issues do you have....

PARTICIPANT: Crossing the street, and yeah.

INTERVIEWER: So, do you have any issues that are specific to the blindness? Whats difficult because you are blind?

PARTICIPANT: Okay, probably the most difficult thing is....I have difficulty with reversing route.

INTERVIEWER: Reversing? Okay.

PARTICIPANT: If I get somewhere, I have difficulty with reversal. It takes me a little while to figure out how to get back from somewhere. So that could be an interesting thing, even if Im inside the building, or inside of a room, I have to really sit and think about how things are...you know in relation to where they were, because I have difficulty with reversal.

INTERVIEWER: Okay, do you currently use any assistive devices to navigate? If so, what?

PARTICIPANT: [indiscernible noise]

INTERVIEWER: Hello?

PARTICIPANT: For example, I went to the vet office this morning. Typically, when I go in, the bench that I sit on is with the door on my left, with the outside door on my left. When I came out of the...when I came to go outside, I sat down on the bench and it put the door, the outside door on my right, but I would have normally sat on the other bench across, with the door still on my left. So, I had to think about, okay where are you, why is that door on your left, because the outside door should be on your left, and then I remembered Im sitting on the bench afterward, and thats why the door is on my left.

INTERVIEWER: Okay.

PARTICIPANT: I have difficulty with reversal, so thats my main difficulty in navigating.

INTERVIEWER: Okay, thats understandable. Do you currently use any assistive devices to navigate? If so, what?

PARTICIPANT: I use a guide dog, and a GPS system on my [indiscernible].

INTERVIEWER: GPS on your what?

PARTICIPANT: GPS on the [indiscernible]?

INTERVIEWER: Im sorry say that last word again?

PARTICIPANT: The [indiscernible], that connects to the [indiscernible]

INTERVIEWER: So you dont use the white cane right?

PARTICIPANT: Well, no I used to, and then I got a guide dog.

INTERVIEWER: So, what is the reason you stopped using the white cane?

PARTICIPANT: I never really liked the cane, and I never really felt as confident with the cane, and I am a dog person. I really like dogs, and I felt like using a dog would give me an independent sense of freedom, and it does. So, Im just still more confident. I am able to travel faster, more...better.

INTERVIEWER: Okay, that sounds good. How important is it for you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: Oh that would be cool. Thats one of the things that...you really have a difficult time...when the dog stops, did it stop for a person or did it stop for an object? Its kind of embarrassing to reach out and...you dont want to feel a person.

INTERVIEWER: Okay.

PARTICIPANT: you just dont want to [indiscernible] detail.

INTERVIEWER: So, you would say its important, or very important, or...

PARTICIPANT: That...itd be really important, itd be extremely important to know if it is an object or person before you touch them.

INTERVIEWER: Yeah. So we plan on creating a navigational device to assist the blind to recognize objects and humans in daily travel. Would you open to using such a device?

PARTICIPANT: Yeah.

INTERVIEWER: Okay. What do you think would be the best way of communicating the information taken from the external environment to the user? So, for example, you can have an option for tactile, or maybe auditory, or maybe a combination of both.

PARTICIPANT: Combination.

INTERVIEWER: Combination, okay. So this device is going to incorporate the Microsoft Kinect, which is a motion sensor system, and the measurements of it are 12 inches by 3 inches by 2.5 inches. There will also be some sort of satchel that you will wear, and in it will contain a tablet that will contain all the information to process the data. So, back to the Microsoft Kinect, which is 12 inches by 3 inches by 2.5 inches, where do you feel would be the best place to put this device on your body? For example, your head, your chest, your waist, some other place in front of you?

PARTICIPANT: I would probably put it on my waist.

INTERVIEWER: Okay.

PARTICIPANT: Yeah. That way it would be easy to access, and easy to...put it on yourself. That would be a little unprecedented on a female.

INTERVIEWER: Okay, yeah yeah yeah.

PARTICIPANT: I would think on your waist, that way you can access it with either hand. A guy could certainly access it with either hand. You could hook it on a belt, and it wouldnt look too abnormal, keep it with pagers, cell phones, and antennae, and anything else on their waist.

INTERVIEWER: Yeah. How comfortable would you be wearing this device on your body?

PARTICIPANT: Well, if it was around the waist I would be totally comfortable. I can keep it with the pagers and cell phones and [indiscernible], and you just things that you would have for a long time, when it lies on the waist, so if it was on my waist, I would be totally comfortable, but if it was on my head, no. Im not going to wear anything on my head.

INTERVIEWER: Yeah.

PARTICIPANT: And Ive seen some of those pyramid things that they sell that you wear on your head, and its like blind people wearing...no Im not going to wear some optical pyramid that sticks out 3 feet on your head no, so yeah. If it was on my waist, I would be totally comfortable.

INTERVIEWER: So do you think this device would efficiently complement...well the question we have in here is efficiently complement a cane or do you feel it would be hindrance, and I guess in your situation, it would be a guide dog.

PARTICIPANT: Im sorry what?

INTERVIEWER: So the question we originally had in here was do you think the device would efficiently complement your cane, or do you feel that it would be a hindrance, and I know you said you use a guide dog.

PARTICIPANT: Oh I think it should be something that have to complement the cane, because some of the stuff use canes.

INTERVIEWER: Do you think it would complement your guide dog?

PARTICIPANT: [indiscernible] whether people canes or guide dogs. Some blind people dont travel with canes, and they can still use that device.

INTERVIEWER: Yeah, all we were getting at is, if somebody does use the cane or another device, and theyre comfortable with it, we just dont want it to get in thats way as well. We only want something that adds to what youre using, as a primary reference, and not something that detracts from it, if you get what Im saying.

PARTICIPANT: Yeah. I mean, I guess it can complement a cane.

INTERVIEWER: Okay, so another question: Lets say you are traveling with the device and you feel a vibration on...a strong vibration on the left side of the body. Do you take that to mean that you should travel towards your left side, or that you should move away from the left side?

PARTICIPANT: I dont know, I mean whatever the vibration is interpreted to mean is what I would interpret it to mean.

INTERVIEWER: Okay. Well, we wanted a component of object avoidance for the device, and so we were just trying to see if...if there was an obstacle in your path, and you felt a vibration on a certain side, would you think that the object is on that side, and you should go away from that side, or do you think that, oh I should move towards that side. Just to get an idea of what someones natural inclination would be when they feel a vibration.

PARTICIPANT: I wouldnt have a natural inclination. If somebody told me that, if you feel a vibration that means you should move away from it, then thats what I would do. If somebody said that if you feel a vibration, youd go towards it thats what I would do. I would do whatever I was taught to do with it.

INTERVIEWER: Okay. Thats fair.

PARTICIPANT: I would do what I was taught to do with the device.

INTERVIEWER: Okay.

PARTICIPANT: Yeah I would not have some natural inclination for the device. I would do what I was taught to do with the device.

INTERVIEWER: Okay. Thats perfectly understandable. Do you have any comments or suggestions regarding the development of this device?

PARTICIPANT: No, have you actually developed it, or...?

INTERVIEWER: Yeah, were in the process of making it. Right now, we would have...what you were talking about before, we have the option of audio, tactile, and a combination of both, because different people have different preferences, so we wanted to make all of those available, and right now were working with attaching straps with a GoPro mount in order to hook it to the body, but yeah were working on creating the device, but we still wanted input from blind individuals.

PARTICIPANT: I guess my only concern about...the audio having it down on the waist is...the person is going to have it up pretty loud to be able to hear or...

INTERVIEWER: Okay. So with the audio, what would happen is there would be some type of earphone, or headphones attached so you have hear it in your ears and not just from the device.

PARTICIPANT: Right, now the problem with that is people dont typically like to have things in their ears. We like to have our ears as [indiscernible] as possible so that we can hear the sounds around us.

INTERVIEWER: Okay.

PARTICIPANT: So, that would be, unless you use those conduction...

INTERVIEWER: What conduction? Sorry?

PARTICIPANT: Something of that nature.

INTERVIEWER: Im sorry, say it again?

PARTICIPANT: The tone conduction earphones? They leave the ear...

INTERVIEWER: Yeah the earphones were

PARTICIPANT: Other sounds around you, because we dont like toe have our ears blocked.

INTERVIEWER: Yeah definitely, the earphones...

PARTICIPANT: My only concern with the audio, and thats one of the reasons that I prefer the Braille-sense GPS, because anything that it says, it also reads it in braille. Now, one of the difficulties of it is that its hard to braille and go down the street.

INTERVIEWER: Just to clarify, the earphones that were looking at they still allow you to hear whats happening outside. They dont block the incoming external environment. But yeah, do you have any other comments, suggestions, or questions?

PARTICIPANT: Have you done research, or are you looking at research with deaf-blind people as well?

INTERVIEWER: Deaf-blind? Not really...[irrelevant information regarding project] [off-topic info regarding deaf-blind people]

PARTICIPANT: I was wondering how much information the tactile would elicit? Would it elicit the same information as the audio? Or...

INTERVIEWER: Right now...

PARTICIPANT: Would it only be giving out some of the information?

INTERVIEWER: So, for right now what were looking at....we want to add more features, but for right now what were looking at is the audio will help you with object avoidance, and it will also help you with object recognition, and tactile will help you with object avoidance; and the combination of both will give you object avoidance through a tactile version, and it will help you recognize objects through the audio version, like it will tell you what object is in front of you.

PARTICIPANT: Okay. What is this...what would this do? Just basically tell you about objects in front of you?

INTERVIEWER: So, for the combination version: if a person is walking and lets say a vibration meant avoid. So if they felt a strong vibration on their left side, they would know to avoid the left side because theres some obstacle in their path that way, and then they would move away, and the vibration will get fainter and stop. But, if you were trying to recognize an object, you can initiate this yourself, you would click some sort of button, I guess, to see which object...if you want to know which object is in front of you, and then the device would go through its library and identify what object is in front of you. If you wanted to know, its not just going to automatically identify everything in front of you unless you want it to.

PARTICIPANT: Okay.

INTERVIEWER: Yeah.

PARTICIPANT: Alright. Well, thats cool.

INTERVIEWER: Well, do you have any other suggestions or questions?

PARTICIPANT: No, thats pretty much it, I think for the questions.

INTERVIEWER: Okay. Thank you so much for your participation, and have a good day?

PARTICIPANT: Alright, youre welcome, and good luck!

INTERVIEWER: Thank you! Bye.

PARTICIPANT: Okay, take care. Bye bye.

Subject 20

PARTICIPANT: [name redacted]

INTERVIEWER: Hi, [name redacted], this is [name redacted], we had an interview scheduled for today?

PARTICIPANT: Oh right.

INTERVIEWER: Are you able to do it now?

PARTICIPANT: Yeah.

INTERVIEWER: Okay, just before we start, I just want to let you know that this is completely confidential. You're just tied to a participant number, so no one will know any of this information is about you specifically, and our conversation is being recorded so I can transcribe it later. Is that okay?

PARTICIPANT: Okay.

INTERVIEWER: The first question: were just required to ask: do you consider yourself male, female, or other?

PARTICIPANT: male

INTERVIEWER: Okay. Your household income: would you say that its zero to nineteen thousand, twenty to thirty-nine thousand, forty to fifty-nine thousand, sixty to seventy-nine thousand, eighty to ninety-nine thousand, one hundred to one hundred and forty-nine thousand, or above one hundred and fifty thousand.

PARTICIPANT: The lowest, zero to nineteen I guess

INTERVIEWER: Your race: whats your race?

PARTICIPANT: Medium white

INTERVIEWER: Okay. And your education: is it some high school, high school diploma/GED, some college, Associates, Bachelors, Masters, Doctorate, or other?

PARTICIPANT: Bachelors

INTERVIEWER: Okay. How old are you?

PARTICIPANT: 44

INTERVIEWER: 44? Okay. Were you born blind or did you develop it during your life?

PARTICIPANT: At the age of 2.

INTERVIEWER: Im sorry, can you repeat that?

PARTICIPANT: At the age of 2.

INTERVIEWER: What caused your blindness?

PARTICIPANT: Retinal deterioration.

INTERVIEWER: What do you struggle most with when navigating through your surroundings?

PARTICIPANT: I dont know. I guess uncertainty, change, and changing environment possibly. A safe thing to offer now that I think about it.

INTERVIEWER: Do you currently use any assistive devices to navigate? If so, what?

PARTICIPANT: Not a thing

INTERVIEWER: So you dont use a cane or anything?

PARTICIPANT: Oh, sorry [unrelated] I do have white cane, so I do do that.

INTERVIEWER: Do you use any apps on a phone or anything like that?

PARTICIPANT: Not at this time. Not yet anyway.

INTERVIEWER: Okay. In the past, have you utilized any assistive devices, and if so why did you stop using it or them?

PARTICIPANT: Its...sound is a little unclear...if I changed the equalization over here. I missed a few of those words.

INTERVIEWER: In the past, have you utilized any other assistive devices? If so, why did you stop using it or them?

PARTICIPANT: Ive never used anything for navigating or anything else. Actually there was something that...it was kind of something that existed, sort of like an awkward, slightly heavy box that you wore around your neck, probably the size of a big paper bag, but heavier, so the light house for the blind, where I lived offered that; something one could borrow, so that was cool, but yeah they just never seemed to be too much need for...now that I think about it, I had a dog, I dont know if that counts.

INTERVIEWER: Wait, Im sorry, for your box that you wore, what was the reason you stopped using it?

PARTICIPANT: Reason for using it?

INTERVIEWER: Reason you stopped.

PARTICIPANT: No reason. Its so boring. This is not something that I own, this is something that they allowed me to use just for fun or just for reason at all. This wasnt yesterday; this was like 40 years, like 30-35 years ago.

INTERVIEWER: Okay. You said you had a dog before? Why did you stop using that?

PARTICIPANT: Well, it was never really mine to begin with.

INTERVIEWER: Okay. Did you like it?

PARTICIPANT: Mh? Did I like it?

INTERVIEWER: Yeah for navigation?

PARTICIPANT: Uhm. It was okay. It was okay.

INTERVIEWER: Okay. How important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: Uhm. Depends. Thats a, you know. It may or may not help. Yeah I mean, you know, its going to be what I will be doing, you know. Probably theres sometimes when these devices could be distracting than listening harder and better could really be a good thing.

INTERVIEWER: So we plan on creating a navigational device to assist the blind to recognize objects and humans in daily travel, would you be open to using such a device?

PARTICIPANT: I certainly might, you know. Things cost money though and whether or not I would definitely have that available is hard to say. But, yeah there are things that these devices may help with. Having

something overhead, is usually not an issue but in theory if there are times when it might be more of an issue or having sudden job loss that are more than 5 or 10 inches. Much of that.

INTERVIEWER: Okay so, what do you think would be; if you were to use our device, what do you think would be the best way of communicating the information taken from the external environment to you, the user. For example, would you like a tactile version, audio or a combination of both?

PARTICIPANT: Yeah. Thats a good question. Actually, you know.

Combination of both let me answer that question first. To go back to a previous question for a second. Sorry about that. Cant be helped or at least couldnt be helped for my case at least, I use to use a brail compass for a little while. I was doing pet care for someone, living at their house, and wanting to give them a good experience walking these cute little dogs. So, I used it because, depending on my years alone, my years and my wits alone didnt seem to be working and I stopped using it because I just wasnt in that kind of situation anymore where I really needed it. But I still have it.

INTERVIEWER: Okay. Hold on one second. Okay so, next question, the device that we are creating is going to incorporate the Microsoft Kinect which is a motion sensor system that is 12 inches by 3 inches by 2.5 inches and there is also going to be a satchel in order to potentially strap on to you and then inside of it, the satchel would be a tablet which would be processing the data the Kinect is receiving. But back to the Microsoft Kinect, which is 12 inches by 3 inches by 2.5 inches, where do you feel would be the best place to put it on your body in front of you. For example, your head, your chest, your waist, what do you think?

PARTICIPANT: It would have to be in front of us?

INTERVIEWER: Say it again, sorry?

PARTICIPANT: It would have to be in front of us.

INTERVIEWER: Yeah.

PARTICIPANT: Uh. Gee, I dont know. Yeah, Im not sure.

INTERVIEWER: So if you were just thinking of that devices of those measurements. Maybe on top of your head, maybe on your chest, maybe on your waist. What could possibly come to your mind as an option?

PARTICIPANT: Yeah. Geez, I think any of them might be, might constitute as improvement in some cases.

INTERVIEWER: Where? Sorry.

PARTICIPANT: Yeah, I guess...theres a way tot put it on around ones waist that might...be comfortable.

INTERVIEWER: The waist? Okay. How comfortable would you be with wearing this device on your body?

PARTICIPANT: Well, off the top of my head it seems rather large, so not very.

INTERVIEWER: Do you think that this device would efficiently complement a cane or do you feel that it would be a hindrance?

PARTICIPANT: Just same. Im sure there are situations where it really would complement the cane. Theres probably situations where wed be better off with just a cane.

INTERVIEWER: Another question: Lets say that you are walking somewhere and on your left of your device...on the left side of your body you feel a vibration...a strong vibration. Would you take that vibration on the left side of your body to mean that you should go towards the left side or so that you should avoid the left side?

PARTICIPANT: Well, I dont know. It depends on what weve been taught, or what our past is maybe.

INTERVIEWER: So you have no natural inclination, to move one way or another?

PARTICIPANT: To go toward maybe...yeah. Right.

INTERVIEWER: So if you felt a vibration on your left side, you would go towards it?

PARTICIPANT: Right. So in other words, if it was an edge that I didnt want to fall off of and that was on my left, Id want the vibration to be on my right, to like nudge me away from the left. I would see it as making sense for me.

INTERVIEWER: Okay. Thats understandable. Do you have any other comments, questions, or suggestions about the development of this device?

PARTICIPANT: Yeah I think thats about it for the device.

INTERVIEWER: Okay. Well, thank you so much for taking the time to interview with me today. We will be emailing in the future, probably the fall about testing the device. So, if by any chance youre interested, we can always be in contact with you, and thank you for your time.
[rest of conversation is irrelevant to study]

Subject 21

PARTICIPANT: This is [name redacted].

INTERVIEWER: Hi [name redacted], this is [name redacted]. We had an interview scheduled today for 3?

PARTICIPANT: Oh, yes!

INTERVIEWER: Are you free to do it right now?

PARTICIPANT: Yes.

INTERVIEWER: Okay, cool. So, before I get started, I just want to let you know that I am recording this conversation so that I can transcribe it later, and also that all your information is completely confidential. You are only tied to a participant number, so no one is going to know that any of this information is about you specifically.

PARTICIPANT: Okay.

INTERVIEWER: Okay. Alright so first question we have to ask: do you identify yourself as male, female, or other?

PARTICIPANT: male

INTERVIEWER: Okay. Your household income: zero to nineteen thousand, twenty to thirty-nine thousand, forty to fifty-nine thousand, sixty to seventy-nine thousand, eighty to ninety-nine thousand, one hundred to one hundred and forty-nine thousand...

PARTICIPANT: Sixty to...

INTERVIEWER: Sorry?

PARTICIPANT: The sixty to seventy nine.

INTERVIEWER: Okay. What would you say your race is?

PARTICIPANT: Caucasian

INTERVIEWER: Okay. Your highest level of education so far?

PARTICIPANT: College graduate: Bachelors degree.

INTERVIEWER: Bachelors...okay. And how old are you?

PARTICIPANT: 43

INTERVIEWER: Were you born blind or did you develop it during your life?

PARTICIPANT: I developed it during my life.

INTERVIEWER: What age?

PARTICIPANT: 33

INTERVIEWER: And what caused your blindness?

PARTICIPANT: Retinal detachment and cataracts.

INTERVIEWER: Alright. What do you struggle most with when navigating through your surroundings?

PARTICIPANT: Probably, anymore its...traffic and limbs...

INTERVIEWER: Traffic and what? Sorry.

PARTICIPANT: Tree limbs and stuff. Hanging over the side in the mornings.

INTERVIEWER: Okay. Did you say overhangs?

PARTICIPANT: Yeah. When they hang over the sidewalk; they hit you in the face.

INTERVIEWER: Okay. Do you currently use any assistive devices to navigate? If so, what?

PARTICIPANT: I use a guide dog.

INTERVIEWER: Okay. And in the past, have you utilized any other assistive devices, and if so why did you stop using it or them?

PARTICIPANT: I used mostly GPS type devices. I think it was called Voice Sense or something?

INTERVIEWER: Why did you stop using it?

PARTICIPANT: The only problem with GPS is when you have the headphones in, you cant hear the traffic patterns, so...

INTERVIEWER: Okay. So, have you ever used anything like the white cane?

PARTICIPANT: Yeah, yeah.

INTERVIEWER: And why did you stop using that?

PARTICIPANT: I like the freedom the guide dog give me, and I still use the white cane from time to time.

INTERVIEWER: Okay.

PARTICIPANT: Technically, you have to do one before you can do the other. So you have to use the white cane before you can progress to a guide dog.

INTERVIEWER: Okay. Alright, how important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: I think it would be very useful.

INTERVIEWER: Okay. And we plan on creating a navigational aid device to assist the blind to recognize objects and humans in daily travel. Would you be open to using such a device?

PARTICIPANT: Id be open to experimenting with it, seeing how it worked, yeah.

INTERVIEWER: Okay. Alright, so what do you think would be the best way of communicating the information taken from the external environment to the user. For example: tactile, auditory, or a combination of both?

PARTICIPANT: I think a combination of both.

INTERVIEWER: Okay. So, our device would incorporate the Microsoft Kinect, which is a motion sensor system that is 12 inches by 3 inches by 2.5 inches, and there would also be a satchel in which would carry a tablet that would process all the data from the Kinect. Where do you feel would be the best place to put the Kinect, the Microsoft Kinect which is 12 inches by 3 inches by 2.5 inches on you body, in front of you. For example: your head, your chest, your waist?

PARTICIPANT: I think probably the chest area, somewhere in there.

INTERVIEWER: Okay, and how comfortable would you be wearing this device on your body?

PARTICIPANT: I guess wardrobe-wise I wouldnt care. I mean, Id be fine with it.

INTERVIEWER: You said if you had a wardrobe on?

PARTICIPANT: I said if it works I dont care how it looks. Thatd be fine with me.

INTERVIEWER: Okay. Alright, do you think this device would efficiently complement a cane or do you feel that it would be a hindrance?

PARTICIPANT: I think it would complement it.

INTERVIEWER: Okay, yeah thats what were aiming to do. Because we dont want to take anything away from anyone. So another question: lets say youre walking and you feel a vibration on your left side from the device, a strong vibration. Would you take that as a natural inclination to move towards the left side or move away to the right side?

PARTICIPANT: I think Id move to the right.

INTERVIEWER: Okay, so you would avoid the side. Okay.

PARTICIPANT: Yeah.

INTERVIEWER: And do you have any other questions, comments, or suggestions regarding the development of this device?
PARTICIPANT: Not right now off the top of my head.
INTERVIEWER: Okay. Well, wonderful. Thank you so much for participating in this interview. I really appreciate you taking the time to do this.
PARTICIPANT: No problem!
INTERVIEWER: Okay. Have a good day [name redacted]!
PARTICIPANT: You too!
INTERVIEWER: Alright bye.

Subject 22

PARTICIPANT: Hello
INTERVIEWER: Hi, sorry, can you hear me now?
PARTICIPANT: Yes, I can
INTERVIEWER: Ok, Good. As I was saying before, the conversation is being recorded so that I can transcribe it later.
PARTICIPANT: Ok
INTERVIEWER: And also all of your information is confidential. So, whatever you say won't be tied to you, it will just be tied to a participant number.
PARTICIPANT: That's fine.
INTERVIEWER: So, for the first question before you said you were female, and then, now the second question is about household income. Is your household income 0 to 19,000, 20 to 39,000, 40 to 59,000, 60 to 79,000, 80 to 99,000, 100 to 149,000, or 150 plus?
PARTICIPANT: 100 to 150
INTERVIEWER: Ok. What is your race?
PARTICIPANT: Caucasian. White.
INTERVIEWER: Ok. What is the highest level of education you've had?
PARTICIPANT: Four years of college.
INTERVIEWER: So, a bachelor's degree?
PARTICIPANT: Yes.
INTERVIEWER: Ok. How old are you?
PARTICIPANT: 59.
INTERVIEWER: Were you born blind, or did you develop it during your life?
PARTICIPANT: I was pretty much born blind. Couple of days after, I guess. Pretty much, yeah.
INTERVIEWER: Ok. What caused your blindness?
PARTICIPANT: Retinopathy prematurity.
INTERVIEWER: What do you struggle most with when navigating through your surroundings?

PARTICIPANT: Umm, not being able to know where things are, if its something I'm not familiar with. Like, you know, sighted people can just look around and say 'Oh, there's that building across the street, that's where I need to go.' Routes that are unfamiliar to me, that I don't go very often are the hardest, I think. Not knowing where bus stops are, if its not something I'm familiar with. That's hard.

INTERVIEWER: Do you currently use any assistive devices to navigate? If so what?

PARTICIPANT: You mean like navigation devices?

INTERVIEWER: Hm

PARTICIPANT: I have a guide dog. I don't the only real navigation devices I use are just to tell where I am, when I'm in a vehicle, or something [unintelligible] access. I have several navigation apps on my iPhone that I use. I don't normally plan routes too much, because I really haven't had a need to plan routes in unfamiliar areas. I'll probably do more of that next year. But for right now, I basically use navigation devices so that I can tell where I am, if I'm in a car and letting someone else drive.

INTERVIEWER: Ok. In the past, have you utilized any other assistive devices, and if so, why did you stop using it or them?

PARTICIPANT: It's really been about the same. I haven't really changed my use of navigation devices. I will, as I said, next year I'm gonna retire and I'm going to be doing other things, other than the same routine every day, where I don't need navigational assistance as much. So when I start doing different things on different days, then I'm going to need navigation assistance. So I'll probably have to plan something, different then. But now and in the past, I haven't really changed much.

INTERVIEWER: So, right now, while you're working, are you taking public transportation to work?

PARTICIPANT: I do. I use metro access in the morning, their transit system, in the morning, just because my work is in a crappy neighborhood and I don't want to wander around there 6 o'clock in the morning. But in the afternoon, except when the weather is really hot or really cold, I use the buses and the subways to go home.

INTERVIEWER: Ok. Have you ever experimented with the white cane?

PARTICIPANT: I've been using the guide dog for 30 years. So, its the way that I travel, and I think its a much better way for me. I'm not real comfortable using the cane.

INTERVIEWER: So, I was just curious to know if you've ever used it.

PARTICIPANT: Pardon?

INTERVIEWER: I'm just curious to know if you've ever used the white cane.

PARTICIPANT: Oh yeah, I was trained to. I mean, we all learned it in school. But I was a very poor cane traveler. The instructor gave me a completion certificate because she felt sorry for me, she told me so. I'm much better with a dog.

INTERVIEWER: Can you name for me the specific reason why the cane wasn't working out for you and why the guide dog is better?

PARTICIPANT: I really don't know. I don't think I have a problem with walking straight. I don't know. I guess psychologically I feel less alone with a dog, and I feel more confident. I can walk straight for longer distances, crossing parking lots, the dog has the vision, the dog can see, the dog can find things from a farther distance away than a cane can. My arm gets tired swinging that cane back and forth. I guess I didn't really have the self confidence to be a really good cane traveler. But with a dog you're never alone. So, I'm a much better dog user.

INTERVIEWER: Those are actually very interesting points about the psychological component of having a dog. How important is it to you to have a navigational aide that allows you to identify objects and people in your path?

PARTICIPANT: I would love them; the thing I did with Gemstone before: they were working on a facial recognition device, and I want that. I don't necessarily need it for obstacles in my path because the dog would lead me around them. But what I would need it for more would be obstacles that I was looking for. Like, for example, when I'm at the Glenmont Metro, waiting for my bus, I don't know where the bench is. And I really don't want to follow around, swinging my cane around [unintelligible] use cane for, to find things, swing a cane around, or feel around with my hands, looking foolish and blind, looking for a bench. I would like to know that that bench is 3 feet to my right or 2 feet in front of me or whatever so that I could gracefully find the damn thing. So that's what I would use it for. To find things like that. But obstacles to avoid the dog would find for me. But I really do want facial recognition. I really do. If you're walking down the hall, and someone says Hi [redacted], and then the brain kicks in 3 seconds later Oh, that was so and so. By the time they kick in, they're ten feet down behind you. And you say Oh my god, I wanted to talk to him about that. You know, so if I knew that they were coming ahead of time, I could process it in my head, and it would say Oh, that's so and so, and oh yeah, I wanted to talk to him about such and such. So facial recognition would be really, really useful. That's my thing.

INTERVIEWER: Our device is, our device right now where its at is more focused on just identifying that a person is there, which could be helpful in instances where maybe like you in the mornings aren't in a safe neighborhood.

PARTICIPANT: Yeah, that could be helpful, but also, as a totally blind person who's been blind forever, I don't know whether anyone's brought this up to you, but we have something that we can utilize called facial vision, which is sort of like what bats do: its like sound that echoes off, some people call it echolocation, where you can hear that there's a thing right there. You can't tell whether its a tree or a

person or mailbox or trashcan or pole, it's a thing. You can hear the echoes bouncing off of it. So that you can know that its a thing there. So, we can pretty much do that already. If its close enough, if its like 2 or 3 feet away. You can tell that there's something there.

INTERVIEWER: Yeah. Hopefully we can one day incorporate what their device did into our device as well. So, we plan on creating a navigational device to assist the blind to recognize objects and humans in daily travel. Would you be open to using our device?

PARTICIPANT: I think I would. I'd have to see how it would incorporate with the dog. Because of course I would have to utilize what the dog was telling me first and foremost. Because if the dog says one thing and the navigation device says something else, and I pay more attention to the navigation device than I do the dog, that the dog will start saying "Well, you don't need me then, I'm just gonna goof off here". So, I have to be very careful that what I do doesn't take away from what the dog is trying to do. The partial vision have this problem where they have to make sure that they don't use this too much to the detriment of what the dog is doing. I think that would be my only concern. I think it would probably work better for someone who uses the cane, than it would be for a dog user. But it might be interesting.

INTERVIEWER: Oh okay. So, for our device; what do you think the best way of communicating information taken from the external environment to the user would be? For example: auditory, tactile, or maybe a combination of both?

PARTICIPANT: I think maybe combination, so you can turn on one or the other, or you could maybe use both? Audio youd have to be really careful, because as a blind person you always have to keep your ear open for whats around you anyway even if you do have a device telling you. You still have to listen to whats going on. So, if it was audio, it would have to be in one ear, I think. Tactile would be good also, because if you were in a place where it was really really noisy, you couldnt hear what your device was telling you, and you have the tactile. But then again, if its really really cold, and your hands are frozen, and you cant really feel anything, then you can use the audio. So it would probably be good to have both, so that you can switch on one or the other or both of them, depends on what your environment is like at the time.

INTERVIEWER: Okay yeah. And, what we were thinking with the combination version would be part tactile, part audio. So, maybe audio for object recognition, and tactile for obstacle avoidance.

PARTICIPANT: Well, I think it should be both or either for everything. Because, like I said, if your environment is really noisy, you couldnt use the audio, and if your hands are freezing, you couldnt use the tactile. So, I would think that both of them would be important for

everything. So that you can choose which ones gonna work best in the particular situation.

INTERVIEWER: Okay. You dont think that would be an overflow of information? Maybe?

PARTICIPANT: Well, you could turn one off and use the other.

INTERVIEWER: Yeah. Definitely.

PARTICIPANT: Because I would think anybody would use both of them at the same time.

INTERVIEWER: Yeah

PARTICIPANT: It might be too much. But, it might be good to have the ability to choose one or the other.

INTERVIEWER: Yeah, well what we were thinking was that we would make a tactilethree different versionsnot three different versions, but three different modes you could use on the device. You could use the tactile mode, the auditory mode, and the mode that I was talking about where some of it would beobstacle avoidance would be done through tactile, and recognition would be done through audio.

PARTICIPANT: Okay. Actually there is something similar now, there are these glasses, called iGlasses, the letter iglasses. And where it gets near something, it vibrates. I bought those for my husband because he was always running into poles. So now when hes 2 feet away from a pole, it vibrates, so that he knows that theres a pole there, and he doesnt bash his head as much.

INTERVIEWER: Okay.

PARTICIPANT: So that works. It was about \$120

INTERVIEWER: Okay. Good to know. There's this...so our device is going to incorporate the Microsoft Kinect, which is a motion sensor system that is 12 inches by 3 inches by 2.5 inches. And there would be a satchel in order to put a tablet into so that the data from the Microsoft Kinect can be processed. Where do you feel would be the best place to put the Microsoft Kinect system on the front of your body? And its 12 inches by 3 inches by 2.5 inches.

PARTICIPANT: So it would have to be in the front? I guess if it would have a camera in it, it would have to be.

INTERVIEWER: Yeah. So

PARTICIPANT: Thats pretty big.

INTERVIEWER: So maybe your chest, your head, your waist. What are you thinking?

PARTICIPANT: Well, I dont know. I carry too much stuff anyway. I mean my pocketbook is big, and I got my Apex with me wherever. I dont think Id carry something that big. Maybe I would carry something the size of an iPhone. If it was on a lanyard, you could hang that around your neck. But

INTERVIEWER: This would be strapped on.

PARTICIPANT: Sort of big.

INTERVIEWER: Yeah. If you had to choose, where would you choose?

PARTICIPANT: I would stick it on a backpack.

INTERVIEWER: Okay. Then it cant be on the front of your body.

PARTICIPANT: Well, thats true. Maybe most of the thing can be on a backpack, and the camera thing could be around the front. You could put a wire over your shoulder, and clip that to your collar.

INTERVIEWER: Okay. But it if were the device, where would youthe 12 inch by 3 inch by 2.5

PARTICIPANT: I wouldnt.

INTERVIEWER: Oh.

PARTICIPANT: Frankly, its too big. If I couldnt hook it on a backpack, or something thats out of the way, I wouldnt use something that big. Sorry.

INTERVIEWER: So.

PARTICIPANT: I wouldnt want something that big in the front of me. Its too big. I would need to be a lot smaller.

INTERVIEWER: Okay. Alright. No worries. Do you think that this device would efficientlywell our question was set to ask if it would efficiently complement your cane, or if you feel it would be a hindrance, but I guess with your situation, with your dog

PARTICIPANT: I think it would definitely complement using the cane.

INTERVIEWER: Right. Okay.

PARTICIPANT: Because the cane doesnt

INTERVIEWER: Do what a dog can do?

PARTICIPANT: The navigation is different. The cane doesnt avoid things actively for you. The caneyou have to find things, say if youre going somewhere and someone says turn left after the third pole, you gotta find all those poles with your cane. So, you bang into the first one, you bang into the second, you bang into the third one, and then you turn left. But with a dog, you dont even know those poles are there, because your dog has avoided them for years. So, the way you travel with a cane is completely different[unrelated] Anyway, so the way you travel with a dog is completely different than the way you travel with a cane. So, I would think that with a cane, since youre not avoiding the obstacles, you want to find the obstacles so that you can locate where you are. So I think this kind of device would be good for using a cane more so than using a dog.

INTERVIEWER: Yeah. Okay. So another question: Imagine that you are wearing this device and walking, and you feel a vibration on your left side, a strong vibration, do you take that to mean you should avoid whats on your left side, or that you should go towards whats on your left side?

PARTICIPANT: I would go towards to see what it was.

INTERVIEWER: Okay.

PARTICIPANT: I wouldnt do it with a dog, because the dog would probably avoid it, but if I was using a cane, I would want to know what it was, just because Im a nosy person. I would probably go towards it to see what it was

INTERVIEWER: Okay.

PARTICIPANT: If I had a cane.

INTERVIEWER: Do you have any other comments or questions or suggestions regarding the development of this device?

PARTICIPANT: No. Id be interested to see it. Again, Im not a real good cane user, so I probably wouldnt be the best person for that part of your study. But it would be interesting to see how it works, and to see how it progresses.

INTERVIEWER: Okay. In the Fall, well be sending out emails to see if anyones interested in taking part in the study where the device is developed and we want to test it on an obstacle course indoors. And if youre interested

PARTICIPANT: Again I dont know how Id be able to do that, because with a dogthe dog is going to avoid all that stuff anyway.

INTERVIEWER: Okay.

PARTICIPANT: So, I dont know if thats gonna work for me, and I probably wouldnt go to wherever it is wed have to go without my dog. So, I never travel without my dog.

INTERVIEWER: No worries, no worries.

PARTICIPANT: Yeah

INTERVIEWER: Okay. Thank you so much for interviewing with me today.

PARTICIPANT: Sure!

INTERVIEWER: I appreciate it.

PARTICIPANT: Anytime!

INTERVIEWER: Have a good day.

PARTICIPANT: You too. Thank you.

INTERVIEWER: Bye.

Subject 23

INTERVIEWER: Before we get started, I just wanted to let you know that all of your answers here are confidential. Also, I am recording this conversation so it can be transcribed later.

PARTICIPANT: Alright.

INTERVIEWER: First question, do you consider yourself Male, Female, or Other.

PARTICIPANT: Male.

INTERVIEWER: Your household income, \$0-\$19,000, \$20,000-\$39,000, \$40,000-\$59,000, \$60,000-\$79,000, \$80,000-\$99,000, \$100,000-\$149,000, or \$150,000+?

PARTICIPANT: \$40 to \$59,000
INTERVIEWER: What would you say your race is?
PARTICIPANT: Caucasian
INTERVIEWER: What is the highest education level you have?
PARTICIPANT: Completed B.A. and I attended, but did not complete post graduate.
INTERVIEWER: How old are you?
INTERVIEWER: Hello?
INTERVIEWER: Hello?
PARTICIPANT: Okay
INTERVIEWER: How old are you?
PARTICIPANT: Im sorry, Im 46
INTERVIEWER: Were you born blind or did you develop it during your life?
INTERVIEWER: Hello?
INTERVIEWER: Hello?
PARTICIPANT: Born
INTERVIEWER: What caused your blindness?
PARTICIPANT: Congenital glaucoma
INTERVIEWER: What do you struggle most with when navigating through your surroundings?
PARTICIPANT: Uhm, probably unfamiliar surroundings. Especially if they are complex and not well, if they lack sidewalks, curbs, and if Im not familiar with them, thats probably the hardest.
INTERVIEWER: Do you currently use any assistive devices to navigate? If so what?
PARTICIPANT: I use apps on my iphone.
INTERVIEWER: Do you use a white cane?
PARTICIPANT: Oh yea, I use actually a guide dog and a white cane, depending on where Im going.
INTERVIEWER: So, are you saying sometimes you use a white cane and sometimes you use a guide dog? Or do you use them in combination?
PARTICIPANT: Oh no sometimes, predominantly guide dog, occasionally the white cane.
INTERVIEWER: In the past have you utilized any other assistive devices? If so why did you stop using it/them?
PARTICIPANT: Uhm, I experimented with somebodys trecker, and I didnt like it. It was just too big, and something extra to carry
INTERVIEWER: How important is it for you to have a navigational aid that allows you to identify objects and people in your path?
PARTICIPANT: I would say not important. When you say in my path, I assume you mean people and obstacles to avoid, and I would say not important.
INTERVIEWER: Okay. Uhm, that and also if there is something that you want to recognize as well. Object recognition.
PARTICIPANT: Object or place?

INTERVIEWER: Object

PARTICIPANT: I would say somewhat important. It depends on the object, but not too much.

INTERVIEWER: Okay

PARTICIPANT: There are certain objects that would be nice to find. Finding the ATM would be nice, finding the ticket machines on train would be nice. But other than that I would say no.

INTERVIEWER: Okay, we plan on creating a navigation device to recognize objects and humans during travel. Would you be open to using such a device?

PARTICIPANT: Probably for routes of memorization. But otherwise I would probably only use it for new routes, or when I wanted to learn something.

INTERVIEWER: Alright, what do you think would be the best way of communication information from the environment to the user. For instance auditory, tactile, or both?

PARTICIPANT: Auditory.

INTERVIEWER: Ok, this device is going to incorporate the Microsoft Kinect, which is a motion sensor system that is 12 inches by 3 inches by 2.5 inches and there will be a satchel in order to carry a tablet, which will contain that information and process the data. Where would you feel would be best place to put the Microsoft Kinect which is again, 12 inches by 3 inches by 2.5 inches on your body for example you head, your chest, your waist, or something else?

PARTICIPANT: I would probably carry it again for flexibility, again, my intention would probably be to use it only intermittently. So if I had to have it attached to myself, I dont know how its oriented, but if it didnt matter, Id like to hang it off my belt clip. If it had to be oriented in a certain way, Im not sure.

INTERVIEWER: If it had to be oriented in front of you, where would you prefer it located, head, chest, or waist?

PARTICIPANT: Probably waist.

INTERVIEWER: How comfortable would you be wearing this device on your body?

PARTICIPANT: Probably not.

INTERVIEWER: Do you think this device could efficiently compliment your cane, or do you think it would be more of a hindrance?

PARTICIPANT: I think it could compliment it in the right situation, for example if it were being used to familiarize with a new route, you would already be going slower, being less efficient with time, but that would be fine. I wouldnt use it in areas Im already familiar with?

INTERVIEWER: If you hear a click on your left side, do you take that to mean there is an obstacle on your left, or that you should go left?

PARTICIPANT: I dont know. I figure I could be taught either way, I dont have an immediate reaction to that.

INTERVIEWER: Do you have any other comments or suggestions regarding the development of this device?

PARTICIPANT: I wouldnt use earphones. It just creates other distractions.

Subject 24

INTERVIEWER: Before we get started, I just wanted to let you know that all of your answers here are confidential. Also, I am recording this conversation so it can be transcribed later.

PARTICIPANT: Alright.

INTERVIEWER: First question, do you consider yourself Male, Female, or Other.

PARTICIPANT: Female.

INTERVIEWER: Your household income, \$0-\$19,000, \$20,000-\$39,000, \$40,000-\$59,000,\$60,000-\$79,000, \$80,000-\$99,000, \$100,000-\$149,000, or \$150,000+? Household income?

PARTICIPANT: I think uhm, probably \$40 to \$59,000

INTERVIEWER: What would you say your race is?

PARTICIPANT: Native American

INTERVIEWER: What is the highest education level you have?

PARTICIPANT: I have a bachelors degree.

INTERVIEWER: How old are you?

PARTICIPANT: Im 65. Ill be 66 in September

INTERVIEWER: Were you born blind or did you develop it during your life?

PARTICIPANT: I was born with Congenital Glaucoma but had usable vision until about age 8.

INTERVIEWER: So congenital glaucoma?

PARTICIPANT: I had it as an infant, and my parents were told Id be blind by age ten.

INTERVIEWER: So you were completely blind by age 8?

PARTICIPANT: Between my eighth and ninth birthdays.

INTERVIEWER: What do you struggle most with when navigating through your surroundings?

PARTICIPANT: Uhm, unexpected things that werent there the last time I went that way. It could be anything from a tricycle on the sidewalk or a trash can out on trash day. Things that have been moved or added.

INTERVIEWER: Do you currently use any assistive devices to navigate? If so what?

PARTICIPANT: I am a white cane user, and I also use a guide dog. I prefer a guide dog, but I am experienced with a cane.

INTERVIEWER: So you said you use the guide dog mostly but you can also use the white cane?

PARTICIPANT: Im a good cane traveler, but the reason I am good, is that one everything I can process, set down just beneath my feet, shadow and sunlight, wind, anything I can process to assist me in travel. And that is tiring if I have a complicated route to go, or a new route, I have to rely on the white cane. With a guide dog I can relax and focus on the mental mapping part, when to turn, that kind of thing.

INTERVIEWER: In the past have you utilized any other assistive devices? If so why did you stop using it/them?

PARTICIPANT: No, I havent mostly because they have been unaffordable.

INTERVIEWER: Ok, so you dont use the cane very much anymore because you dont have to put as much work in when you use the dog, correct?

PARTICIPANT: Yes, yes.

INTERVIEWER: How important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: Uhm, I am concerned because at my age, mobility impairment might be coming up, so that I might have to navigate with a walker or even from a wheel chair, and there isnt really a good way for a visually impaired person to handle those situations. Potentially there will come a day when I will not be able to use a guide dog, I will go back to my cane, or use something for mobility impairment, that will add another level of complexity to my ability to maintain my independence.

INTERVIEWER: So, before the walker stage, I guess, how important is it for you to have an aid that allows you to identify objects and people in your path?

PARTICIPANT: At this time, its not really an issue. I am an excellent cane traveler, and an excellent guide dog user. And Im also a person who does not allow my, its hard to inhibit me in things I have to get done. The only thing that it inhibits is, uhm, my level of energy that day. If I have to walk a complicated route for 20 minutes and catch a bus and end up in an unfamiliar area, and end up at an apartment of some kind, I can do that most days, but on days where I may have a slight cold or back pains, or other issues that impinge my focus, that isnt something that I will do unless I absolutely have no other option.

INTERVIEWER: Were also working our device into handling overhanging objects, so would you be open to using such a device?

PARTICIPANT: Drop offs would also be important. At a conference with many visually impaired people, a man was walking towards me with a white cane, employing it incorrectly, and he fell down some stairs.

INTERVIEWER: So definitely noticing staircases are important to you?

PARTICIPANT: Yes, yes.

INTERVIEWER: Okay, we plan on creating a navigation device to recognize objects and humans during travel. Would you be open to using such a device?

PARTICIPANT: Sure, especially if I am needing to use a walker or a wheel chair. At some point, Im gonna need some way to find out what is in

front of me. Especially then, because if I am using a walker, because if my walker goes over a curb and I'm using it for balance, that's not gonna be a pretty thing.

INTERVIEWER: Yeah that's an interesting case, because originally we hadn't considered issues like that which you just mentioned.

PARTICIPANT: I'm almost in an alley with my flexibility at this point, after a lifetime of a person who moves a lot, you know walks a lot and is physically fit. But I'm reaching the point where that is not going to be the case.

INTERVIEWER: So what do you think is going to be the best way to communicate taken from the external environment to the user? Auditory, tactile, or a combination of the both?

PARTICIPANT: I think it would have to be a combination of the both, because this population tends to have hearing loss, which also affects mobility. Because you can't hear directionally anymore, because the hearing loss in one ear or whatever that seriously impacts your mobility. Also the device that you have, if you would have to use protection with it, it should be one of the new types of things like Aftershock is the company that produces an open-ears headset that lets your cheekbones and further opens your ears so that you can hear a broadcast and ambient noise around you.

INTERVIEWER: The headset we were looking at, I think they are called air dries, because they said they allowed you to process ambient noise as well, so we definitely considered that as well.

INTERVIEWER: Ok, this device is going to incorporate the Microsoft Kinect, which is a motion sensor system that is 12 inches by 3 inches by 2.5 inches and there is also gonna be a satchel that you would wear in order to carry a tablet which will process all the data from the Kinect. Where do you think would be the best place to put the Microsoft Kinect which is again, 12 inches by 3 inches by 2.5 inches on your body for example your head, your chest, your waist, or something else?

PARTICIPANT: I would probably suggest wearing it on the belt or on the collar for whatever reason, so you can get overheads or whatever, or maybe something that goes over your shoulder and across your body and place it in the middle of your body. Does that make sense?

INTERVIEWER: So chest? Or waist?

PARTICIPANT: I'd say either the chest or the waist. Something that centers it on your body.

INTERVIEWER: We are looking at something called the GoPro mount, which is a set of straps. And we were thinking about mounting the Kinect on that and centering it on your chest. How comfortable would you be wearing this device on your body?

PARTICIPANT: I'm used to being creative about how I have to carry things, I have lower back issues.

INTERVIEWER: So if it works, you're comfortable with it?

PARTICIPANT: Yes

INTERVIEWER: Do you think this device could efficiently compliment your cane, or do you think it would be more of a hindrance?

PARTICIPANT: Oh Im sure it would be a good thing actually, especially for the ability for processing information is so much higher that perhaps your device could even do some things like recognize your friends, so it can find some people youre looking for.

INTERVIEWER: Facial recognition.

PARTICIPANT: You know, right now when youre in a large crowd of people and stuff, I have a hard time. People dont like being hit by a cane or being stepped on

INTERVIEWER: So another question, lets imagine you are walking with our device and the device makes you feel a vibration on your right side? Would you take that to mean there is an obstacle on your right side or that your right side is safe to go? What is your natural inclination to a vibration on your right side?

PARTICIPANT: Move away. Move away to the left. Perhaps reach out and identify what it is, if Im using my cane. Or use my hand to determine whats there.

INTERVIEWER: Yeah definitely because most people we talked to, since were working on the obstacle avoidance part of the device. Most people we talked to said they would walk away from the vibration. So now we know how to tailor the device.

INTERVIEWER: Do you have any other comments or suggestions regarding the development of this device? I know you had your mention about the stairs and actually able to have facial recognition. Anytihng else youd want to add?

PARTICIPANT: Well it would be nice if you could have it alert you to things that you need for direction determination.

INTERVIEWER: Im sorry, you said that it would be nice if it recorded what?

PARTICIPANT: Way-finding points. Maybe record an announcement that tells you, youre at 4th and 10th street and youve reached the corner of 4th and 10th. Things like that.

INTERVIEWER: So GPS type things.

PARTICIPANT: It would be nice to have information about intersections, about where I am.

INTERVIEWER: Thank you for this information, I will take it back to my team. Have a great day.

Subject 25

INTERVIEWER: Do you have any other questions for me?

PARTICIPANT: I dont think so, no.

INTERVIEWER: Okay, we can get started. We have to ask thi

PARTICIPANT: do you consider yourself male, female, or other?
PARTICIPANT: Male.
INTERVIEWER: Okay. What is your household income? Zero to nineteen thousand, twenty to thirty-nine thousand, forty to fifty-nine thousand, sixty-
PARTICIPANT: uh, twenty to thirty nine.
INTERVIEWER: Okay. Uh, what race would you say you were?
PARTICIPANT: White.
INTERVIEWER: Okay. And what is the highest degree you have obtained?
PARTICIPANT: High School.
INTERVIEWER: How old are you?
PARTICIPANT: uhh 62.
INTERVIEWER: 62?
PARTICIPANT: Yeah.
INTERVIEWER: Alright. Were you born blind or did you develop it during your life?
PARTICIPANT: Prematurely I was born blind. ROP-
INTERVIEWER: And what caused your blindness?
PARTICIPANT: ROP. Retinopathy of prematurity.
INTERVIEWER: Retinopathy-
PARTICIPANT: Yeah, you can put ROP, people should know what that means.
INTERVIEWER: Alright. What do you struggle most with when navigating through your surroundings?
PARTICIPANT: Uh, probably the most biggest things would be, you know, anytime there are traffic detours and finding bus stops in unfamiliar areas. That kind of thing.
INTERVIEWER: Okay. Do you currently use any assistive devices to navigate and if so, what?
PARTICIPANT: Uh, I do have a Seeing Eye dog.
INTERVIEWER: In the past have you utilized any other assistive devices and if so why did you stop using it or them?
PARTICIPANT: Well I used a cane, before I got a dog and between dogs.
INTERVIEWER: And why do you prefer the dog over the cane or why did you stop using the cane?
PARTICIPANT: Yea. The biggest thing for me is the dog is much faster to get around.
INTERVIEWER: Okay
PARTICIPANT: And, I think especially with traffic these days, a lot safer.
INTERVIEWER: Okay
PARTICIPANT: I also do use occasionally- I have a human wear Trekker breeze. I do use that occasionally.
INTERVIEWER: Uh, so you still use the trekker breeze?
PARTICIPANT: Yeah.
INTERVIEWER: Okay. And what...why do you use that?

PARTICIPANT: Um, especially if Im going someplace that Im not familiar with um it can be easy to figure out which direction Im going and where the streets are.

INTERVIEWER: Okay. Alright uhm, how important is it to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: Uh, I would find it pretty useful, I think.

INTERVIEWER: Alright. So what were planning on is creating a navigational device to assist the blind to recognize objects and humans in daily travel. Would you be open to using such a device?

PARTICIPANT: I would.

INTERVIEWER: Okay. Now, what do you think would be the best way of communicating the information taken from the external environment to you, the user? For example, tactile, audio, or maybe a combination of both?

PARTICIPANT: Um, for me probably auditory.

INTERVIEWER: Okay. So the device would incorporate the Microsoft Kinect which is a motion sensor system that is 12 inches by 3 inches by 2.5 inches and there would also be a satchel that you would wear and in it would be a tablet in order to process the data from the Microsoft Kinect. Now, back to the Microsoft Kinect which is 12 inches by 3 inches by 2.5 inches, where do you feel would be the best place in front of you to put the Kinect on your body? For example, your head, your chest, your waist...?

PARTICIPANT: Well, without seeing it its a little hard to say, probably my- probably my chest, yes, but thats just a guess.

INTERVIEWER: Yeah. The way were developing it right now, we have something called a Go-Pro mount which is a set of straps and you would strap it onto your chest. Um, How comfortable would you be wearing this device on your body?

PARTICIPANT: I think pretty comfortable.

INTERVIEWER: Okay. Now, do you think that this device would efficiently complement- okay, so we were mainly looking at cane users, I guess,- so um do you think it would efficiently complement your cane or do you feel that it would be a hindrance?

PARTICIPANT: Well, where I would want to use it would be especially in unfamiliar areas say finding a bus stop or something like that. Maybe finding a door to a building. Probably wouldnt use it that much for identifying people, I dont think.

INTERVIEWER: Okay. So....you dont think it would complement a cane or..?

PARTICIPANT: Oh, I do, Im just thinking in terms of the way I would use it. Yeah, depending on what it identified I could see lots of possible uses for it.

INTERVIEWER: Okay. Right now, the two main functions of it would be object avoidance and recognition.

PARTICIPANT: Yeah, avoidance with a cane would be especially useful. With a dog, not so much.

INTERVIEWER: Yeah. So, another question: Lets say that you were walking with this device and you feel a vibration or maybe if youre using the audio version you hear a lot of beeps and more intense beeps or you feel an intense vibration on your right side. Would you take that- in your natural inclination, would you take that to mean go towards your right side or move away from your right side?

PARTICIPANT: I would take that that theres something on the right side that should be avoided, thats how I would interpret it.

INTERVIEWER: And do you have any other comments or suggestions regarding the development of this device?

PARTICIPANT: Not off hand, the one thing I can think of for a cane user would be handy perhaps avoiding the stairs or something like that could be useful.

INTERVIEWER: Yeah, Definitely, a valid point. Well, thank you so much for your input, its been very helpful.

PARTICIPANT: Sure

INTERVIEWER: Have a good rest of the day.

PARTICIPANT: When you have more information, Id certainly be glad to receive an email.

INTERVIEWER: Yes, um, on your consent form did you fill out that you would be open to coming for testing?

PARTICIPANT: Im not sure how feasible that is given that [retracted]. If theres a way, certainly.

INTERVIEWER: Well probably emailing people in the fall just to see for their interest for coming out to test the device; I know its not feasible for you [retracted]. If you want any other updates as well, you have my email, so just let me know.

PARTICIPANT: Okay.

Subject 26

INTERVIEWER: Ok, can you hear me fine?

PARTICIPANT: Yes.

INTERVIEWER: Alright, so...um, first question we have to ask: do you consider yourself male, female, or other?

PARTICIPANT: Male

INTERVIEWER: Okay. Household income...would you say is 0-19,000; 20-39,000; 40-59,000; 60-79,000; 80-99,000; 100-149,000; or 150,000 plus?

PARTICIPANT: 40-59,000

INTERVIEWER: Okay. Um, what is your race?

PARTICIPANT: African-American.

INTERVIEWER: Okay. (Pause) And what is your education level, your highest degree that you have obtained?

PARTICIPANT: Bachelors.

INTERVIEWER: Okay. And how old are you?

PARTICIPANT: 57.

INTERVIEWER: (Echoing) ...57.

INTERVIEWER: Were you born blind, or did you develop it [blindness] during your life?

PARTICIPANT: Eight years old.

INTERVIEWER: (Echoing) Eight years old.

INTERVIEWER: And what caused you to go fully blind?

PARTICIPANT: Glaucoma.

INTERVIEWER: (Echoing) Glaucoma...

INTERVIEWER: And what do you struggle most with when navigating through your surroundings?

PARTICIPANT: Uh...Addresses, mainly.

INTERVIEWER: Addre...[cut off]...like, finding places?

PARTICIPANT: I think, unfamiliar places, yeah.

INTERVIEWER: Okay. (pause) Alright, and do you currently use any assistive devices to navigate, and if so, what?

PARTICIPANT: I use a cane.

INTERVIEWER: Alright, and in the past have you utilized any other assistive devices and if so, why did you stop using it or them?

PARTICIPANT: Say that again?

INTERVIEWER: Uh, in the past have you utilized any other assistive devices and if so, why did you stop using it or them?

PARTICIPANT: Uhhh...(drawn out) I think the cane is the only thing Ive used. I use the (inaudible) thing now, Ive tried to learn the GPS thing on the iPhone.

INTERVIEWER: So you currently use the GPS thing, you havent stopped using it?

PARTICIPANT: I havent figured out how to use it yet, but Im uh...I can at least uh...I figured out how to use it when Im in a car with somebody, how to do that. But I havent figured out how to do the walking directions for it.

INTERVIEWER: Okay, Okay.

PARTICIPANT: And I can use the points of interest for the area.

INTERVIEWER: Okay, so you havent used certain apps on the iPhone because they might be complicated to understand or...?

PARTICIPANT: I just..I just havent gotten around to it, because I dont need to.

INTERVIEWER: Okay, okay. Um...How important is it to...to you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: Ummm...objects and people in my path? Um, I think Im more interested in finding places...than anything. I think that...uh...

INTERVIEWER: (interrupting) Okay...so...

PARTICIPANT: You know, when you live in an urban area, its pretty hard...I was gonna say why I was gonna (inaudible)...in the [urban] area, I think it would just make you crazy if youre trying to identify people because theres people all around you anyway; I live in a big city...or near a big city. So, uh...I would say that its more important in terms of finding places...are more important.

INTERVIEWER: Okay, thats fair. So my next question...well, I probably can predict your answer...um, we plan on creating a navigational device to assist the blind to recognize objects and humans in daily travel. Would you be open to using such a device?

PARTICIPANT: Identifying humans...Identifying humans as obstacles, or identifying humans in terms of people in general?

INTERVIEWER: Just um, just to recognize objects and also just to recognize if a human is there, because we know that some blind people say that...

PARTICIPANT: (interrupting) An obstacle.

INTERVIEWER: I guess. But I mean, I guess some people just say...some blind people have mentioned that they just would like to know if another person is in the room with them and theyre not alone or something like that,

PARTICIPANT: Yeah, I guess Ive never thought about that, Ive never worried about that. Yeah, Im not...Yeah, no, I dont think Id worry about that as much. I think the obstacle thing could be helpful too, I think that...that probably could be something thats helpful. I mean, I dont worry about people and you know...that...would I be interested in using something like that?

INTERVIEWER: Yeah, would you be open to using it?

PARTICIPANT: Id be open.

INTERVIEWER: Okay. And what do you think would be the best way of communicating the information taken from the external environment to the user? So, for example, tactile, auditory, or maybe a combination of both?

PARTICIPANT: I think tactile is better, I just think that having one more thing chirping at us is not...is a little too distracting.

INTERVIEWER: Yeah, definitely understandable.

PARTICIPANT: Yeah, I just dont think we need anything more chirping...you know, one more thing yelling at us.

INTERVIEWER: Yeah.

PARTICIPANT: Thats just my opinion, and Im sure there are others who disagree vehemently.

INTERVIEWER: Its a fair opinion, yeah.

PARTICIPANT: I mean, I dont need a lot of things talking to me.

INTERVIEWER: Okay, so this device is going to incorporate the Microsoft Kinect, which is a motion sensor system that is 12 inches by 3 inches by 2.5 inches, and there will also be a satchel in which you put a...a tablet, which processes the data from this Microsoft Kinect. Now where do you feel would be the best place to place...uh, best place to put the Microsoft Kinect, which is 12 inches by 3 inches by 2.5 inches, on your body? For example, your head, your chest, your waist, somewhere in front of you.

PARTICIPANT: Well, I guess the question I would wonder...and it probably wouldnt be possible: could you put it in a backpack?

INTERVIEWER: Uh, probably not because you want it...the whole purpose of the Microsoft Kinect is to be able to detect the obstacles and everything that are in front of you.

PARTICIPANT: And what does it look like?

INTERVIEWER: So, its like...uh...its 12 inches by 3 inches by 2.5 inches; its basically a black box that (pause) ...black box with those dimensions.

PARTICIPANT: Um, so you cant really carry it in a bag, it has to be visible it sounds like.

INTERVIEWER: Yeah.

PARTICIPANT: Um...I dont know. Actually, I guess um...I think carrying another device in my opinion...however it would draw the less [sic] attention to us.

INTERVIEWER: It would be...I would be strapped onto you so you wouldnt be carrying it per se. Well, I guess youd...itd be strapped onto you.

PARTICIPANT: It would be strapped on.

INTERVIEWER: Yeah. So maybe the...

PARTICIPANT: (Interrupting) I dont really know the answer to that, you know I would say however it could be less attention-getting.

INTERVIEWER: Okay.

PARTICIPANT: By other people. Like, somebody, they see you and say whats that thing that that blind girls carrying? You know, I dont know, I would prefer that its something that draws...whatever makes it draw the less attention.

INTERVIEWER: Yeah.

PARTICIPANT: That would be what I would be in favor of. And I dont know what that would be. I dont know where or how that could work but I would be in favor of [it]...because I think that people nowadays with all the paranoia we have about safety and all this kind of thing, I think its one more thing for people to get nervous about.

INTERVIEWER: Oh, yeah, yeah.

PARTICIPANT: Yeah, I think that when youre looking like...someones carrying a black box strapped to their body...

INTERVIEWER: Yeah.

PARTICIPANT: You know what Im saying?

INTERVIEWER: Yeah.

PARTICIPANT: So...whatever can make it the most discreet would be what I would be in favor of.

INTERVIEWER: Okay. And how comfortable would you be wearing this device on your body?

PARTICIPANT: Uh, I would be fine with it...again, its sort of like...again, if its nothing that screams out to the public, because, you know, we scream out to the public as it is as blind people.

INTERVIEWER: Yeah.

PARTICIPANT: You know, cane or walking with a dog or whatever. Its just one more thing that draws attention.

INTERVIEWER: Okay.

PARTICIPANT: And for me it may be, and it may be just me because Im getting older in life, sometimes you just want to be left alone, just do what you need to do, you know? So that would be my thought.

INTERVIEWER: Yeah, yeah, yeah. Thats definitely a fair thought.

PARTICIPANT: Yeah, whatever...whatever...whatever possible how it could be designed that you could have the least attention. While somebody walking up would say...its typical that theyd ask about the cane and all, were used to that...whats that thing strapped to your body?

INTERVIEWER: Yeah.

PARTICIPANT: What if some smartass white person says well its a bomb? That wouldnt be good. [not quite sure on that last sentence]

INTERVIEWER: Okay, do you...do you think that this device would efficiently complement your cane or do you feel like it would be a hindrance?

PARTICIPANT: Um, I think in some ways it could be good. I think that, especially now, in the town I live in...a lot of the stuff...trees grow weird over the sidewalks so theres a lot of overhang here.

INTERVIEWER: Mmhmm.

PARTICIPANT: And, uh, if it can pick up an overhang without getting yourself uh...you know, one of the big things that were fighting with the city...theres quite a few blind people that live in this little island where I am, and one of the things that we fight the city all the time is that people should cut the overhangs off the sidewalk.

INTERVIEWER: Thats actually...thats actually one of the novel things about our device; it will have the ability to detect overhanging objects which the cane or a dog really cant do.

PARTICIPANT: Yeah, that would be the big thing I would see, cause thats the huge issue here.

INTERVIEWER: Yup.

PARTICIPANT: ...Is we have a lot of the overhangs and people dont really...arent very mindful about taking care of their...especially on the little side streets...

INTERVIEWER: Yeah.

PARTICIPANT: ...cutting back their foliage, and big limbs, the big heavy limbs on the tree trunks.

INTERVIEWER: Ok, um, another...

PARTICIPANT: (Interrupting) I would say in that sense, yes, definitely it would complement the cane.

INTERVIEWER: Yeah, um...hold on one second. (long pause) Alright, um, another question: Lets say that you are walking with this device, in its tactile version, and it vibrates on your right side...a strong vibration on your right side. Would you take that to mean...would your natural inclination be to move away from the right side or towards the right side?

PARTICIPANT: Well if it was designed to let me know theres something on the right, I would think that I would move away from it.

INTERVIEWER: Okay. Yeah, we just wanted to know what people would...naturally take it to mean and tailor the device that way. But, yeah, most people have said that if the felt a strong vibration, they would move away from it. Besides that, do you have any other comments or suggestions regarding the development of this device?

PARTICIPANT: I think the big thing that I see for it...I think the overhanging is a good thing.

INTERVIEWER: Yeah.

PARTICIPANT: I think that maybe letting us know, uh, if youre walking down a sidewalk and youre passing by things, could it potentially let you know youre passing by a trash can or a bus bench which is always helpful, judging by the size of the object youre moving by.

INTERVIEWER: Okay.

PARTICIPANT: So I think that...it could potentially be good for those things, to let you know that youre passing something on your left, which potentially could be when youre on a block and the bus stops arent consistent and theyre either in the middle of the block or...or um, wherever. Uh, that would be the kinds of things I think would be really helpful to know.

INTERVIEWER: Okay.

PARTICIPANT: ...Where theres benches or where you need to...where youre gonna catch the bus or something like that so...and the overhangs! That would be the...

INTERVIEWER: Yeah, the overhangs.

PARTICIPANT: Yeah, and that would be the thing.

INTERVIEWER: Um, I just wanted to say thank you for taking time out of your day to interview with me. But yeah, email me to let me know if you have any other questions or anything like that, but thank you so much.

PARTICIPANT: Have a wonderful Fourth!

INTERVIEWER: Thank you, you too.

PARTICIPANT: Bye.

INTERVIEWER: Bye.

Subject 27

INTERVIEWER: Alright, and the other thing I wanted to tell you was that all the information you've given me today is confidential. You'll only be tied back to a participant number, so no one will trace anything you said back to you.

PARTICIPANT: Okay.

INTERVIEWER: Okay. First question, and we're required to ask this. Do you consider yourself male, female, or other?

PARTICIPANT: Female.

INTERVIEWER: Okay. Your household income: would you say it's from 0 to 19 thousand, 20 to 39 thousand, 40 to 59 thousand, 60 to 79 thousand, 80 to 99 thousand, 100 to 149 thousand, or 150 thousand plus?

PARTICIPANT: 20 to 39.

INTERVIEWER: Okay. What is your race?

PARTICIPANT: Plain old Caucasian.

INTERVIEWER: Okay, and what is the highest degree you have obtained education wise?

PARTICIPANT: High school diploma.

INTERVIEWER: Okay. And, how old are you?

PARTICIPANT: 60.

INTERVIEWER: Six zero? 60?

PARTICIPANT: Yes.

INTERVIEWER: Okay. Now were you born blind or did you develop it during your life?

PARTICIPANT: Well, I was born with a visual impairment. I was born with glaucoma, and when I went into my mid, well probably later 30s, it went, and it went maybe there was light perception, and for the past probably 20 to 24 years, there is no vision at all.

INTERVIEWER: So, in I guess the lower 30s is when you went completely blind.

PARTICIPANT: Yes.

INTERVIEWER: Okay. Give me one second. Oh, what did you say was the cause of your blindness?

PARTICIPANT: Glaucoma. Congenital Glaucoma.

INTERVIEWER: Okay. And, what do you struggle most with when navigating through your surroundings?

PARTICIPANT: There are differences between indoor and outdoor. You're just concerned with indoor right?

INTERVIEWER: Yes.

PARTICIPANT: Okay. I guess the thing...so one of my biggest problems is people.

INTERVIEWER: People?

PARTICIPANT: Dealing with people reaching out to my dog, my dog diverting off the path, you know because someone is holding out a hand to him or something.

INTERVIEWER: So the dog diverts from the people?

PARTICIPANT: He diverts to the people.

INTERVIEWER: Oh, which you dont want.

PARTICIPANT: Correct, and sometime its hard to tell at the very instant because theres no way for me to tell is he going around an obstacle, or you know what I mean? So thats my biggest problem, its kind of a strange one.

INTERVIEWER: So, sorry one second. So, what are your general problems, indoor or outdoor, whats the biggest problem that doesnt concern the dog, but just as a blind person?

PARTICIPANT: Changes in elevation, like if theres suddenly a step, or if theres any sidewalk. Thats a tough one.

INTERVIEWER: Okay.

PARTICIPANT: Obstacles in the way, something hanging obstacles are bad too.

INTERVIEWER: Yes.

PARTICIPANT: Even indoor, there could be a flag, or banner, or something that hangs. Then outside you got the tree limbs.

INTERVIEWER: Yeah. Thats one of the things...one of the novel things were trying to do with our device: detect overhanging obstacles.

PARTICIPANT: Oh thats great.

INTERVIEWER: Do you currently use any assistive devices to navigate? If so, what? You said your Seeing Eye dog?

PARTICIPANT: Yes, on occasion, I use the cane. If its somewhere I cant be with the dog. I do have a BreezeTrekker, a GPS. Thats about it for mobility aid.

INTERVIEWER: Alright. And you said the BreezeTrekker?

PARTICIPANT: Yes.

INTERVIEWER: Now, in the past, have you utilized any other assistive devices, and if so, why did you stop using it or them?

PARTICIPANT: Well, before I got my dog, I used a white cane all the time.

INTERVIEWER: Why did you...what was your preference for the dog, over the cane?

PARTICIPANT: Part of it was safety.

INTERVIEWER: Okay. Can you explain?

PARTICIPANT: Im a small person. Im 5 foot 1, and when I would get turned around...when I first lost my sight I lived in an area with a lot of cul-de-sacs, and its pretty easy to get....you know you feel like youre heading the same way because the curve of the cul-de-sac can be so...it can be so slight that you cant really tell if theres no traffic, and usually around a cul-de-sac you dont really have any. And, so when I had to ask someone for help... if I heard someone in the distance, and I asked

someone for help, it seem like with a cane, people would ignore you more. But if you have a dog, they go aw, a dog. Did you need some help?

INTERVIEWER: Wow, people ignored you?

PARTICIPANT: Sometimes they will. Maybe they didnt, you know, were far enough away that they didnt actually see me. I dont know, but I do feel so much safer outdoors with the dog, even if I get confused by something, Im not by myself. Theres some security there, with that.

INTERVIEWER: Yeah, definitely. Let me just add that. Sorry, Im just recording things down. How important is it for you to have a navigational aid that allows you to identify objects and people in your path?

PARTICIPANT: Oh my gosh, that is one of the things I miss so much. Bumping into someone who...if youre in a store or even just getting to customer service, its not that hard, usually. People dont watch where theyre going. And, on occasion, sometimes...the dog is very good, but there are time when the person is going so fast that...and the dog doesnt know where to go to get you out of the way. Do you know what I mean? Or not a very good way, and people just kind of bump into you, or Ill bump into something there just a little, like just with an elbow, and I wonder what was that?

INTERVIEWER: Yeah, yeah.

PARTICIPANT: And its just concerning, in a way, because then youre losing your concentration, because you have that reaction...everybody...has that...when you go gasp. And everything you were in the midst of thinking about, okay I know this this here, and this this there, you kind of lose it for a minute, because you were startled.

INTERVIEWER: Yeah, two of the biggest things that we want to do with our device is obstacle avoidance and then like object detection.

PARTICIPANT: That would be great.

INTERVIEWER: So we plan on creating a navigation device to assist the blind to recognize objects and humans in daily travel. Would you be open to using such a device?

PARTICIPANT: Oh, yes.

INTERVIEWER: Alright. Now, what do you think would be the best way of communicating the information taken from the external environment to you, the user, for example: tactile, auditory, or maybe a combination of both?

PARTICIPANT: You know, I thought about this since I saw your questionnaire. Mostly, audio is good, but if it were possible, could do both or in between because sometimes there a lot of traffic noise, but other times your hands are busy carrying your groceries or whatever the subject, however the tactile would be, unless...Im thinking tactile as something you would read with your person, but I guess now that I said that I keep hearing about all these sensors that can...like vests or

things that people could wear. Those Bluetooth shoes that were in the news a while back, so I guess theres other means of tactile isnt there?

INTERVIEWER: So for our combination version with audio and tactile. First of all, I just want to say that for audio, the headset that you would be using would be something that will allow you to hear ambient noise, so it wouldnt just be you hearing the noises from the device. Youd also be hearing everything else, everything else that was in your outer environment.

PARTICIPANT: Ah, wonderful.

INTERVIEWER: Also, for tactile, okay so for the combination version, what would happen is for object recognition, if you want to recognize something, youd click a button and then through audio, the device would tell you what the object is, and then if you want to do obstacle avoidance, there would be vibrations to kind of tell you what to avoid and what to go towards I guess.

PARTICIPANT: Oh wow.

INTERVIEWER: So, the device that were creating is going to incorporate the Microsoft Kinect, which is a motion sensor system thats 12 inches by 3 inches by 2.5 inches, and there would also be a satchel in which you carry a tablet, which processes the data from this Microsoft Kinect. Where do you feel would be the best place to put this Microsoft Kinect, its 12 inches by 3 inches by 2.5 inches, on your body? Somewhere in front of you, for example: the head, the chest, or the waist? What are you thinking?

PARTICIPANT: Well, probably would have to be chest, because waist level would be kind of...specifically on short people.

INTERVIEWER: Yeah.

PARTICIPANT: Yeah, probably you know, probably chest Im guessing, because I dont know how it would work on head.

INTERVIEWER: Yeah, thats what we were thinking right now too. Theres something called the GoPro mount, which is a set of straps, and then we would attach our device to that, strap it onto that, and we would strap it to your chest. So that was the direction we were heading in as well.

PARTICIPANT: Kind of like those baby front pack?

INTERVIEWER: I guess. I dont know what that looks like.

PARTICIPANT: Theyre things you put newborns in, and they...its like a backpack but its kind of on your front, and then baby just holds onto your chest.

INTERVIEWER: Yeah, but not as big as that, but yeah.

PARTICIPANT: Okay. I get it.

INTERVIEWER: How comfortable would you be wearing this device on your body?

PARTICIPANT: You know, Im thinking that at first, in all honesty, I would probably be a little self-conscience, but you know what...?

INTERVIEWER: If it helps...yeah.

PARTICIPANT: That would just go away, I think, really quickly. The amount of freedom, I think, and the amount of information that I could actually get would be amazing, I think. That's one of the things I truly miss, even though I only ever had limited vision. There's so many things that, that we miss. And maybe physically you don't need to know, you know, as much as you do, but it's so great it makes you feel like a person. You know when you're walking by, you know?

INTERVIEWER: Yeah.

PARTICIPANT: You know, you can kind of feel things a little bit, and they're kind of oh...I at least always kind of wonder, wonder what that just was that I just walked by.

INTERVIEWER: Yeah definitely, wait where are you located? Where do you live?

PARTICIPANT: [redacted].

INTERVIEWER: [redacted]. Okay. I was just curious, because we're going to...I think it's in the consent form that we're going to be doing testing, but I guess you can't come out since you're all the way in [redacted].

PARTICIPANT: Well, actually, you know what. I've mentioned this to 2 people, and they told me tell me if they choose you to go do it, we will get you there.

INTERVIEWER: Okay. Oh, like other people?

PARTICIPANT: Yes. Sighted people who drive, and I've even mentioned it to my boss at work, if I get picked for this, I'm going, so you may not get your weeks notice I need a day off.

INTERVIEWER: [chuckle]. Well that would be great. So, another...so do you think this device would efficiently complement your cane or do you feel that it would be a hindrance?

PARTICIPANT: I think it would complement it. I wonder how much would it scan, like would it scan all the way to the ground, see the differences in the pavement, you know, would a cane still be used for just goofy things like that.

INTERVIEWER: [stutter]. Since most blind people, their natural inclination is to use the cane, we didn't want to take that away from them, we wanted something that added to it, instead of replacing it, you know?

PARTICIPANT: I understand that, and who knows, maybe once a blind person would get used to it, we would...right now I think we would feel a little naked.

INTERVIEWER: Yeah, yeah for sure.

PARTICIPANT: You know, exposed and all that, but like everything else, once we've fully gotten used to it and learned to trust it, and realize, hey, this finds everything. I would hang the cane up. You betcha.

INTERVIEWER: Okay. So another question, let's say that you are walking with this device, and you feel a strong vibration on your right side.

Would you take that to mean...would your natural inclination be to move away from the right side or to move towards the right side?

PARTICIPANT: Move away from it.

INTERVIEWER: Away? Okay. Yeah thats what most people said. So, those are all my questions, do you have any other comments or suggestions regarding the development of this device?

PARTICIPANT: No, you covered more than Id even thought of. I think its just great that, you know, that youre even trying to develop. It sounds like youve, you know, youve put a lot of work into it already. With the things that youve mentioned, you know like this choice or this choice, and you know, it sounds like theres awful a lot of thought put into it.

INTERVIEWER: Yeah, especially being undergraduate researchers, its hard to put out something when, you know, the project will be over by the time youre done with college, but I know one of our concerns was that our device may be a bit bulky, but what we want to do more than anything is add research to the field, and maybe somebody one day can tailor it and make it something thats marketable.

PARTICIPANT: Yeah, are you aware of the [redacted] back in the 90s developed this device, and apparently it is still working in a grocery store somewhere in the Utah area? But it does wonders in the store, its only good in this one store, but it was size of a vacuum cleaner.

INTERVIEWER: Oh really?

PARTICIPANT: No, apparently...someone told me about it, and I had a second friend look it up, and the...watch the video, but it is. It is the size of a vacuum cleaner. That would be awkward to be walking down the street...with a vacuum cleaner. But what you got is nice. Man its like nothing. You got this...you know my purse is bigger than that, than you know its on your chest.

INTERVIEWER: Okay. But I just want to say thank you so...that ends my questions but I just want to say thank you so much for interviewing with me today, and it was a pleasure to listen to your opinions on everything.

PARTICIPANT: Do you send emails or have a website where we can follow your progress?

INTERVIEWER: So what were aiming to do is by the fall, have like a product ready and working, and we were going to send out emails to the people who said they would be willing to come to test, and kind of email those people and see if they wanted to come out and test, and then start testing at our University.

PARTICIPANT: Well, thats good. Great.

INTERVIEWER: So if you by any chance dont hear from us by the fall time, just email me, because you seem like you would be very interested in doing this. I just want to make sure we dont accidentally overlook you because youre location is set in [redacted] or anything, but if youre willing to come out, then that would be great.

PARTICIPANT: Alright. Oh thank you so much.

INTERVIEWER: Yeah. So when we get back to school, maybe September something, just email me if you dont hear from us.

PARTICIPANT: Okay.

INTERVIEWER: Okay, thank you so much [redacted], its been so great talking to you.

PARTICIPANT: Me too, bye!

INTERVIEWER: Bye.

PARTICIPANT: Wow.

Appendix C: RESULTS FROM SIGHTED INTERVIEWS

Age:

1	8, 9
2	1
3	9
4	9
5	0, 0, 7, 7

Gender:

Male	2
Female	7

Household Income:

\$0-\$19,000	0
\$20,000-\$39,000	1
\$40,000-\$59,000	1
\$60,000-\$79,000	0
\$80,000-\$99,000	1
\$100,000-\$149,000	3
\$150,000+	1
Prefer not to answer	2

Race:

American Indian/Alaskan Native	0
Black or African American	0
Asian or Pacific Islander	2
Hispanic/Latino	1
White	6
Other or Not Reported	0

Education (Highest degree obtained):

Some High School	0
High School Diploma/GED	1
Some College	1
Associates	1
Bachelors	2
Masters	3
Doctorate/Professional School	1
Other	0

How often do you interact with the blind?

Never	0
Rarely	2
Sometimes	2
Often	5

Do you experience any difficulties when interacting socially with the blind? If so, what?

Yes	4
No	5

What do you struggle most with when navigating through your surroundings?

- No. Interactions were online.
- Yes. Giving instructions can be difficult. When I need to examine their eyes, it is difficult to specify where to look.
- Yes. Takes a while to get comfortable with what they can and cannot do.
- Yes. Generally just feel awkward.
- Yes. Try too hard to be inoffensive.

How does your behavior change when interacting with a person who is blind?

- Has to constantly watch where the blind person is going (had to guide her). I always had to confirm things for the blind person (anything visual).
- Because friend cant see pictures, has to be aware of what they are posting (ex.cant see smiley faces).
- When introducing people, you have to make sure that everyone speaks so that they recognize peoples voices. When giving something, you have to put it in their hand. More verbal communication needed.
- When I'm a sighted guide, I have to make sure that I'm is cautious (ex.they do not fall into hole). A lot of people think that blind people are really sensitive, but for the most part, you can joke around.

- In the past, I may have raised my voice(which is ridiculous), but as I grew older, I realized that the individual just had a deficit in that one sense and other ones may be more acute.
- Sometimes I try to speak louder and slower but I dont want to do that so I try to check myself. Initially, I didnt give them as much of an opportunity to remain autonomous.
- Had to take care of person more because they were blind (out of familial obligation).
- I guess talking more slowly to make sure they understand.
- Aware that I had to give verbal instructions and communications and its rude to just start talking and have them know not who it is
 - Always identify yourself before speaking.
 - Learn what they can and cant do by themselves.
 - Tendency to do too much for blind people.

How would you react if you saw a person equipped with a navigational device on their chest?

Uncomfortable	1
Neutral	2
Intrigued	6

Please elaborate on your reaction.

- used to seeing people with illnesses wearing stuff, fascinated by technology that helps people.
- depending on how visible it is, but it might be scary to her (they may look like iron man or alien
- excited if it was a device that made it easier for people to get around. Interested to see if it would actually help them.
- most of the devices that I have seen my students with, it was in their belt.
- curiosity and discomfort with the unknown, maybe I would want the person to explain what it was, and after they did, I would be fine and comfortable.
- question what it is. Impressed that this would be able to increase mobility and independence.
- It would just be normal.
- I see a lot of patients with seeing eye dogs and canes. This is just another way of getting around
- Anything we can use to make blind people more independent

Would your opinion change if you knew the device was aimed at helping the individual avoid objects in their path?

Yes	1
No	8

Would the implementation of such a device make you hesitant to interact with the individual? Why or why not?

Yes	1
No	7
Maybe	1

- Yes: because they know where she is now, interaction is not as necessary.
- No: doesnt affect how I feel about someone if they had navigational aid device that is necessary for their life
- No: if it is helping someone why not?
- Maybe: but one I knew what it was, I would not be hesitant.
- No: it may change the way I interact with them because I would really encourage their independence.
- No: but that is an odd social thing with interacting with the blind

Do you have any other comments or concerns?

- Perhaps they can use a device with beeps. It would show direction, and the frequency of beeps would increase if closer to object.
- Kaptan Plus GPS device (GPS capabilities are what the blind need, this is the best device). NAVIGATEs device needs to be extremely responsive. When giving them directions, it might be helpful to use clock directions (they may be familiar with that). With the GPS device, it would have to be something that gives them street names. On the iPhone, there is an accessibility app (voice over) that reads app names out loud and if they want it, they double click it.

Appendix D: TRANSCRIPTS FOR SIGHTED PARTICIPANT INTERVIEWS

Subject 1

INTERVIEWER: Hello?

PARTICIPANT: Hi, (name redacted), this is Yolanda Zhang calling

PARTICIPANT: Hi, how are you?

INTERVIEWER: Hi Im good, how are you?

PARTICIPANT: Good

INTERVIEWER: Good, okay so are you available right now for the interview?

PARTICIPANT: Yes

INTERVIEWER: Okay so before we begin Id like to remind you that all your responses will be kept confidential

PARTICIPANT: Okay

INTERVIEWER: and feel free to ask any questions at any time during the interview

PARTICIPANT: alright

INTERVIEWER: Okay so first, what is your age?

PARTICIPANT: Uh, 39, [laughs] couldnt remember

INTERVIEWER: Thats fine. What is your household income? [proceeds to list range of salaries][omitted some extraneous minor miscommunication]

PARTICIPANT: That one, the 1 to 149,000

INTERVIEWER: 100 to 149

PARTICIPANT: Yeah

INTERVIEWER: Right

INTERVIEWER: What is your race?

PARTICIPANT: Caucasian

INTERVIEWER: What is the highest level of education that you obtained, or the highest degree that you obtained?

PARTICIPANT: Uh, degree Bachelors

INTERVIEWER: How often do you interact with the blind Never, rarely, sometimes, or often?

PARTICIPANT: Um, so what does interact mean? This is my question to you actually

INTERVIEWER: Right

PARTICIPANT: We, uh, I have a really good friend that... mostly all my communication with her now is online

INTERVIEWER: Oh okay
PARTICIPANT: Does that does that qualify still?
INTERVIEWER: Yeah, it does, I guess
PARTICIPANT: Okay
INTERVIEWER: So how often do you talk to your friend?
PARTICIPANT: Um, at least once a week, what does that qualify as?
INTERVIEWER: Probably sometimes
PARTICIPANT: Okay
INTERVIEWER: I guess in this case, do you still experience any difficulties when interacting socially with the blind? If so, what?
PARTICIPANT: Um yeah see that one [laughs] the answer to that would be no because I dont talk to her face-to-face very often so
INTERVIEWER: Right so, you would still be talking to her normally, like, I mean, through online
PARTICIPANT: Yeah, yeah
INTERVIEWER: Right
INTERVIEWER: Okay, how does your behavior change when interacting with a person who is blind, or in this case I guess, do you find your behavior changing at all through talking?
PARTICIPANT: No. Well, yes, yeah I dont know if its because...she cant see all the things that are on... like if Im talking to her on Facebook, she cant see everything, so I have to think about what Im actually posting so that its visible you know, so that she can read what Im writing and [clears throat]
INTERVIEWER: Right, okay
PARTICIPANT: cant make smiley faces and things [laughs]
INTERVIEWER: Right, emoticons I guess
PARTICIPANT: Mhmm, right
INTERVIEWER: That doesnt translate well
INTERVIEWER: How would you react if you saw a person equipped with a navigational device on their chest? Would you be uncomfortable, neutral, or intrigued?
PARTICIPANT: Intrigued would be the answer to that one
INTERVIEWER: Please elaborate a little bit on your reaction, like what would your initial thoughts be I guess?
PARTICIPANT: Well, my sons diabetic so he wears a insulin pump, and then I have a friend who wears a cochlear implant so you know, Im just, Im fascinated by all the technology that helps people with you know issues, that basically wondering what it did
INTERVIEWER: Right okay
INTERVIEWER: Would your opinion change if you knew that the device was aimed at helping the individual avoid objects in their path? Please explain your opinion
PARTICIPANT: No, it wouldnt change because I was intrigued in the first place so I guess I would still be intrigued

INTERVIEWER: Right, like how it would work and stuff
PARTICIPANT: Yeah, right
INTERVIEWER: Okay, would the implementation of such a device make you
hesitant to interact with the individual? Why or why not?
PARTICIPANT: No.
INTERVIEWER: No? Okay, and why I guess? Why wouldnt you be hesitant?
PARTICIPANT: Well I guess for the same reason that it doesnt... it doesnt
affect how I feel about somebody if they got stuff thats helping them
just navigate life
INTERVIEWER: Right, yeah. Okay so, thats basically all the questions do
you have any other comments or concerns?
PARTICIPANT: Nope
INTERVIEWER: Okay thank you very much for your time
PARTICIPANT: Alright, yep, no problem, sorry that it was hard to track me
down
INTERVIEWER: No, its fine, thank you
PARTICIPANT: Good luck with the rest of your stuff, yep uh huh
INTERVIEWER: Mhmm, thank you, bye
PARTICIPANT: Bye

Subject 2

[omitted introductions]

INTERVIEWER: Also, I just want to confirm on your consent form you
mentioned that you did not want to be audio recorded for this
interview?
PARTICIPANT: Yeah thats preferred
INTERVIEWER: Okay, sure. We will keep that in mind...
PARTICIPANT: Okay
INTERVIEWER: So before we begin Id like to remind you that all your
responses will be kept confidential and feel free to ask me any questions
at any time during the interview
PARTICIPANT: Mhmm
INTERVIEWER: Okay so the first question is: what is your age?
PARTICIPANT: Lets see...almost 20, do I say 19?
INTERVIEWER: Yeah okay Ill just put 19
PARTICIPANT: Just put 19...Ill be 20 in like a couple days
INTERVIEWER: Oh a couple days? Cool...
INTERVIEWER: What is your household income? [proceeds to list ranges]
PARTICIPANT: Wait...cause I actually...the amount of money confuses
me...Could I skip this question?
INTERVIEWER: Um yeah sure, if you dont know it, or if you prefer not to
thats fine
INTERVIEWER: What is your race?

PARTICIPANT: I am Asian. 100 percent

INTERVIEWER: Right okay

INTERVIEWER: What is your education or the highest degree you obtained?

PARTICIPANT: I just finished sophomore year in college...

INTERVIEWER: Right, yeah theres a Some College option so

PARTICIPANT: Oh okay

INTERVIEWER: Okay so how often do you interact with the blind? Never, rarely, sometimes, or often?

PARTICIPANT: Um...I guess...Well Ive only had so far like one interaction with the blind, so I guess that would fit into the rarely? I worked for about a month at my doctors office. And I...ushered patients. So there was this one lady, who was blind and she has to go from inside the office to catch a bus outside and...its kind of complicated because she has a dog. And she was like Well, I have to let the dog go, relieve itself and then she has to like walk across the parking lot, she like...like you know how like parking lots have like a green spot, like a green grass spot. And then she was trying to like, she was like Where can I find some grass? And I was like, Well, thats the only place and so I basically took her over there and just waited for her to let her dog go, and then like brought her back. So this was like a process that I had kind of in common with her...and its really tough for them I think, because like...to relieve the dog, she doesnt even know whether the dog goes right? She has to ask me, Has the dog done it yet? And I was saying, Well no, not really and then after, asking me like...one time she was like, Okay...it probably doesnt want to go. So, I brought her back to in front of the office. And another portion was curbed, so I had to tell her like, to step in front of here, theres like a drop, like a curb. And then like maybe 1, 2 step in front of her there theres like another curb so, had to be really careful with that

INTERVIEWER: Right, so, she didnt have a white cane with her?

PARTICIPANT: A what with her?

INTERVIEWER: A white cane? Like the walking stick?

PARTICIPANT: No, she did not. Or she did? I totally didnt remember if she has a white cane...Yeah cause...she did not have a white cane, otherwise, I wouldnt be, I wouldnt have to tell her...yeah, aw thats kinda sad.

INTERVIEWER: Yeah, my next question would be: specifically, so this one time you interacted with her, did you experience any difficulties when interacting socially with her? If so, like what?

PARTICIPANT: Uh lets see...she was a nice lady. She was cautious [??], she appreciated me helping her. And one thing while we were sitting in the office she was asking me, Does my clothes match? cause she doesnt know, and I was like, Yeah, it matches, its great and stuff...yeah she doesnt know if she, if her clothes match and she has to ask me about

it. She asked me [a] couple times...it might be some kind of like...she was not confident in terms of that

INTERVIEWER: Yeah, she wanted to appear maybe more normal in some way to other people?

PARTICIPANT: Yeah, yeah, at least like not bizarre

INTERVIEWER: Mhmm yeah

INTERVIEWER: Okay the next question is: how does your behavior change when youre interacting with a person who is blind?

PARTICIPANT: Uh, watching where she knows where she is going. And she can go further range than she used to. And then her confirms would have been answered through letting her know that her clothes matched and Yes, the bus is coming so

INTERVIEWER: Mhmm yeah just like everything visual

PARTICIPANT: Yeah, everything visual, its like they um...her like...counts a lot.

INTERVIEWER: Okay, the next question: how would you react if you saw a person equipped with a navigational device on their chest? Uncomfortable, neutral, or intrigued?

PARTICIPANT: Um...I think intrigued. Depending on like how...how visible it is, the object is. You know, some people have like not [unintelligible] and it looks a bit scary, but some people have things that look normal, and some people have things that looks like theyre Iron Man. So...yeah it really depends on the device actually.

INTERVIEWER: The design? It depends on the design?

PARTICIPANT: The device. And design.

INTERVIEWER: That was kind of the follow-up: please elaborate on your reaction or initial thoughts, but I guess you already answered that...if you saw someone with that

PARTICIPANT: Oh...what? The reaction part?

INTERVIEWER: Yeah

PARTICIPANT: Oh okay

INTERVIEWER: Or if you wanna explain more, like what would your initial thoughts be if you saw something like that?

PARTICIPANT: Yeah um yeah Ill be...intrigued, and depending on how it looked [unintelligible] I might be like...a little bit like...you know when you first look at an alien thing, youre like, Oh, what is it? So its kind of like that kind of feeling, and depending on how cool it is [laughs] the intrigue-ment [sic] will...might...yeah [unintelligible]

INTERVIEWER: Mhmm okay

INTERVIEWER: Would your opinion change if you knew the device was aimed at helping people, um, helping the individual avoid objects in their path?

PARTICIPANT: Mm...I still think itd be pretty cool. And probably intrigued. And tolerant more

INTERVIEWER: Mhmm more tolerant yeah

PARTICIPANT: Yeah I could understand if the majority of people have a different opinion

INTERVIEWER: Yeah yeah for sure

INTERVIEWER: Would the implementation of such a device make you hesitant to interact with the individual? Why or why not?

PARTICIPANT: Hesitant, I would be more [unintelligible-quiet? Maybe [laughs] they know where I am now.

INTERVIEWER: Okay, great. Thats basically the end of the interview, do you have any other comments or concerns?

PARTICIPANT: Um, I do have questions.

INTERVIEWER: Okay, yeah?

PARTICIPANT: How many people have participated in this study?

INTERVIEWER: In the study?

PARTICIPANT: Yeah like people like me.

INTERVIEWER: Oh right. Um well so far theres been a couple people...were trying to interview blind people and also people that can see. We ask them different questions...depending...these questions will affect the design of our device so...

PARTICIPANT: Cool

INTERVIEWER: Yeah, I guess a common consensus thats between sighted people and blind is that they dont want a device that looks too obvious...they just wanna appear normal

PARTICIPANT: Yeah I guess thats mostly the concern

INTERVIEWER: Yeah

PARTICIPANT: I see

INTERVIEWER: Yeah so...everyones responses help a lot

PARTICIPANT: Yeah...its a pretty interesting project that youre doing. How is the study going?

INTERVIEWER: Yeah, thank you. Yeah theres about 14 people on our team actually, so, its good.

PARTICIPANT: Okay cool. I was wondering how the device is gonna do, like what kind of stuff youre proposing?

INTERVIEWER: Right, do you know the Microsoft Kinect?

PARTICIPANT: Yeah, yeah yeah the one where like you wave your hand, it shows up like something on the screen

INTERVIEWER: Yeah, so were using that as our sensor that will detect objects in their path like people would like strap it on themselves somehow and we would...it would detect objects in their path, then we would relay that information back to them so they can avoid it and stuff. It has a really good sensor that a lot of scientists actually use for research purposes for this kind of stuff instead of gaming and all that good stuff

PARTICIPANT: Yeah the speaking could be a little bit annoying, unless theyre wearing earphones or something

INTERVIEWER: Mhmm yeah I think thats...if we decide to communicate that way, thats...they would probably wear earphones or something

PARTICIPANT: Yeah, yeah I watched...a show a couple days ago and they had um like a future like a beeping device that shows the direction

INTERVIEWER: Oh, theyre like beeps?

PARTICIPANT: Yeah, like how close someone is to something. Actually, I think that would apply because the character in the show was, couldnt see at that moment so...yeah maybe

INTERVIEWER: Oh, kinda like a radar thing?

PARTICIPANT: Um, yeah I guess kind of? Its like a kind of speaker thing um...its um...its in the Precious Stone episode of Doctor Who [unintelligible] Im kinda addicted to Doctor Who [laughs]

INTERVIEWER: Yeah Ive heard, its a very good show

PARTICIPANT: It is a very good show

INTERVIEWER: Yeah. Oh so...they had a device [where] the frequency of beeps would increase if like an object came closer to them or something?

PARTICIPANT: Yeah yeah yeah. Well, her character is trying to...was stuck in the forest...with her eyes...like she has to keep her eyes shut to prevent...this one evil being from entering her eye its an interesting plot line, the topic is pretty interesting but the thing is that she...the extra walk to the place [where] shes supposed to walk, she is told to avoid like...the beeping, the intensity will increase if she goes where she dont want to go, so listening to the frequency of the beeping, she can get to where she wants to go. She doesnt have the same [unintelligible] though

INTERVIEWER: Right oh, okay, kinda like a...youre getting warmer or colder or something

PARTICIPANT: Yeah yeah yeah that. Exactly

INTERVIEWER: Yeah, thats interesting...we might consider that as a way

PARTICIPANT: Yeah

INTERVIEWER: Okay, thank you for your time for this interview.

PARTICIPANT: Yeah thank you! [*omitted further off-topic conversation*]

Subject 3

[omitted introductions]

INTERVIEWER: So the first question is: what is your age?

PARTICIPANT: I am 21

INTERVIEWER: 21, okay. And your gender what would you identify as:
Male, female or other?

PARTICIPANT: Female

INTERVIEWER: And what is your household income? [proceeds to list ranges]

PARTICIPANT: Uh between my husband and myself were the 2nd bracket, whatd you say 20 to 39,000

INTERVIEWER: Okay, and what is your race?

PARTICIPANT: I am white

INTERVIEWER: Okay, and what is the highest degree of education that you obtained?

PARTICIPANT: I have an Associates degree.

INTERVIEWER: You have an Associates?

PARTICIPANT: Yeah thats a community degree

INTERVIEWER: Right okay

INTERVIEWER: And how often do you interact with the blind never, rarely, sometimes, or often?

PARTICIPANT: Um, often

INTERVIEWER: Often, okay. Do you experience any difficulties when interacting socially with the blind? If so, what?

PARTICIPANT: Um...nope, no.

INTERVIEWER: No difficulties?

PARTICIPANT: No, you kinda have to keep in mind when youre eating with them you have to like get their food for them if its like buffet style or things like that, but its not difficult. I mean, when you know what they need already.

INTERVIEWER: Mhmm, okay. How does your behavior change when interacting with a person who is blind?

PARTICIPANT: Um...just in...when you introduce people, you have to try to kinda you know make sure they speak so that they can recognize their voice and...and when youre like giving them something you have to make sure you put it in their hands and stuff instead of just oh, Im putting this in front of you or something like that. Its more verbal communication

INTERVIEWER: How would you react if you saw a person equipped with a navigational device on their chest? Uncomfortable, neutral, or intrigued?

PARTICIPANT: Intrigued.

INTERVIEWER: Right and...can you elaborate a little bit I guess on your initial thoughts, if you saw someone with that.

PARTICIPANT: Um I mean, Id be kinda like excited if they were making it easier for people to get around, and Id be interested if itd actually help, cause you see a lot of like...[unintelligible-get mixed up in], so Id just be interested if it was something that could actually help them instead of kinda of like a nothing like [unintelligible]

INTERVIEWER: Mhmm yeah. Would your opinion change if you knew the device was aimed at helping the individual avoid objects in their path?

PARTICIPANT: Uh no, cause thats kinda what Id assume it would be

INTERVIEWER: Right yeah

INTERVIEWER: Would the implementation of such a device make you hesitant to interact with the individual? Why or why not?

PARTICIPANT: Implementation as in if they had it planted inside of their body?

INTERVIEWER: Er...if they were just wearing it on their body

PARTICIPANT: Oh...no it wouldnt.

INTERVIEWER: Right yeah I think you explained yourself earlier.

INTERVIEWER: Okay so do you have any other comments or concerns?

PARTICIPANT: Um I dont know what your article said exactly or what youre doing but...I do know that one of the learning problems they run into is like...is for getting aid and stuff from the government. The government has different things, like giving them a couple thousand and stuff but theres like...as far as housing goes, like once people get on, what they call Section 8 Housing or something like that is an example, they like try not to earn more so they dont like move out of that housing. So I think what has been like a detriment to them is people using a lot of the aid that dont need it and people that really cant do things on their own like blind people, cant like earn enough money to keep their house for their family, that kinda effects them negatively.

INTERVIEWER: Mhmm yeah thats definitely a concern, yeah.

PARTICIPANT: Yeah...[unintelligible] specifically, theyre both blind and theyre married and they have like 6 kids at this point, and you know youd think if anyone could get help it would be them but the lists are so long and people just stay on, like for example on Section 8, and theyd just stay on their whole lives you know. Its crazy that they cant get the help

INTERVIEWER: Yeah, especially with so many kids...

PARTICIPANT: Yeah

INTERVIEWER: Oh thats unfortunate...okay, yeah we could look into that then.

PARTICIPANT: Okay

INTERVIEWER: Okay, thank you for your time

PARTICIPANT: Youre welcome, Yolanda, nice to meet you

INTERVIEWER: Nice to meet you too, okay

PARTICIPANT: Alright, good luck

INTERVIEWER: Thanks, bye

PARTICIPANT: Buh bye

Subject 4

[omitted introductions]

INTERVIEWER: So before we begin Id like to remind you that this interview is being audio recorded, and all your responses will be kept confidential, and feel free to ask me any questions at any time during the interview

PARTICIPANT: Okay
INTERVIEWER: Okay so the first question is: what is your age?
PARTICIPANT: Im 18.
INTERVIEWER: 18, okay. And what is your household income? [proceeds to list ranges]
PARTICIPANT: Uh I think its in the 40s
INTERVIEWER: 40 to 59 thousand?
PARTICIPANT: Yeah
INTERVIEWER: Okay. And what is your race?
PARTICIPANT: Latino
INTERVIEWER: Mhmm okay. And what is the highest degree or education that you obtained?
PARTICIPANT: Ive obtained high school.
INTERVIEWER: High school, okay.
INTERVIEWER: How often do you interact with the blind never, rarely, sometimes, or often?
PARTICIPANT: Often.
INTERVIEWER: Mhmm
INTERVIEWER: Do you experience any difficulties when interacting socially with the blind? If so, what?
PARTICIPANT: No, never.
INTERVIEWER: No, never?
PARTICIPANT: Nope
INTERVIEWER: Okay.
INTERVIEWER: Do you find your behavior changing at all when interacting with a person who is blind?
PARTICIPANT: Ummmm...I guess if Im being a sighted guide, I have to be cautious that theyre not...you know, gonna fall into a hole. But I mean...no? A lot of people think that blind people like are really sensitive and to the for the most part theyre not you know, you can joke around [laughs] yeah
INTERVIEWER: So how would you react if you saw a person equipped with a navigational device on their chest? Uncomfortable, neutral, or intrigued?
PARTICIPANT: Uh...intrigued.
INTERVIEWER: Uh huh...and can you elaborate a little bit on your thoughts or your reaction to seeing...
PARTICIPANT: Uh...most of the devices that Ive seen my students with, its like in their belt or something.
INTERVIEWER: Okay
PARTICIPANT: Yeah
INTERVIEWER: Are they like navigational devices or...what are they used for?
PARTICIPANT: Yeah [theyre navigational devices], mhmm
INTERVIEWER: Cool

INTERVIEWER: Would your opinion change if you knew the device was aimed at helping the individual avoid objects in their path?

PARTICIPANT: Oh well um like of cou- I mean I would assume so [laughs]. If theyre blind [unintelligible] I dont know, but yeah

INTERVIEWER: Yeah I understand

INTERVIEWER: So would them wearing this kind of device make you hesitant to interact with the individual? Why or why not?

PARTICIPANT: Uh no it wouldnt. If its helping them then why not

INTERVIEWER: Right

INTERVIEWER: Uh so yeah thats basically all the questions in the interview do you have any other comments or concerns?

PARTICIPANT: Well...what type of device are you guys making?

INTERVIEWER: Right well, were still in the design process, but were thinking something like um...do you know the Microsft Kinect?

PARTICIPANT: Yeah

INTERVIEWER: Yeah we wanna use that cause its really good to use, it can detect objects and obstacles in the way and like um we were gonna put that on like the blind persons chest and then it would, we would somehow relay that information like identify the object thats in their path, and then tell them...

PARTICIPANT: Ohhhhhh so this is like...its almost like replacing a cane or a guide dog.

INTERVIEWER: Right well, we dont really wanna replace it, it would I guess just be like a complement to their cane and stuff but yeah ...

PARTICIPANT: Yeah okay, I thought this was like a GPS device

INTERVIEWER: Ohh..

PARTICIPANT: Like something that would tell them the street names and stuff

INTERVIEWER: Mhmm umm I think thats like a further goal we have but right now were trying to keep it pretty simple so...

PARTICIPANT: Oh okay

INTERVIEWER: Do you think if it was like a GPS that would be really helpful?

PARTICIPANT: Um...I think thats more needed

INTERVIEWER: Mhmm

PARTICIPANT: cause umm...I mean my students usually kind of like a...I dont want to say well a guide dog is definitely enough for them to get around, but rarely do kids get the opportunity to get the guide dog.

INTERVIEWER: Mhmm

PARTICIPANT: Uhhmm...I can see how that could help with the cane...yeah. Especially if um...yeah I see how that can help with the cane, itd have to be extremely responsive

INTERVIEWER: Right like real time

PARTICIPANT: I can tell you like the name of the top, the best GPS I guess device for the blind

INTERVIEWER: That the blind use?
PARTICIPANT: That I know of
INTERVIEWER: Uh huh, yeah what is it called?
PARTICIPANT: Its called Kapten spelled K-A-P-T-E-N, PLUS in all capital letters. Its by a company called Leader Dog. Its one of the companies that trains and gives out guide dogs. So they have a little video so um...its helpful
INTERVIEWER: Oh cool...so in your opinion, do you think that is the most pressing issue that blind people want? Like GPS kind of navigation? Or like identification of objects?
PARTICIPANT: Uhh...yeah [to GPS navigation]. Any type of...are you guys looking specifically at blind individuals? Or low vision too, like visually impaired, do you know what Im talking about?
INTERVIEWER: Right yeah we know, I think were focusing on blind
PARTICIPANT: So completely blind?
INTERVIEWER: Yeah
PARTICIPANT: Okay um...anything...if the device could somehow...I know this I think the GPS I told you about does this, I dont know how it does it, but Ive seen devices where it can tell the individual how to place their feet. Like um, blind people...when Im teaching a blind child to eat, for example, on a plate...like all children, cause like all vision teachers use this, they teach blind people with like the directions of a clock. So Ill be like, theres a piece of chicken at 12 oclock. You know what Im saying?
INTERVIEWER: Right, right yeah
PARTICIPANT: So that kind of um...direction is also used in their feet. Right so Ill be like place your feet at 3 oclock, and walk forward. I dont know if that helps
INTERVIEWER: Okay, so would you say thats the kind of directional stuff theyre most familiar with?
PARTICIPANT: Mhmm or also cardinal north, south, east, west.
INTERVIEWER: Right, okay, cool.
PARTICIPANT: Also um...
INTERVIEWER: Yeah
PARTICIPANT: I can give you the phone number of my best friend who is fully blind
INTERVIEWER: Oh, really?
PARTICIPANT: Um maybe...cause yeah well I I told him that I was speaking to you guys and he said, Well, you can shoot them my number if they want it Hes really open, really easy to talk to [laughs]
INTERVIEWER: Oh, thats great, yeah. We are actually also interviewing blind people so
PARTICIPANT: Oh okay
INTERVIEWER: Yeah so that would be helpful. Yeah can I have his name and number?

PARTICIPANT: Okay and I also have his email address, I dont which one youd prefer, I can give you all of it.

INTERVIEWER: Yeah I guess, all of it, yeah

PARTICIPANT: Okay. [proceeds to give contact information]

INTERVIEWER: So is he like pretty comfortable with technology and stuff?

PARTICIPANT: Yeah, extremely.

INTERVIEWER: Right

PARTICIPANT: He yeah [laughs], he knows a lot about technology. Also if you dont know, are you guys familiar with VoiceOver?

INTERVIEWER: Um...no, what is that?

PARTICIPANT: VoiceOver is something thats on the iPhone

INTERVIEWER: Oh okay, is it an iPhone app?

PARTICIPANT: Its not an app, its in the iPhone, like its...do you have an iPhone?

INTERVIEWER: Uh no, I have an Android

PARTICIPANT: Okay well its does anyone in your group have one?

INTERVIEWER: Uh yeah. Yeah

PARTICIPANT: Probably, most likely. If you go to Settings General Accessibility, it will turn on something called VoiceOver. And that um...when the...once a person touches the device, like I cant describe it, like one touch will tell them what it is, like if theyre touching for example, like the Messages little bubble, and then they double-click it, to actually press the button. So, I dont know, I think thats just like cool. You can get ideas from them, cause thats a really good um...

INTERVIEWER: So its really accessible to blind people

PARTICIPANT: Yeah, its really accessible

INTERVIEWER: Right, yeah that sounds interesting, we would have to check that out too.

PARTICIPANT: So...

INTERVIEWER: So yeah okay, anything else that you wanna say?

PARTICIPANT: Uhhhh...no.

INTERVIEWER: Okay

PARTICIPANT: Well um, if um...

INTERVIEWER: Yeah?

PARTICIPANT: I also have the email of the head of Orientation and Mobility at Florida State University thats where Im gonna go this fall. He obviously knows everything about blind people and moving around. Hes a very very nice man, I remember the first time I spoke to him, he talked to me like we were best friends. Im sure if you shoot him an email or something, hed be happy to have some input, if you want his email.

INTERVIEWER: Okay yeah sure thatd be great too.

PARTICIPANT: Okay [proceeds to give contact information]

INTERVIEWER: And hes the Orientation and Mobility

PARTICIPANT: Hes the Orientation and Mobility Coordinator for the Visual Disabilities Program at Florida State University. He goes by Mickey, I think his actual name is like Albert or something like that I dont know, but everyone calls him Mickey. And he signs all his emails Mickey, Mickey, Mickey so I dont know [laughs]

INTERVIEWER: Okay thats cool. So youre planning on like working with him?

PARTICIPANT: Yeah, hes one of my professors

INTERVIEWER: Oh cool

PARTICIPANT: Yeah, Im majoring in teaching the blind so

INTERVIEWER: Mhmm yeah, thats great

PARTICIPANT: Yeah feel free to you know to email me any questions, and Ill answer them

INTERVIEWER: Okay yeah thatd be great. Yeah, thank you so much for your time and for your input

PARTICIPANT: No yeah its...I dont mind at all [laughs]

INTERVIEWER: Yeah well contact you if we need to talk to you again, thank you!

PARTICIPANT: Okay sounds great, bye

INTERVIEWER: Bye

Subject 5

[omitted introductions]

INTERVIEWER: So I just want to remind you that everything said in this interview remains confidential

PARTICIPANT: Okay

INTERVIEWER: Okay, we are going to start now

INTERVIEWER: What is your age?

PARTICIPANT: My age is fifty years old

INTERVIEWER: And your gender?

PARTICIPANT: My gender is male

INTERVIEWER: And what is the total household income?

PARTICIPANT: Uhhhh I dont remember... Uhhh lets go with 90,000 a year

INTERVIEWER: Okay

INTERVIEWER: And what is your race?

PARTICIPANT: Im Caucasian

INTERVIEWER: And what is your highest degree obtained?

PARTICIPANT: Masters degree

INTERVIEWER: How often would you say do you interact with the blind?
Either: never, rarely, sometimes, or often.

PARTICIPANT: I would say umm really rarely

INTERVIEWER: Okay

PARTICIPANT: Its interesting that that would be the case but really rarely

INTERVIEWER: Umm do you experience any difficulties when interacting socially with the blind and if so what?

PARTICIPANT: I dont think I do because I try to be aware of any reaction that I may have internally and um understand that and then deal with it internally and not let it be apparent in my actual outward interaction with anybody

INTERVIEWER: Okay

PARTICIPANT: And the reaction internally would be because it is a rare occurrence you know just understanding that its different thats all. You take pause and you realize that its just a little different, unique.

INTERVIEWER: So how does your behavior change when interacting with a person that is blind?

PARTICIPANT: Well I think its funny because in the past when I was younger I may have raised my voice a little bit more, speak loudly to someone who is blind which is of course ridiculous... um I would thats really the only unusual response that I would have. When I was younger I would be uncomfortable but as I grew older I just realized that it was just an individual deficit in that one sense but I understand now as I grow older also that the other senses may be more acute especially someone who has had blindness from a very early age they themselves may not even regard blindness as a limitation its just a different way of interacting with the world

INTERVIEWER: Right so you would say that you really would not act in a different way than you would with someone who is sighted?

PARTICIPANT: No I dont think so I would just try to be normal

INTERVIEWER: Okay great

INTERVIEWER: How would you react if you saw a person with a navigational device equipped to their chest? Would you either be uncomfortable, neutral, or intrigued?

PARTICIPANT: Well can you explain the navigational device?

INTERVIEWER: Yes. So basically it is a device that we are working on and most likely it is going to be on their chest and hopefully it wont be so bulky but as of now we are using the Microsoft kinect machine which tends to be a little bit of a bulkier device and it would be mounted and it is used as a navigational device so it takes in external information and either through tactile or audio it is communicated back to the user so its something that is connected to them

PARTICIPANT: Interesting interesting... Uh yeah I would be taken aback at first

INTERVIEWER: So you would be a little bit uncomfortable?

PARTICIPANT: Possibly uhh

INTERVIEWER: So please elaborate on why you would be uncomfortable

PARTICIPANT: Its a curiosity and maybe a discomfort with the unknown just like before I even tried to ask you the question I asked you to explain it so maybe I would want the person to explain to me what it was um

especially if I thought it was recording my voice then I would like to know that but after it was explained it would be fine then I would be cool with it I would be very comfortable

INTERVIEWER: Okay great

INTERVIEWER: Would your opinion of the object change if you knew the device was aimed at helping the individual avoid objects in their path and you basically just said that yes you would not feel uncomfortable with that

PARTICIPANT: Yes its a wonderful idea

INTERVIEWER: Okay um would the implementation of such a device make you hesitant to interact with the individual? Why or why not?

PARTICIPANT: No

INTERVIEWER: So first seeing it on them, would that make you hesitant to go and approach them to talk to them

PARTICIPANT: The very first time I saw someone with it

INTERVIEWER: Yes

PARTICIPANT: Maybe but once I understand what the device was and once it was publicized and marketed more and more people had one of those

INTERVIEWER: Yeah

PARTICIPANT: Then I would not be hesitant to interact with them at all

INTERVIEWER: Okay

INTERVIEWER: So our last question is do you have any other questions, comments, concerns regarding anything that we are planning on doing?

PARTICIPANT: Um no have you tried it on anybody yet? Does one actually exist a prototype or anything?

INTERVIEWER: So nothing exists thus far but we are in the process of creating it

PARTICIPANT: Good

INTERVIEWER: And once we finish creating it, which will hopefully be by this fall, we are going to start doing testing with people who are visually impaired

PARTICIPANT: Excellent

INTERVIEWER: So from then well have (cuts off after this)

Subject 6

[omitted introductions]

INTERVIEWER: Just want you to know that everything you say remains confidential. Uhm, okay. So lets begin. How old are you?

PARTICIPANT: 49.

INTERVIEWER: And what is your gender?

PARTICIPANT: Female.

INTERVIEWER: And what is your estimated household income?

PARTICIPANT: 125 thousand.

INTERVIEWER: Okay. Annd what is your race?

PARTICIPANT: Caucasian.

INTERVIEWER: Great. And what is the highest degree you obtained?

PARTICIPANT: Masters degree.

INTERVIEWER: How often would you say do you interact with the blind?

Either: never, rarely, sometimes, or often.

PARTICIPANT: Often.

INTERVIEWER: Aand do you experience any difficulties when interacting socially with the blind and if so what?

PARTICIPANT: No difficulties.

INTERVIEWER: How does your behavior change when when interacting with a person that is blind?

PARTICIPANT: ...I think sometimes I tend to speak a little louder and a little slower but Im pretty aware that I dont want to do that so I kind of check myself but I am sure that there are times that I do. Uhmm ... Initially, I created I didnt give them as much ability to be autonomous and recognize that they had the abilities to compensate for their lack of vision.

INTERVIEWER: Okay Great. Okay.

INTERVIEWER: How would you react if you saw a person equipped with a navigational device on their chest? And this is, just to clarify, a device that takes in external information from the environment and it gives the feedback back to the user so it allows them to better navigate through their surroundings. So such things as like object recognition and path detection.

PARTICIPANT: So, in essence it would work aas much more of a comprehensive walking stick.

INTERVIEWER: Yeah.

PARTICIPANT: Would it?....

INTERVIEWER: So, would you feel comfortable, neutral, or intrigued?

PARTICIPANT: Intrigued.

INTERVIEWER: Intrigued. Okay.

PARTICIPANT: But very comfortable with it.

INTERVIEWER: Okay. So, please elaborate on your reaction. So you said very comfortable. So you wouldnt be taken aback if you saw this device that is easily seen by the public eye, its not something that is going to be very masked at least in this stage of it.

PARTICIPANT: I would be intrigued by it, Id question what it is. But Id be pretty impressed that this can help to increase their mobility, increase their autonomy, and their independence.

INTERVIEWER: Okay great.

PARTICIPANT: Im much more you know, Im much more sensitive to people with walking sticks now, uhm people with with uh seeing-eye dogs, people with disabilities because of my exposure to um being around someone with macular degeneration who had lost her vision.

INTERVIEWER: Would your opinion of change if you knew the device was aimed at helping the individual avoid objects in your path? So, in other words, if right off the bat you knew exactly what the device was uhm enabling these people to do. You wouldnt feel right - feel very comfortable right away.

PARTICIPANT: I would feel very comfortable right away.

INTERVIEWER: Okay, and would the implementation of such a device make you hesitant to interact with the individual? Why or why not?

PARTICIPANT: Absolutely not! It would It would not change it might change the way I interacted because I would probably uhm... really encourage their independence.

INTERVIEWER: And lastly, do you have any other comments or concerns that youd like to address in this interview. B No. Anything that can increase their independence and mobility is wonderful and terrific.

INTERVIEWER: Okay cool. Thank you so much for doing this.

PARTICIPANT: You are so welcome.

Subject 7

[omitted introductions]

INTERVIEWER: Okay so before we begin Id like to remind you that all your answers will be held confidential and if you have any questions during the interview please feel free to ask me at any time.

PARTICIPANT: Okay.

INTERVIEWER: Okay so the first question is what is your age?

PARTICIPANT: 50 years old.

INTERVIEWER: uhuh and what is your gender- male, female, or other?

PARTICIPANT: Female.

INTERVIEWER: Sorry, it is like a standard question that we have to ask.

PARTICIPANT: Okay

INTERVIEWER: What is your household income? Is it 0-\$19,000, \$20,000-\$39,000, \$40,000-\$59,000, \$60,000-\$79,000, \$80,000-\$99,000, \$100,000-\$149,000, or greater than \$150,000?

PARTICIPANT: its 90 to 140 thousand about.

INTERVIEWER: Uhm well theres one range that is from 100 to 149 thousand or 80 to 99 thousand.

PARTICIPANT: Okay, 100 to-

INTERVIEWER: 149?

PARTICIPANT: Yes.

INTERVIEWER: What is your race?

PARTICIPANT: Asian.

INTERVIEWER: What is the highest degree you have obtained?

PARTICIPANT: Masters degree.

INTERVIEWER: And how often do you interact with the blind- never, rarely, sometimes, or often?

PARTICIPANT: Yes, so my grandma was a blind person so I live with her from my 5 years old and all the way till 5th grade. So its uhm...

INTERVIEWER: so 6 years?

PARTICIPANT: No, its uhm....yea, 6 or 7 years.

INTERVIEWER: When you interacted with your grandma did you experience any difficulties when interacting socially with her? If so, what? Like social cues or something

PARTICIPANT: Not really. I mean, I know my grandma cannot see me, but shes very sensitive to hear things so even sometimes I tried to play kind of try to trick her and try to sneak into a room and she could easily hear the little noise and uhm, of course the difficulty is she she has to you know, we dont have any uh guiding dog or anything. Everything has to be helped by the family members. Like the three meals, always me or my cousin, we brought it to her. And we brought water to her for - wash herself and take a shower and all that...she need all the help. But she could kind of wash her clothing but I kinda raising it finally for her but she could do the initial. But amazingly, she could do the

INTERVIEWER: Knitting?

PARTICIPANT: she could do the knitting work, some of it.

INTERVIEWER: So she didnt have like a white cane, the stick thing to help her?

PARTICIPANT: If we took her out for walking and get some sunshine, then yes we would give her to figure out the roadway, whether it is flat or have some bump.

INTERVIEWER: How did your behavior change when interacting with her? Like compared to a person that can see

PARTICIPANT: Of course, we always think we needed to take care of her. And she needed the help. So, its obligations. And its just uh, as a family member, the whole family has to take of her. Its a responsibility. Of course, for a normal person, you dont need to put a great care for a normal person as family member they can help themselves, but for a blind person of course, its uh its in a way more of a responsibility for a family member. Yes.

INTERVIEWER: How would you react if you saw a person with a navigational device strapped on their chest? Uncomfortable, neutral, or intrigued?

PARTICIPANT: Its just normal. I think that they should have it.

INTERVIEWER: But how would you feel if you saw that?

PARTICIPANT: Just normal.

INTERVIEWER: So, neutral?

PARTICIPANT: Yes, neutral.

INTERVIEWER: Like it would and the follow up to that question is like can you elaborate on that reaction?

PARTICIPANT: The blind person, of course they need some kind of guidance or device and normally in here you will see the blind persons they will be guided by a dog. And if you create this device, and it is publicized and people know what the device is and of course, people will not have any suspicions or anything about it and not react strangely to that.

INTERVIEWER: Would your opinion change if you knew the device was aimed at helping the blind person avoid objects in their path, or.. ? I guess you would feel the same.

PARTICIPANT: Of course I would feel that same. And that they ...as I said before, for a blind person, its not normal, they definitely need the extra help and as a society we should create the kind of condition to kind of accommodate and support them.

INTERVIEWER: Would them wearing the device make you hesitant to react with the individual? Why or why not?

PARTICIPANT: No, absolutely not. And why, as I say, it should be viewed as normal. Probably, people will be happy to see such a device be created to help them. That would be a great help.

INTERVIEWER: So if you saw a person, I guess that you would assume is blind, that had that kind of device on their chest you would assume that it would be helping them to see ...

PARTICIPANT: Uh yes, it would be helping them navigate the roadways safely, not to bump into objects and fall on the ground and all that.

INTERVIEWER: Do you have any comments or concerns about the project or anything?

PARTICIPANT: No, Im just glad that the subject was choosed and then researched. And then a question is I dont know if such a device exist already, and yes or no?

INTERVIEWER: There are some similar devices but with our project we are using a device that isnt normally used by blind people but could potentially help them. But the function is similar to other devices out there. It could possibly identify objects and then tell the blind person how to avoid it or how to get to a destination. I was also going to ask you, like, I guess with your experience with your grandma, did you see a priority for a blind person in terms of navigating, what would help them the most in , in like navigating? Like do they need help with avoiding objects or just knowing how to get to a destination in an unknown place?

PARTICIPANT: Thats a good question. Since my grandma was blind and she doesnt need to go to work, and she doesnt need to see a doctor, those things will be helped by us, so she doesnt have any desitnation to go if she walks she just goes to get the sunshine and get some fresh air. But for general, here in society, blind has a destination to go, so I think those two purposes should be combined. Go to the destination just like a GPS, and where to go and how to take a transit and how do you- from where to get on transit stop and how do you work and got to your

destination which bus to take or which metro to take and all that. Of course they cannot drive. So, its both- navigation and get to the destination. The place.

INTERVIEWER: Yeah, that is helpful. Someone actually told us about a similar device that does that. But its like, based in the U.K. but Im not sure if it can be used in America. But it helps, it like tells them [public transportation in like London and reads out street names to them and which stops to take and stuff.

PARTICIPANT: Wow.

INTERVIEWER: Yeah I saw a demonstration of it on youtube and it seemed it really useful to blind people.

PARTICIPANT: Oh yea, that would be great. I mean, reading the street names and all that.

INTERVIEWER: Hopefully our device can kind of do that too.

PARTICIPANT: ;laughs; okay.

INTERVIEWER: But well see. Okay, thank you for your time.

PARTICIPANT: Youre welcome

Subject 8

[omitted introductions]

INTERVIEWER: Okay are you ready?

PARTICIPANT: Yes

INTERVIEWER: Can I have your age?

PARTICIPANT: Fifty-Seven

INTERVIEWER: Okay, did you say fifty or sixty?

PARTICIPANT: Fifty

INTERVIEWER: Okay

INTERVIEWER: And your gender is female

INTERVIEWER: Is your household income... (Proceeded to list all of the salary options)

PARTICIPANT: Above 150,000

INTERVIEWER: Okay

INTERVIEWER: What is your race?

PARTICIPANT: Caucasian

INTERVIEWER: Okay

INTERVIEWER: How far have you gotten in your education?

PARTICIPANT: College graduate

INTERVIEWER: Okay so is that Bachelors

PARTICIPANT: Yes

INTERVIEWER: How often do you interact with the blind?

PARTICIPANT: uhh daily

INTERVIEWER: Daily okay

INTERVIEWER: You work with them right?

PARTICIPANT: Yeah I examine patients eyes. Not every patient is blind but at least some are blind.

INTERVIEWER: Okay

INTERVIEWER: So do you experience any difficulties when interacting socially with the blind? If so what?

PARTICIPANT: Umm it depends on what you mean by blind. Are they completely blind where they cant see anything or do they just have a restricted vision? What do you mean by blind?

INTERVIEWER: Okay were trying to focus on the people that are completely blind

PARTICIPANT: So they cant see anything?

INTERVIEWER: Yes

PARTICIPANT: Okay umm I guess I should rephrase that then I dont see them everyday if they are completely blind, some patients have a little bit of vision, so I guess that I should say that I see them daily. I see people that have vision loss daily but not completely blind. But as far as interactions...

INTERVIEWER: Are some of your patients completely blind?

PARTICIPANT: Sometimes they may be completely blind in one eye but not necessarily in both eyes so I dont really know how to answer that. Sometimes I dont know if theyre completely blind or not when I see them, but I dont what about it is difficult. I guess the greatest difficulty would be giving them instructions, because in my job I have to tell them to move their eyes in certain directions.

INTERVIEWER: And when you tell them theyre not able to do it or...?

PARTICIPANT: Sometimes when you cant see its hard to figure out which way youre moving your eye so you have to move your eyes up or down or left to right its hard to know when you cant see where youre supposed to be looking.

INTERVIEWER: Okay

PARTICIPANT: Does that make sense?

INTERVIEWER: Yeah

INTERVIEWER: So how does your behavior change when interacting with a person who is blind?

PARTICIPANT: Um I guess talking more slowly and I guess that would be it. Just talking more slowly than I should so they can understand what I am saying.

INTERVIEWER: Okay

INTERVIEWER: How would you react if you saw a person equipped with a navigational device on their chest (uncomfortable, neutral, or intrigued)?

PARTICIPANT: How would I react to it? I wouldnt really think too much about it.

INTERVIEWER: Okay so neutral?

PARTICIPANT: Right

INTERVIEWER: Okay can you tell me more about why you wouldnt think too much about it?

PARTICIPANT: I guess because I see a lot of patients with seeing-eye dogs and with canes; its just one other way of getting around.

INTERVIEWER: All right thank you.

INTERVIEWER: Okay next question, would your opinion change if you knew the device was aimed at helping the individual avoid objects in their path?

PARTICIPANT: I would say neutral again

INTERVIEWER: Okay, and can you tell me why you would be neutral again?

PARTICIPANT: Well I think its great that they would have something that assists them

INTERVIEWER: Okay

PARTICIPANT: I wouldnt want to treat them any differently than anyone who does have vision

INTERVIEWER: Okay

INTERVIEWER: Would the implementation of such a device make you hesitant to interact with the individual? Why or why not?

INTERVIEWER: Im assuming no

PARTICIPANT: No I wouldnt want them to made to feel like they are different from somebody else

INTERVIEWER: Okay

INTERVIEWER: Do you have any other comments or concerns for us?

PARTICIPANT: No

INTERVIEWER: Okay well thank you so much.

PARTICIPANT: Good luck with everything!

INTERVIEWER: And if you know anyone else please just send them our way

PARTICIPANT: I sure will

INTERVIEWER: Okay thank you

Subject 9

INTERVIEWER: Okay, so how do, or did in your case, your behavior change when interacting with a person who was blind?

PARTICIPANT: Well, I was very aware that, that I had to give verbal instructions and communication, and its rude to just start talking to blind people and expect them to know who it is. I mean, I think often people dont realize it, but I would regularly see people just start talking like they might not have seen my mother for 10 years, and so I would always identify myself. What was the original question again?

INTERVIEWER: How does your behavior change when interacting...

PARTICIPANT: Well I lost my uncomfortableness with it, I didnt, you know, I was comfortable. Im sorry, tell me the question one more time?

INTERVIEWER: Its okay. Its how does your behavior change when interacting... and if it didnt really, you can say that too.

PARTICIPANT: No, but I was very conscience of how...I learned how to walk with someone, you dont pull them, and take them. You just let them put their arm on you. I would learn what things she was able to do by herself, and what she couldnt. Theres often tendency sometime to almost do too much for blind people. They havent loss all of their functions. You know, blind people that are otherwise healthy and mentally fit can do most things themselves. P.S. I think I told [redacted] to tape it, but if you watch on ESPN, they repeat over and over stories. Today they had a blind pole vaulter. A young woman. You know what pole vaulting is?

INTERVIEWER: What is it?

PARTICIPANT: Pole vaulting, when you run and you stick in a pole in the ground, and then you go over a pole?

INTERVIEWER: Yeah, I do.

PARTICIPANT: Shes blind. Yeah, so that you should try to catch that on ESPN. We can see if we caught it, but...so blind people can do quite a bit. So you have to get over the tendency to infantilize blind people.

INTERVIEWER: So how would you react if you saw a person equipped with a navigational device on their chest? The device that we are creating would be located...

PARTICIPANT: How would I what?

INTERVIEWER: So how would you react if you saw someone walking with this...

PARTICIPANT: And they were blind?

INTERVIEWER: And you knew they were blind.

PARTICIPANT: I think its great!

INTERVIEWER: You think its great.

PARTICIPANT: Sure!

INTERVIEWER: Okay. So youd be intrigued by it.

PARTICIPANT: Yeah I dont see any doubts about it.

INTERVIEWER: Okay

PARTICIPANT: Its anything we can use in science to make people more independent. The key blind people just wanted to do whatever sighted people could do. Obviously there are a few limits but even that. I was going to say driving, but who knows...

INTERVIEWER: Yeah. Its amazing.

PARTICIPANT: So who knows, but yeah I think a navigational system would be a phenomenal device.

INTERVIEWER: Okay. So, would your opinion change, in your case you would think itd be great, but if you knew the device was aimed at helping them avoid objects, so you would...that would even more probably.

PARTICIPANT: Yeah, I dont know if you saw the...wondering if sometime equipment freaks people out. Like I dont know if you saw people that have lost their voice, but they use that little...

INTERVIEWER: The...I forgot what its called, but I know.

PARTICIPANT: Deliver the pizza dont clown with that. So, I guess with some things, it would make people uncomfortable, but I dont see why a navigational device would make other people uncomfortable. Its not like youre watching somebody, you know, shoot an insulin in, or other things that physically make us uncomfortable. I dont see uncomfortable as being an issue. And frankly, even if it did, no one would really care how other people perceive them.

INTERVIEWER: Okay. Great. And would implementation of such a device make you hesitant to interact with them or approach them in any way?

PARTICIPANT: Say that again? Would it make me...?

INTERVIEWER: Would it make...yeah. Would it make you hesitant to interact with them in any way or approach them

PARTICIPANT: [incomprehensible] No it would not make me hesitant. But again, that is one of the, I think, odd social things with a blind person, where you could see them, but they cant see you, and you dont know if you should offer to give help or offer to help, or offer to make conversation. And I guess a navigational device might make you feel that if you invaded someones space that it might go off an alarm, and I dont know, but I mean generally what I do is, if I see someone thats blind and they seem to be in an awkward situation, like maybe crossing or something, Ill offer help, but if I otherwise see someone whos blind just walking along fine with a cane, I wont get involved.

INTERVIEWER: Right. Okay. Do you have any other comments or concerns regarding our project?

PARTICIPANT: Yeah, I think its a phenomenal project, I dont know why science and big business isnt working on it more, I think its a...once you say it its so obvious that there should be all kinds of things whether its sonar, or etc that should be in place to help blind people. It almost seems like when we go with dogs, were still, which I understand has a lot of other benefits, but we using science from like 100 years ago. So, it seems like science and technology has not been applied to whats a huge problem, so I think its a great great idea.

INTERVIEWER: Okay. Well, thank you very much for doing this interview. We appreciate it

PARTICIPANT: Well, its a wonderful project, and youre doing Gods work, and good luck, I want to hear how it all works out.

INTERVIEWER: Thank you. We will let you know.

PARTICIPANT: Thank you.

Appendix E: DATA AND SURVEY RESULTS FOR HAPTIC TESTING

Demographics

Gender:

Male	6
Female	9

Household Income:

\$0-\$19,000	3
\$20,000-\$39,000	0
\$40,000-\$59,000	1
\$60,000-\$79,000	0
\$80,000-\$99,000	0
\$100,000-\$149,000	3
\$150,000+	3
Prefer not to answer	5

Race:

American Indian/Alaskan Native	0
Black or African American	3
Asian or Pacific Islander	3
Hispanic/Latino	1
White	8
Other or Not Reported	0

Education (Highest degree obtained):

Some High School	0
High School Diploma/GED	2
Some College	13
Other	0

Age:

1	9, 9
2	0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1

Experiment / Survey Results

Date of Experiment	Subject ID
2/22/14	01, 02, 03, 05, 06, 08, 12
3/01/14	04, 07, 09, 10, 11, 14, 15, 16

Reaction to Vibration	Number of Subjects
Away	8
Toward	4
Sporadic	1
No Reaction	2

Question 1:

How did you interpret the vibration when you initially felt it?

- Subject 01: “It was letting me know that an object may be in my way when it vibrated”
- Subject 02: “it was an obstacle on the side I felt the vibration”
- Subject 04: “By feeling a vibration on my right shoulder, I knew I needed to move right instead of continuing left”
- Subject 06: “As a signal to go the other way (away from the vibrating side)”
- Subject 07: “A signal of an obstacle on the same side as the vibration i.e. move away from the vibration”
- Subject 08: “At first I was inclined to turn in the direction of vibration, but after I felt an object in my path reversed my reaction. After reversal, vibration avoidance felt quite natural.”
- Subject 09: “something was blocking me on my right if it vibrated on my right side”
- Subject 10: “there was an object on the side of the vibration”
- Subject 11: “...I turned towards it”
- Subject 16: “I interpreted the vibration as the direction in which to turn and continue walking.”

Question 2:

Why do you believe you responded in this manner?

- Subject 01: “natural to respond in this manner”
- Subject 02: “to avoid the obstacle”

Orientation of Reaction	Number of Subjects
Turn	8
Strafe	4
Strafe then Turn	1
Turn then Strafe	1
No Reaction	1

- Subject 04: “The non-vibrating side gave me no information. The vibrating side recommended a specific direction or course of action”
- Subject 06: “Because I normally [sic] try to walk away from unusual stimuli”
- Subject 07: “If a person was guiding me around an obstacle, I would interpret a light, short signal (like a tap or push) as a signal to move away from the origin of the signal”
- Subject 08: “Perhaps Ive been trained to vibrations (phones, etc)?”
- Subject 09: “The vibration was like a warning sign...”
- Subject 10: “...I feel like the device would tell me where an object was...”
- Subject 11: “It felt like someone was trying to get my attention from that side”
- Subject 12: “It seemed that it was signaling there was on obstacle on the right side, so I moved left”
- Subject 14: “it felt more natural”
- Subject 16: “My natural inclination is to move towards the stimuli and not away from it, and felt the vibration as an attractor and not a repellent.”

Appendix F: SCRIPT READ TO SIGHTED/BLIND PARTICIPANTS

Sighted Testing Part 1 (With cane only):

Hello number _____,

You have just received brief experience with usage of the cane. You are now about to enter an obstacle course to test once without our device and once with our device. There are boundaries within this obstacle course, and our guides who will be walking with you will direct you back onto the obstacle course should you ever stray from it. You will attempt to navigate through the course until you hear STOP. You have reached the end of the course. The first run will be without the device. Begin walking and use the cane to navigate. Go.

You will now be guided back to the beginning of the course and one of our helpers will place the device on your body.

[Once they put it on] As told in the conference room, you are trying to stray away from the side of vibration. If you feel both motors vibrating, there is an obstacle directly in front of you, and you can go in either direction to avoid the obstacle. You will attempt to navigate through the course until you hear “STOP. You have reached the end of the course.” You may begin walking now.

Thank you for participating, you will now be guided out of the lab.

Blind Testing Part 1 (With cane only):

Hello,

You are now about to enter an obstacle course to test our device. You will go through our test course once without our device and twice with our device. The first run will be without the device. You will attempt to walk towards the other end of the room, where my voice is currently. You will navigate through the course until you hear “STOP. You have reached the end of the course.” Do you have any questions? Begin walking and use the cane to navigate. Go

You will now be guided off the course and one of our helpers will place the device on your body to pretest before joining us again for another test.

Blind Testing Part 2 (With cane and device):

Hello,

As told in the pretest room, you are trying to stray away from the side of vibration. For example, if the device vibrates on the left side, you should move to the right. If you feel the center motor vibrating, there is an obstacle directly in front of you, and you can go in either direction to avoid the obstacle. While navigating this course, you may encounter over-hanging objects. In addition, if you hear the phrase “Stair ahead”, be aware of a raised platform in front of you that you may step up on. You will attempt to navigate through the course until you hear “STOP. You have reached the end of the course.” Do you have any questions? Please wait while the device is being configured. You may begin walking now. Go.

You will now be guided off the course and one of our helpers will bring you back once we have a new course ready for you to navigate.

Welcome back for the third round of testing. Do you want the conditions of the device read to you again? (Yes/No). Do you have any questions? You may begin walking now. Go.

You will now be guided off the course and one of our helpers will bring you back once we have a new course ready for you to navigate.

Welcome back for the final round of testing. Do you want the conditions of the device read to you again? (Yes/No). Do you have any questions? You may begin walking now. Go.

Thank you for participating, you will now be guided out of the lab.

Appendix G: DATA FOR SIGHTED PROTOTYPE TESTS #1

Experiment was performed on 12/06/2014

Demographics

Gender:

Male	7
Female	5

Household Income:

\$0-\$19,000	1
\$20,000-\$39,000	0
\$40,000-\$59,000	1
\$60,000-\$79,000	2
\$80,000-\$99,000	1
\$100,000-\$149,000	2
\$150,000+	2
Prefer not to answer	3

Race:

American Indian/Alaskan Native	0
Black or African American	0
Asian or Pacific Islander	6
Hispanic/Latino	0
White	6
Other or Not Reported	0

Education (Highest degree obtained):

Some High School	1
High School Diploma/GED	2
Some College	8
Bachelor's	1
Other	0

Age:

1	8, 9
2	0, 1, 1, 1, 1, 1, 2, 2, 2, 3

Height: (a few participants were omitted)

5'	2", 5", 6", 7", 9", 10", 11"
6'	0", 1"

Experiment / Survey Results

It was easy for me to use this device.

Strongly Disagree	0
Disagree	2
Neutral	1
Agree	5
Strongly Agree	4

The device was accurate when detecting an object in my path.

Strongly Disagree	0
Disagree	1
Neutral	3
Agree	7
Strongly Agree	1

The device was accurate in navigating me away from an object.

Strongly Disagree	0
Disagree	2
Neutral	0
Agree	10
Strongly Agree	0

Please describe any difficulties you had while using this device or suggestions you have for improvement that would better aid a blind user.

- It essentially vibrated the whole time so it was hard to figure out which way to go.
- Wasnt sure if there were any objects at head level until I ran into it. At ground level, had to rely on using the cane. The intensity vibrations were kind of stressful but I guess it was a warning so thats what its supposed to do (or maybe I just needed to get used to the device).
- It seemed to have the same amount of feedback no matter how far away the obstacle was (ie, I could not tell if it was 1 foot away or .23)
- The vibrations were sometimes too frequent. If there was more time to use the device maybe give 3 examples for the participants to feel. For depth perception I didnt really know how far ahead an obstacle was. It may be different for a blind person.
- It was stressful to have the device buzzing all of the time. I think I got caught up in paying attention to the vibrations of the device and didnt use the cane much at the beginning. Then I started using the cane more and got overwhelmed with all the different things happening cane hitting things and device vibrating- and got more lost than before.
- Binary results, left or right, and a combined result forward dont provide enough resolutions to be as useful as most visually impaired people would probably want to improve over current methods of self-navigation.
- It was more difficult to navigate when the device mostly because there were more sensory inputs for me to process.
- There was one moment during the test that I encountered a low object that the device did not warn me about, but the cane was a useful pairing to help navigation, otherwise it worked well.
- Possibly break up vibrations kind of like mores code, so theres not a constant vibrations.
- I felt like a few times it was inconsistent. There were objects that I found with my cane that I dont believe got picked up by the device. I do think the device was pretty good for the most part.
- It often switched vibrating one shoulder to both and vice versa too fast to get a sense of what was around me. Also if there was something in front of me I knew to turn, but not which direction.
- I found that the device warned me of objects that did not seem to be there a few times. It would vibrate on one side, but I didnt need to change my direction. Also, at one point there was what felt like a piece of paper at eye level and neither the device nor the cane helped me navigate past it. I just ducked and hoped for the best. So, maybe try to detect objects that are off the ground as well.

Please describe any difficulties you had while using this device or suggestions you have for improvement that would better aid a blind user.

- The vibrations were helpful in alerting me of larger objects but still relied for the cane for things at ground level and ran into an object at head level. Basically just had to turn until I didnt feel any vibrations.
- The vibration on either side was useful, but for a few items both would buzz when I bumped into something on my left/right, so I felt away from it with the cane.
- The vibrations were sometimes hard to distinguish when both were vibrating then switching to one side
- The vibrations were very strong and overwhelming at times. If given more time to use it and if it were a necessity then I would probably put up with using it. However, it would need to be tones down in intensity for the device to be comfortable to use. The vibrations were also very loud so I couldnt hear as well the subtitles if the cane touching different flooring which ultimately was a hindrance. Interpreting the buzzing was fine.
- The vibrations were clear, but it would be useful to have more resolution in the X-Y plane and feedback in the Y-Z plane.
- Its easy to interpret that the buzzing indicates an obstacle, but when using the cane I would get inputs that disagreed with what the vibrations were telling me.
- The vibrations were very helpful and easy to interpret.
- It took a while to interpret the buzzing but it was easy to grasp. However, I personally felt the cane was more helpful.
- Sometimes they were helpful. Other times I felt the cane was sometimes the easier option. I did get confused when it vibrated both shoulders, and the left as well (I got confused what direction to go).
- I think the cane was more intuitive and the vibrations confused me. Maybe if I had more practice it would work better.
- The vibrations were easy to interpret and they were helpful overall. I felt more confident walking forward with the device when there were no vibrations than with a cane alone, because I trusted I would not hit anything. They were helpful in allowing me to better visualize my surroundings.

Times

Test #	Time without Device	Time with Device
1	2:10	1:22
2	0:56	0:49
3	1:01	0:52
4	1:38	1:51
5	1:39	2:52
6	1:19	1:54
7	1:16	3:13
8	1:36	1:12
9	1:07	1:18
10	2:48	N/A
11	2:06	4:06
12	1:37	2:01

Appendix H: QUALITATIVE NOTES FOR SIGHTED PROTOTYPE TESTS #1

Subject 1

Note: we had technical problems with the prototype for this participant

First Round: Course A

Second Round: Course B

First Round- Test using only cane, configuration 1: Her starting position is between chairs and door, facing towards my side of the room. Hit chair with cane. Slowly walked forward, using cane. Walked past table using cane. Turned around, went toward farther boundary. Close to the boundary farther away from me. Made a full circle around table. Walked past table. Went in the same circle again. Stepped off the course. Asked to move backward, asked to turn right. Walked forward. About to hit a team member in the room. Asked to stop, guided outside. Did not touch the pallets. No sense of direction, subject turned twice in open space until she stepped out of the course.

Second Round- Test using cane and our device, configuration 2: Same starting position. Problem with prototype; motors not responding, wire problem. Fixed. Walking forward. Turned around properly. Asked to move to left to avoid moving off course. Hit pallet with stick, walked around them. Moving at an angle toward edge of course. Hit camera with stick. Facing toward far edge of course. Moved off course again. Asked to move back and to right. About to hit a team member in the room. Reached end of course. Subject stopped at times, signifying she might be confused about what shes experiencing.

At this point, we changed the overhanging obstacle to be wider.

Run #1 (Without device): 2 minutes, 10 seconds

Run #2 (With device): 1 minute, 22 seconds

Subject 2

First Round: Course B

Second Round: Course A

First Round- Test using only cane, configuration 2: Subject was faced away from door. Hit chairs with cane. Strafed around them. Walked past the chairs. Walked around the pallets. Almost hit a team member in the room. Turned around, walked forward, walked toward the finish.

Second Round- Test using cane and our device, configuration 1: Same starting position. Turned around, walked parallel to chairs towards table. Turned away from table, walked off course, asked to go back. Walked to edge of course, turned around. Hit overhanging obstacle. Hit pallets with cane. Reached the end of course. Either the device did not recognize overhanging poster as an obstacle or the device simply didn't see it.

Subject 3

First Round: Course A

Second Round: Course B

First Round- Test using only cane, configuration 1: The subject was faced away from door. Hit chairs with cane, turned around, walked forward. Went off course, asked to move left. Hit table because the cane did not detect it. Walked around table, went off course again. Table moved. Walked off other side of course, asked to move right. Hit overhanging obstacle, walked off course. Hit pallets with stick, walked around, reached end of course.

Second Round- Test using cane and our device, configuration 2: The subject was faced away from door. Walked around chairs. Walked off course, asked to move left. Walked around pallet, off course, asked to move left. Turned around near overhanging obstacle, facing beginning of course. Subject avoided overhanging object, and was careful around it. Turned back around, shoulder bag fell off (note: strap too short, did not go on opposite shoulder). Walked to end of course.

Subject 4

First Round: Course B

Second Round: Course A

First Round- Test using only cane, configuration 2: The subject was faced away from door. Hit chairs with cane, strafed toward closer wall. Strafed past the chairs toward the opening now. Walked forward, turning around the chairs. Walked forward toward edge of course, but turned around, facing forward. Slowly walking forward. Hit overhanging obstacle, walked around it. Hit table with cane. Strafed around the table. Reached the end of the course.

Second Round- Test using cane and our device, configuration 1: The subject

was faced away from door. Strafed around the chairs, first right way, then went back the wrong way. Then went back the right way. Walked forward through the gap. Walked around the table, because the device detected it. About to hit the edge of the course, but turned around before that. Hit overhanging obstacle again, because the device did not detect it. Hit pallet with cane. Hit overhanging obstacle again, used hand to move it. Reached the end of the course. Subject seemed to be confused about the vibrations in the beginning.

Subject 5

First Round: Course A

Second Round: Course B

First Round- Test using only cane, configuration 1: The subject was faced away from door. Walked around the chairs. Walked off course, asked to move left. Hit table with cane hit the legs of the table, walked around it off edge of course. Turned around, walked past table. Walked off course, asked to move right. Moved forward, hit pallet with cane. Briefly touched overhanging obstacle.

Second Round- Test using cane and our device, configuration 2: The subject was faced away from door. Walked forward into chair. Turned around, walked around the chairs. Hit pallet with cane. Strayed off course to avoid the pallet. Turned around backwards, heading back to the door. Turned around. Turned back around, walked forward towards the course. Walked off course, asked to turn left. Walked forward, went off course to avoid pallet. Walked toward other edge of course, asked to move right. Hit overhanging obstacle. Walked forward, turned around, walked toward me, but turned around, and finished walking toward the end. Subject seems to be confused about what the device is telling her.

Subject 6

First Round: Course B

Second Round: Course A

First Round- Test using only cane, configuration 2: The subject was faced away from door. Strafed around the chairs. Walked toward wrong edge of course. Turned around, walked forward. Hit pallet with cane. Walked around pallet, went off course, asked to slide left. Stepped on pallet without difficulty. Used cane to check when to come down. Walked toward end of course. Finished.

Second Round- Test using cane and our device, configuration 1: The subject was faced away from door. Turned around, walked away from chairs. Strayed from course, asked to back up and turn left. Strayed again, asked to slide left. Walked around the table. Went off course, but turned around by himself. Walked into

overhanging obstacle, because the device did not detect it, asked whether it was supposed to be there. Didn't get any feedback on that one. Stepped on pallet from the side. Walked on it and reached the end of the course.

Subject 7

First Round: Course A

Second Round: Course B

First Round- Test using only cane, configuration 1: The subject was faced away from door. Turned around, walked parallel to chairs. Stepped off course, asked to move left. Walked between chairs and table. Walked toward edge of course, asked to back up and turn right. Walked forward, briefly touched overhanging obstacle. Reached end of course.

Second Round- Test using cane and our device, configuration 2: The subject was faced away from door. Turned 90 degrees, walked parallel to chairs. Turned 90 degrees, went forward. Strayed off course, asked to slide left. Turned around, avoiding the pallet. Walked forward, hit overhanging obstacle. Turned 90 degrees, then turned 180 degrees, eventually walked past the overhanging obstacle. Walked toward the right side wall, turned around, hit pallet with stick. Strayed off course, asked to turn left. Turned around, walked back toward obstacle. Turned all the way around to beginning of course, said vibrating all the time now. Strayed off course, asked to go right. Turned around, hit pallet with stick. Walked towards the right side wall, turned, and reached the end of the course. On the second circle, device recognized overhanging object and subject avoided the obstacle. Subject went around in circle towards the end with no sense of direction.

Subject 8

First Round: Course B

Second Round: Course A

First Round- Test using only cane, configuration 2: The subject was faced away from door. Walked toward chair, bent over to examine it. Turned 90 degrees, walked along chair. Turned 90 degrees again to walk forward. Kept walking forward, hit the overhanging obstacle. Walked through it, walked to table. Went around the table, but off course. Asked to move back and to the right. Asked to turn left. Reached end of course.

Second Round= Test using cane and our device, configuration 1: The subject was faced away from door. Turned 90 degrees, walked along chairs. Paused before reaching end of obstacle course, then turned 90 degrees to face proper way. Walked around the table. Turned 90 degrees when facing overhanging obstacle, avoiding

it. Walked toward pallet, hit it with cane, paused, then turned 90 degrees. Walked forward, reaching the end of the course. Subject avoided the overhanging object on both attempts, as he circled back around.

Subject 9

First Round: Course A

Second Round: Course B

First Round- Test using only cane, configuration 1: The subject was faced away from door. Hit chairs with cane. Turned 90 degrees, walked forward, turned 90 degrees to enter course. Strayed off course, asked to move left. Went around the table on the narrow side. Moved forward, parallel to table, into the other edge of course. Turned 90 degrees, avoiding the overhanging obstacle without touching it. Hit the pallet and reached the end of the course.

Second Round- Testing using cane and our device, configuration 2: The subject was faced away from door. Walked around the chairs, strayed off course, asked to slide left. Walked around pallet again. Turned completely around, and went back to the chairs. Strayed off course, asked to back up and turn right. Walked forward, turned towards me near the table, walked away from the end. Strayed off course, asked to turn around, and walked to the end of course.

Subject 10

First Round: Course B

Second Round: Course A

First Round- Test using only cane, configuration 2: The subject was faced away from door. Touched chair with cane, turned 90 degrees, walked forward. Swept cane in front of him. Turned 90 degrees, walked forward. Hit pallet, turned, strayed off course. Asked to turn around, he walked parallel to chairs. Turned in a circle near edge of course, walked back toward chairs. Hit chair with cane, turned around, walked forward. Hit overhanging obstacle, walked past it, hit table with cane. Turned around again, hit obstacle paused. Went off course. Turned around, hit pallet with cane again. Turned around, walked forward, reached end of course.

Second Round- Test using cane and our device, configuration 1: The subject was faced away from door. Turned 90 degrees after hitting chair with cane. Walked forward, turning a bit with each step. Turned 90 degrees once he got to the entrance point. Strayed off course, asked to slide to left. Hit table with cane, walked around it. Kept going until he hit the boundary, asked to go back and turn right. Continued walking forward; before he got to overhanging obstacle, turned 90 degrees, hit pallet with cane, turned 180 degrees. Walked forward until he hit boundary,

asked to turn back. Nudged overhanging obstacle, turned 90 degrees, went back toward table. Hit pallet with stick. Got in a position between table and pallet. Walked toward edge of the course again. Turned 180 degrees, hit pallet with cane, continued walking forward. Turned 180 degrees near edge, walked forward until he hit the other edge. Turned 90 degrees towards overhanging obstacle. Hit pallet with cane, turned around. Got near my edge, asked to turn around. Hit pallet with cane, walked forward, turned around to face beginning of course. Turned around again, hit overhanging obstacle, turned around again. Walked towards the beginning of the course. Asked to turn around when he got to the edge of the course. In between table and pallet again. Walked between them. Walking toward overhanging obstacle, turned 90 degrees near it. Turned 90 degrees again, facing toward start of course. Turned around, stopped using the cane for a while. Walked around in a circle after hitting pallet and table. Taking much longer than usual. Got back to the beginning of the course. Asked to turn around. Walked forward, walking toward the pallet. Walked in space between pallet and table. Hit table, walked out of space. Walked forward, then turned left toward beginning of the course. Continued to move about in a circle. Strayed off course, asked to back up and turn around. Walked past overhanging obstacle, but decided to turn around. Finished trial without subject completing the course. Subject seemed to be confused about vibrations. He was walking in the direction of the vibrations.

Subject 11

First Round: Course B

Second Round: Course A

First Round- Test using only cane, configuration 2: The subject was faced away from door. Hit chairs with cane, strafed around the chairs. Walked forward towards table, turned 90 degrees once she hit it. Reached the edge of course, asked to turn right. Walked toward space between pallet and table. Veered off course, asked to turn around. Walked forward, veered off course again. Went between chairs and table, veered off course. Went through overhanging obstacle, reached the end of the course.

Second Round- Testing using cane and our device, configuration 1: The subject was faced away from door. Walked around the chairs, around the wooden box. Walked around the table, toward me, but turned around, facing the wrong direction. Went about the obstacle course again, veering off course. Walked back to the beginning of the obstacle course. Hit box with stick again, continued forward. Veered off course. Went back to door. Back at starting position. Veered off course, back to starting position again. Walked toward box. Veered off course, went toward overhanging obstacle, hit it, hit table, went around the table. Walked toward me, veered of course, asked to turn around, then reached end of obstacle course. Device did not detect overhanging object.

Subject 12

First Round: Course A

Second Round: Course B

First Round- Test using only cane, configuration 1: The subject was faced away from door. Used cane to find the chairs. Turned 180 degrees, walked toward the door. Turned 90 degrees, started walking along the wall. Tried to find space between chairs and computer desk. Went forward, veered off course, asked to turn left. Walked alongside the box near edge of course. Hit table, walked forward, finished the labyrinth.

Second Round- Test using cane and our device, configuration 2: The subject was faced away from door. Turned 180 degrees, then turned 90 degrees and moved along the door. Walked off the course, asked to turn left. Hit the table with the cane, turned 90 degrees, walked forward along the chairs. Veered off course, asked to turn right. Hit overhanging obstacle, and touched box with cane. Turned 90 degrees to avoid overhanging obstacle, veered off course, asked to turn 180 degrees. Hit box with cane again. Ducked under overhanging obstacle. Walked forward, completed the course.

Appendix I: DATA FOR SIGHTED PROTOTYPE TESTS #2

Date of Experimentation	Subject ID
01/31/2015	1, 2, 3, 4, 5, 6, 7, 8, 9

Demographics

Gender:

Male	0
Female	9

Household Income:

\$0-\$19,000	1
\$20,000-\$39,000	0
\$40,000-\$59,000	1
\$60,000-\$79,000	0
\$80,000-\$99,000	0
\$100,000-\$149,000	1
\$150,000+	1
Prefer not to answer	5

Race:

American Indian/Alaskan Native	0
Black or African American	1
Asian or Pacific Islander	2
Hispanic/Latino	0
White	5
Other or Not Reported	1

Education (Highest degree obtained):

Some High School	0
High School Diploma/GED	1
Some College	7
Associates	1
Other	0

Age:

1	9
2	0, 0, 1, 1, 1, 1, 2, 3

Height:

5'	1", 2", 3", 3", 4", 5", 6", 7", 9"
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Experiment / Survey Results

It was easy for me to use this device.

Strongly Disagree	0
Disagree	0
Neutral	0
Agree	7
Strongly Agree	2

The device was accurate when detecting an object in my path.

Strongly Disagree	0
Disagree	0
Neutral	1
Agree	7
Strongly Agree	1

The device was accurate when detecting an object in my path.

Strongly Disagree	0
Disagree	1
Neutral	5
Agree	3
Strongly Agree	0

Describe any difficulties you had while using this device or suggestions you have for improvement that would better aid a blind user.

- Suggestions: more compact; if the blind user was wearing layers of clothing in a colder environment it would be difficult to feel the vibrations; overall it was a cool device and if I used it for a long period of time I'd get more used to it
- Difficulties: I wouldn't know how to set it up or charge it before putting it on; there seemed to be a low object on the ground that the device didn't vibrate for
- I couldn't tell how close or far away the objects were. At one point it seemed like there was an object in front of me and an object on the side of me, and a path between them, which I couldn't really detect using the device, but could with the cane. Maybe have a more 180 or 360 degree range with the vibrations telling more clear directions or varied intensity of vibration as objects approach.
- It can get confusing sometimes when two vibrations are going off at the same time. Try to make the vibrations for each side (left, right, center) distinct vibrations, so that one can accurately determine which vibration it is and where to go from there.
- Sometimes I felt I was still relying on the cane more than the device and that the device made the course more confusing to navigate. It was confusing to use both a cane and the device, but maybe a person who is actually blind could adapt faster than I did.
- It took a few moments to get used to the device. I had to pay attention to both what the machine was telling me as well as the walking stick.
- I did not feel the double vibrations as accurately as the single vibrations, which hindered my ability to navigate.
- At some point it seemed like the device was inconsistent. I kept receiving vibrations from the left side, and then upon moving to the right the vibration would go away, only for me to still run into something. It was also frustrating at times when both the center and side motors kept vibrating. I was at a bit of a loss as to how to avoid the obstacle.
- I felt that it was vibrating very frequently when I was walking through the obstacle course, even when there weren't obstacles so close to me.

What did you think of the vibrations? Were they helpful or a hindrance to your navigation? Was it easy to interpret what the buzzing means?

- I felt more confused with the vibrations because now I had the cane and the vibrations trying to give me directions. Sometimes one would see an object, but the other would not. The vibrations were almost constantly going off, so I had to keep thinking about how to adjust. The vibrations were more of a hindrance, but if I kept using until the vibrations became second nature, where I didn't have to think and interpret, it would be more helpful.
- They were easier to move with than the cane alone
- They were the most helpful for objects directly in front of me, not necessarily for ones on the side. Sometimes they were confusing to interpret. They didn't

seem to detect really low or really high objects. It was weird having my boobs vibrate.

- The vibrations were very helpful.
- Yes and no. It was good when there was an object really far in advance to avoid, but also I found that if I shifted my shoulders even slightly sometimes the device would buzz when I couldn't detect an obstacle; maybe the wall?
- It was weirdly distracting, however, it was also helpful, and yes it was straightforward as far as interpretation.
- The vibrations were helpful in notifying me of an obstacle, but it may not have notified me of all obstacles. Sometimes the cane was more useful, possibly due to the angle at which I was facing the obstacle.
- They were helpful, it would just take a while using the device to really get used to responding to them.
- I thought the buzzing was helpful to an extent, but I think I was relying more on the cane to help me navigate.

Times

Test #	Time without Device	Time with Device
1	0:53	1:07
2	2:48	1:34
3	0:49	1:04
4	2:39	1:59
5	1:06	1:02
6	1:40	2:27
7	2:59	2:20
8	1:11	1:21
9	1:08	1:37

Appendix J: QUALITATIVE NOTES FOR SIGHTED PROTOTYPE TESTS #2

Subject 1

First Round - Test using only cane: The subject swiftly navigated through the course, completely avoiding all obstacles by sweeping the cane wide. The subject neither detected nor bumped into the overhanging object. The subject walked around, not over the step.

Second Round Test using cane and our device: The subject was directed towards one of the first obstacles. The subject walked right into the overhanging object and into several walls. After the initial few obstacles, the subject was able to navigate around the rest successfully, clearly relying on the cane.

Subject 2

First Round Test using only the cane: The subject walked very slowly, struggled to navigate under the overhanging object. The subject also had difficulty navigating around the raised platform, relying on broad sweeps to find a path.

Second Round - Test using cane and our device: The device seemed to guide her into the initial obstacle and somewhat into the edge of the overhanging obstacle. The subject turned to face a wall but turned away a couple of times. The subject clearly relied more on the device than the cane at times and was successfully able to navigate through the second half of the course.

Subject 3

First Round Test using only the cane: The subject proceeds through the course at a decent speed, navigating successfully for the most part, but bumping into the wall and a chair. She was able to avoid the overhanging obstacle without detecting it.

Second Round - Test using cane and our device: The device trapped her on the initial obstacle and did not guide her around the overhanging obstacle. The subject was able to navigate the rest of the course, clearly relying on the device to avoid walls and a couple obstacles on the side.

Subject 4

First Round Test using only the cane: The subject proceeded slowly, bumping into the initial obstacles as well as the overhanging object. After that, proceeding more cautiously, she still had difficulty navigating around the platform and bumped into one of the chairs.

Second Round - Test using cane and our device: The subject was able to slowly navigate around the initial obstacle but failed to avoid the overhanging obstacle. The subject was stationary at times as if receiving confusing instructions from the device. She mostly avoided obstacles other than the overhanging, but it was unclear how much she relied on the device.

Subject 5

First Round Test using only the cane: The subject was able to slowly navigate through the course, avoiding all obstacles except the overhanging object.

Second Round - Test using cane and our device: The subject clearly relied on the use of the device more than our device to avoid walls and obstacles. The subject bumped into one of the platforms softly with her foot, but overall avoided ground obstacles and walls without trouble. While the device initially detected the overhanging obstacle, the subject turned back into it and hit it.

Subject 6

First Round - Test using only the cane: The subject had some difficulty navigating around the first platform, but was able to get around it without bumping into anything. The subject was able to navigate around all ground obstacles, but was unable to avoid the overhanging.

Second Round - Test using cane and our device: The subject proceeded slower, successfully detecting objects with and without the cane, but appeared to be receiving confusing feedback from the device at certain points, turning towards the wall and going into reverse at points. The device successfully navigated her away from the overhanging obstacle, but wall detection directed her back into the piata (overhanging obstacle).

Subject 7

First Round Test using only the cane: The subject proceeded at a slow pace, successfully navigating around the chair and the first platform. The subject was tripped up by the second platform and had to back up and re-approach it several

times before finding a navigable path around it. The subject also hit the overhanging obstacle and proceeded to the exit very slowly.

Second Round - Test using cane and our device: The subject clipped the edge of one of the obstacles at the beginning and had a similar struggle to navigate around the platform as in the previous test. The device successfully guided the user around the other obstacles but failed to even pick up on the overhanging object.

Subject 8

First Round Test using only the cane: The subject proceeded very slowly through the course

Second Round - Test using cane and our device: The subject struggled with the device at times - bumping into the platform, getting stuck between a chair and the wall and completely failing to detect the pinata (overhanging obstacle).

Subject 9

First Round Test using only the cane: The subject was able to successfully navigate the course at a moderate pace. By chance, she was able to navigate around the piata (overhanging obstacle).

Second Round - Test using cane and our device: The subject struggled to find her way between the initial obstacles and walked into the first platform. The device was successful in getting her around the remaining chairs and platform and she did not hit the overhanging obstacle, seemingly by chance.

Appendix K: DATA FOR BLIND TESTS

Experiment was performed on 2/14/2015

Gender:

Male	3
Female	1

Ages: 38, 50, 61, 83

Psychosocial Impact of Assistive Devices Scale (PIADS):

	-3	-2	-1	0	1	2	3
Competence				X	X	X	X
Happiness				X	X	X	X
Independence				X		XX	X
Adequacy				X	XX		X
Confusion		XX	XX	X			
Efficiency				X	XX	X	
Self Esteem	X			XX	X		
Productivity			X	X		XX	
Security			X	X	X	X	
Frustration			XXX	X			
Usefulness				XX			XX
Self Confidence		X			X	X	X
Expertise					XX	XX	
Skillfulness					XX	XX	
Well-being				XX	XX		
Capability				X	X	XX	
Quality of Life				X	X	XX	
Performance					XX	XX	
Sense of Power				XX		X	X
Sense of Control				X	X	X	X
Embarrassment	X			XXX			
Willingness to Take Chances				X		XX	X
Ability to Participate				X	X	X	X
Eagerness to Try New Things					X		XXX
Adaptability				X	XX		X
Ability to Take Advantage of Opportunity					XXX		X

Score Summary:

Subscale	Subject 1	Subject 2	Subject 3	Subject 4	Average Scores
Competence	1.5	0.75	1.58	1.42	1.31
Adaptability	0.5	2.17	1.5	1.83	1.5
Self-Esteem	0.88	-0.63	1.13	1.13	0.63

Times:

Participant	Run #1 Time	Run #2 Time	Run #3 Time	Run #4 Time
Subject 1	0:55	1:11	2:16	0:44
Subject 2	0:32	1:49	0:42	N/A
Subject 3	0:38	1:06	0:33	N/A
Subject 4	0:31	0:32	0:36	0:33

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