SynthSense

Team

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Users

Given the time constraints for this project, we selected particular people who we were acquainted with (two students on campus, and one man outside of campus).

User 1

- Senior student at Berkeley. He's completely blind and prefers using a white cane.
- More so than obstacle avoidance, navigation was an important feature he was looking for in new assistive devices

User 2

- Has extreme myopia, unable to see functionally past a few inches.
- Navigates without walking cane, but with caution.
- Doesn't travel to new places often
- Primarily uses a mobile phone and a monocle to see and navigate.

User 3

- Has cerebral palsy, is locked in a wheelchair, and is legally blind.
- He is able to navigate around familiar environments alone, but depends on a caretaker for navigating through unfamiliar places.
- He has trouble avoiding obstacles above ground level, curves, trash cans, getting through door openings, and moving on ramps.
- When using public transportation, he has trouble locating his wheelchair as he has no sense of what is behind him.

Process

We attempted to conduct our interviews in an minimally obtrusive environment that was selected and prefered by our users. Thus we interviewed in a cafe (User #1), the user's home (User #2), and a classroom (User #3). We asked questions focused on challenges in navigation (getting from place to place), obstacle avoidance and explored questions based upon their problems. In addition we asked what assistive devices they already used and what type of device and/or features they wanted most. Overall, all three interviewees mentioned that navigation is an important feature they wanted apart from obstacle avoidance (which we were primarily focusing on in our initial designs).

Interviews

Interview 1

User #1 was completely blind and extensively used a white cane. We were really surprised at his keen listening and auditory skills. The interview was held at a cafe but we also walked with him for a while and observed how to dealt with obstacle avoidance on a busy Friday afternoon rush on campus.

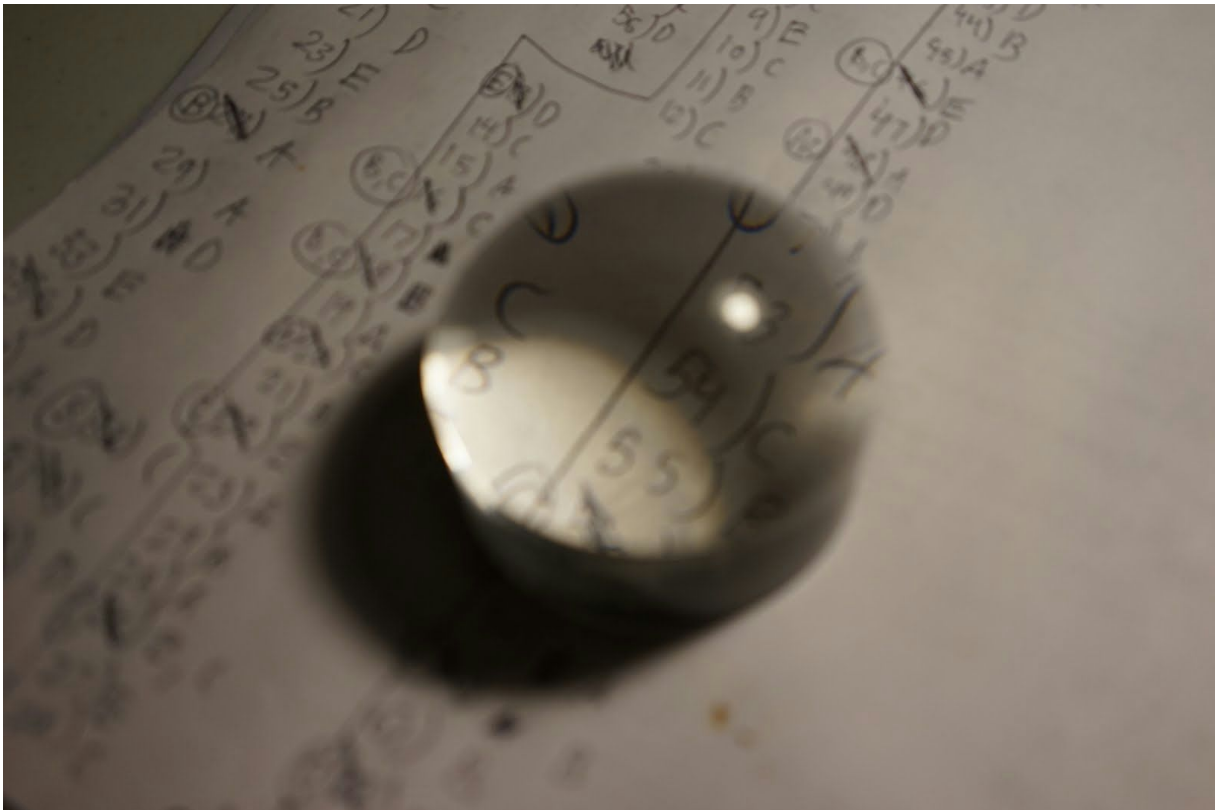
The acknowledged that as a student he doesn't face too much navigation difficulties. Nonetheless, whenever he needs to travel and use public transportation, he'd use Google Maps to plan every detail of his trip and any device that provides locational feedback (or landmarks and directions) would be beneficial. As a completely blind user, some of the common obstacles he faces are low-hanging branches, cracks in the pavement (once he mentioned his cane broke when he twisted against the crack), crossing the street, etc.

He emphasized on creating a device that built upon/added features to well-established assistive devices like the white cane. Furthermore, he mentioned an established convention in the field - where the length of the cane should be proportional to the height of the user. This means the cane gives around two-meters lookahead and he would prefer the system to give a minimum of three-meters of information.

Interview 2

This interviewee was legally blind, with very limited vision at close proximity, and thus was able to provide a unique level of feedback, having a balance between experience with ability and disability. The interviewee is trained to use all manners of assistive devices, but is not absolutely reliant on them, unlike User 1. Primarily, the interviewee’s challenges involved traveling in a new place (this is rarely done as a consequence), which would involve intensive planning of routes using Google Maps and the use of a assistive person and a turn by turn navigation system on a phone. Since his vision is somewhat operable at small distances, a hand held assistive device the accentuates contrasts and feature edges is used, as well as a cell phone camera. Public transportation was easy to navigate, given then local systems use extensive audio systems to allow disabled people to use them.

He often ran into small and thin objects, such as poles, lamp post, and tree branches, especially things that are not prominent or colourful. At home, cord and cables were especially dangerous, and night time walking was difficult. His dream device would be a wrist based obstacle avoidance system that would provide unobtrusive tactile feedback (Especially directional), and that was fashionable. Since primary sensory feedback relies on audio, any device that impeded with that (and/or headphones) were unwanted. He suggested a multimode device that could be activated when needed, and deactivated at other times, stating that he would only need a supplementary device to alert him when things were **not** going normally.



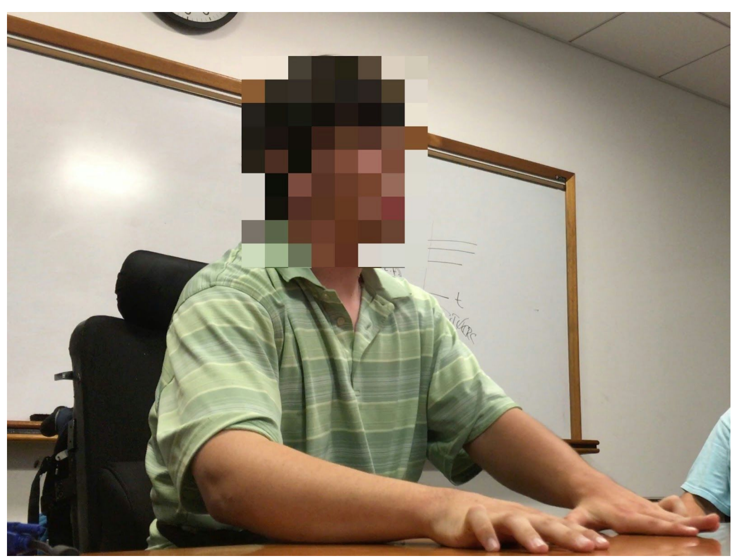
Magnifier for seeing written text better

Monocular for seeing in lectures

A camera based magnifier for making objects at various distances larger. It can also adjust color/contrast

Interview 3

This interviewee has cerebral palsy, is locked in a wheelchair, and is legally blind. Since this interview subject came up from Los Gatos so that we could talk to him, we met in a quiet conference room in Cory Hall. This location was also somewhat similar to normal room in a university, where the subject spends a lot of time. This room also provided a large floor area for him to move in his wheelchair to demonstrate actions. We wanted to minimize other noise and be in as comfortable of an environment as possible. This subject was able to see that there was a blue wall in the room, as well as five people. This interview showed us a whole different set of problems that people can face. In this user's commute, he is dropped off by an assistive service and has an aid with him. For familiar locations such as his college campus, he knows and can navigate the halls



and between buildings without too much difficulty. However objects that can move such as trash cans or denote boundaries such as walls or door frames can be difficult to avoid.

Unlike the prior users, this subject does not use any of assistive devices due to his situation. Although he was unable to comment on devices that are currently available, he did say that a device that could help him navigate and provide auditory or haptic feedback would be immensely useful. Alerts for objects within about 5 feet would be the most relevant, and would allow him to not run into pillars, walls, or people.

Additionally, the user utilizes public transportation but finds that there is a lot of noise from people, cars, the bus itself which could inhibit an audio signal being used for communicating information. On the note of public transportation, he said it is difficult to tell when he is backing into someone with his chair. He demonstrated this with his brother standing behind him, and running into him. It would be nice, he said, if this wouldn't have to be a problem.

When asked if there was a device that he wished would exist to help him, he wanted something with GPS to help him navigate and provide instructions on when and how much to turn and that would help him avoid obstacles. We tapped in a linear fashion on his body showing our current idea of how this could be implemented, and he thought it would be useful.

Problem

People with visual impairment have a hard time sensing their environment. They have difficulty with both obstacle avoidance and navigation. For obstacle avoidance, the most common assistive device is the white cane. This provides them with feedback of the ground plane in front of them by swiping the cane in a parabolic motion. However, this solution doesn't prevent running into obstacles above ground-level, such as low-hanging branches or even being careful when walking on uneven/bumpy surfaces. For navigation, they rely on mental maps and the help of strangers on the street. However, this is not always reliable and asking for help is not a solution that fosters their independence.

Solution

We first wanted to concentrate on tackling obstacle avoidance only. After the user interviews, we realized navigation is a vital part for them when interacting with the environment. Thus we determined a two part system would work best - augmenting a cane with obstacle detection and wrist wearables for navigation.

- Obstacle Avoidance
    - Augment the white cane
    - Delivers feedback on objects above ground-level
    - Magnetometer + multiple distance sensors (TBD)
- Navigation
    - Wristband that signals next direction to take
    - Array of vibration motors

Key Tasks

1. **Navigation**

   It’s usually a hassle for blind people to get from point A to point B. They have to plan out the routes ahead of time and utilize public transportation, which are sometimes not well-designed for the visually impaired. Other times, they have to use a distracting hand held GPS/ Moreover, lack of “checkpoints” and landmarks makes it hard to navigate and gauge how far they are away from the destination. Our wrist based, non intrusive system will allow for a hands free and comforting journey.

2. **Obstacle Avoidance**

   Navigating to a completely unfamiliar surrounding is already difficult, it’s also a challenge to avoid obstacles on the way to a destination.

   a. **Sidewalk crack detection**

      Cracks are really hard to notice. An uneven road surface can easily trip anyone. Moreover, canes can get stuck in a crack and break. No current cane system we could find detects this. Our alert system will alert the user before such situations occur.

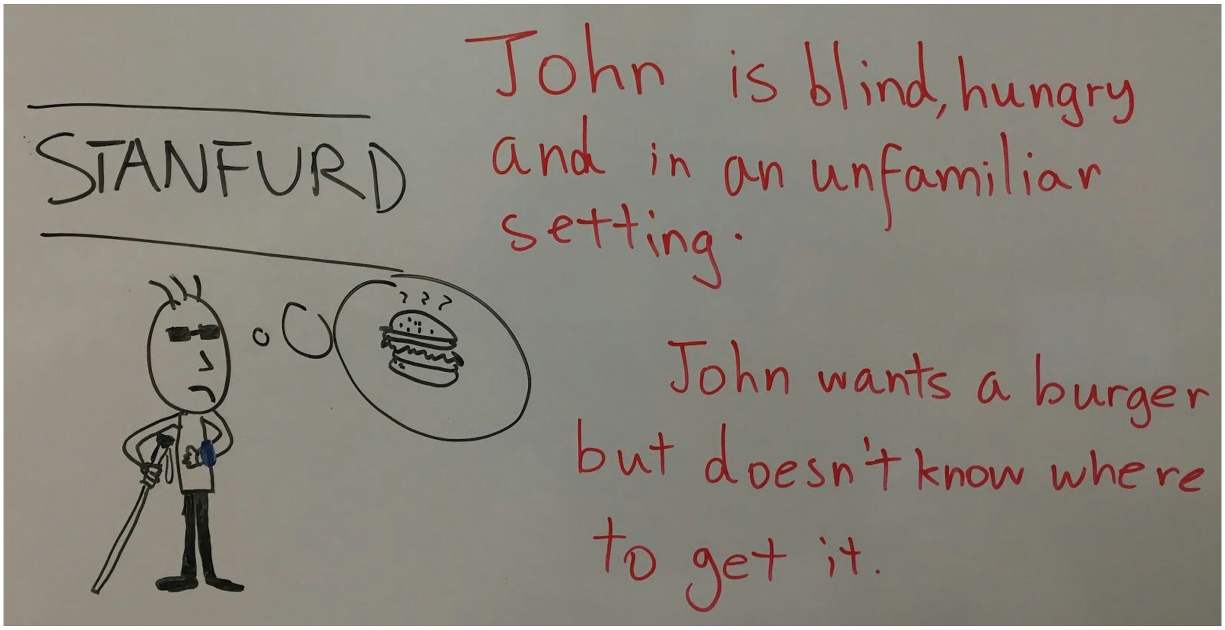
   b. **Overhead obstacles**

      Low hanging tree branches are hard to detect because the normal assistive device only detects ground level objects. Current systems allow for this. We intend to integrate it into our device.

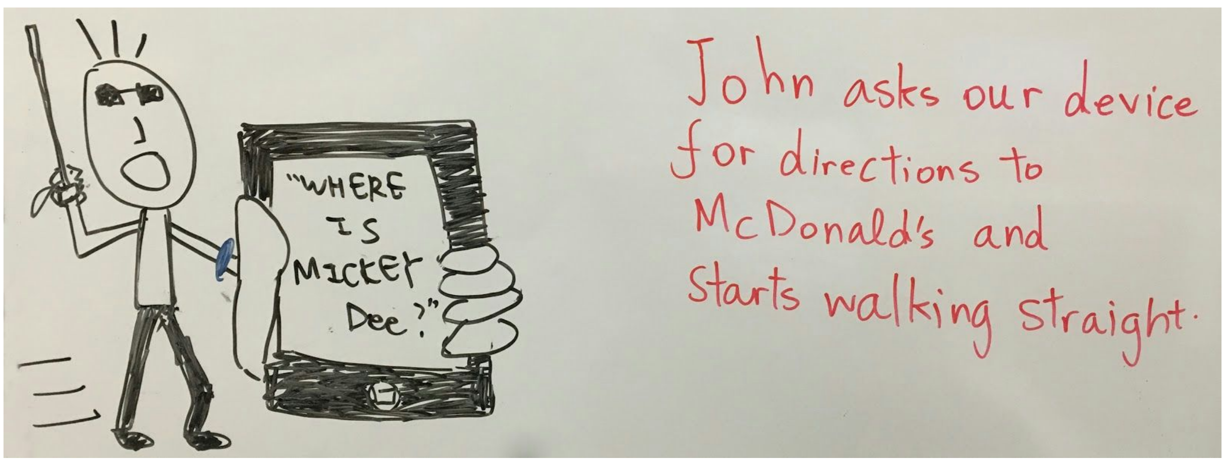
   c. **Thin objects**

      Objects such as flag poles and tree trunks are very easy to miss due to how skinny they are.

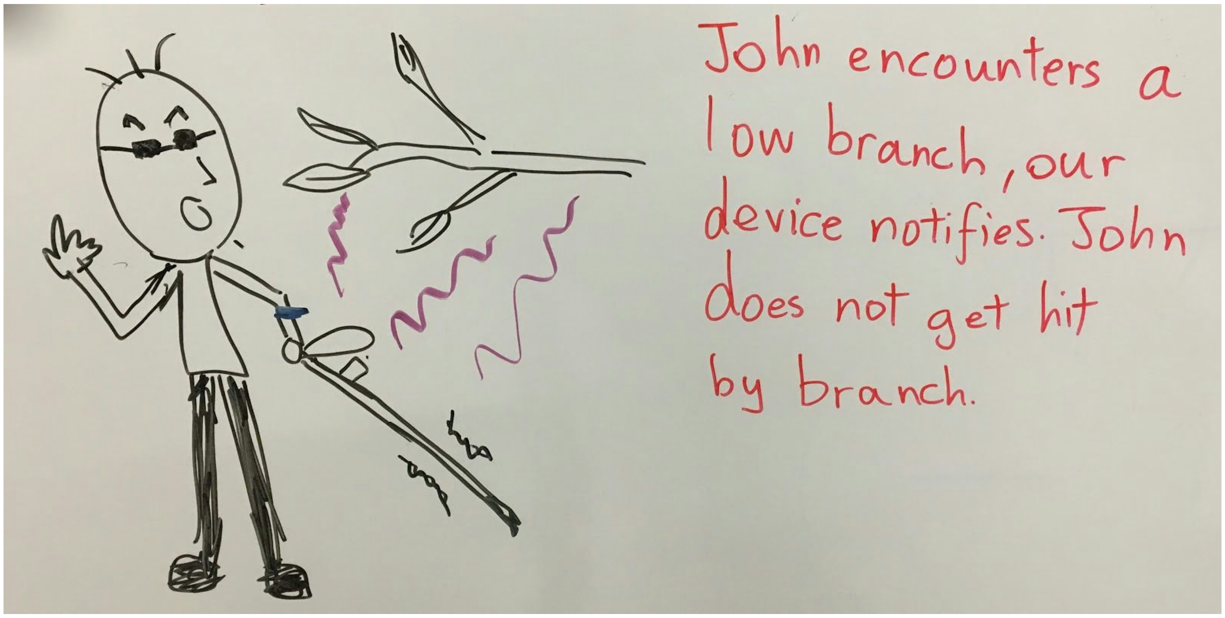
Storyboard

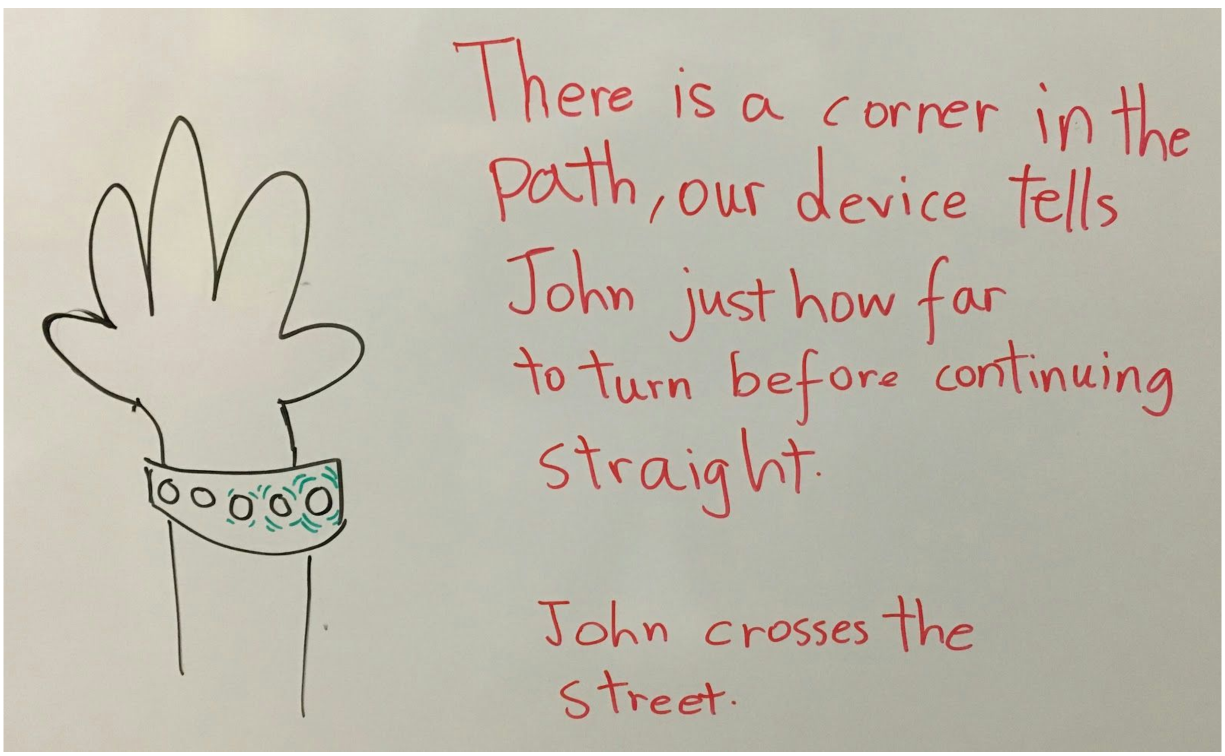


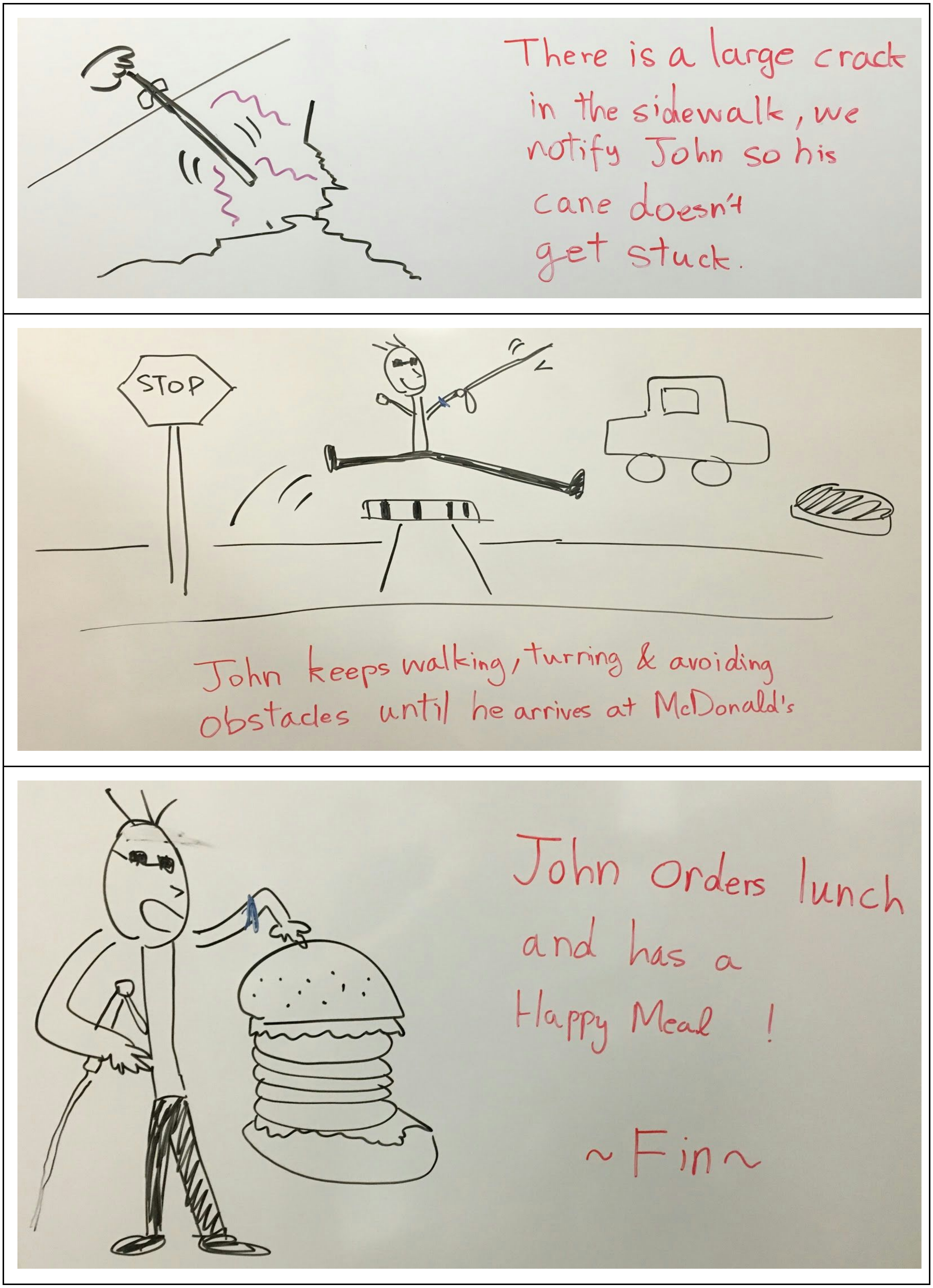
STANFURD
???
John is blind, hungry and in an unfamiliar setting.
John wants a burger but doesn't know where to get it.



"WHERE IS MICKEY Dee?"
John asks our device for directions to McDonald's and starts walking straight.


John encounters a low branch, our device notifies. John does not get hit by branch.


There is a corner in the path, our device tells John just how far to turn before continuing straight.
John crosses the street.


There is a large crack
in the sidewalk, we
notify John so his
cane doesn't
get stuck.
STOP
John keeps walking, turning & avoiding
obstacles until he arrives at McDonald's
John orders lunch
and has a
Happy Meal !
~Fin~

Competition

1 | Buzzclip

https://www.indiegogo.com/projects/the-buzzclip-wearable-ultrasound-for-the-blind#/

Target User Group:

The market for Buzzclip is blind people, as it provides tactile obstacle detection. We have the same primary market as them, although a target market for Buzzclip very low cost solution is the third world, which we don't necessarily have the capacity for.

Usability:

Buzzclip is still undergoing their funding, and is widely untested; Early users are happy with not running into things.

Functionality:

Buzzclips allows users to avoid obstacles outside the range of a cane, we will implement similar technology in an existing advice (the cane), as well as augment the system with a bracelet based navigation.

2 | Sunu

http://sunu.io

The mission of Sunu is to empower the **visually impaired** by improving their awareness of their environment.

Target User Group:

They are targeting the same user group as us.

Usability:

Sunu has been collaborating with the visually impaired in order to create something that really solves the problem. However, it seems that the user needs to rotate their wrist in non-natural ways in order to point the ultrasound range finder. Our solution will improve in the comfort of use in order to provide a more natural and intuitive way of pointing and receiving information.

Functionality:

The application provides three functionalities. The main one is proximity sensing to prevent running into obstacles, a vibration clock that provides the user with the time, and an object finder using beacons attached to objects. All of this information is delivered via haptic feedback on the wrist. Our implementation wants to prevent feature overload, so we are focusing on obstacle avoidance and navigation.

3 | Miniguide US

https://shop.aph.org/webapp/wcs/stores/servlet/Product_Miniguide%20US_1189771P_10001_11051

Augment information from other mobility aids, like the cane or dog guide,with obstacle detection by the Miniguide from 1.5 to 26 feet.

Target User Group:

Miniguide's target user group is the same as our target user group with a primary focus on blind and deafblind persons.

Usability:

The Miniguide US can only used along with a human guide, dog guide, or cane because it does not detect drop-offs and does not provide sufficient information to ensure safety. Our proposed idea of integration of a cane and detective sensors will solve this problem.

Functionality:

It uses ultrasound to detect objects, and gives tactual or auditory feedback by vibrating or chirping more rapidly as you approach an object. Though the device is lightweight and easy to carry around, our idea of integrating with a cane and a bracelet to provide full navigation abilities.

4 | Trekker

http://store.humanware.com/hus/trekker-breeze-plus-handheld-talking-gps.html

Target User Group

The target audience is the same as ours, the visually-impaired.

Usability

Given a destination that a user would like to go to, the device gives information on an user's location based on GPS and directions he should take. It also verbally announces when important landmarks (a street, crossing) is reached and connects to GPS within 10 seconds.

Functionality:

Our device strives to achieve the same goal. Nonetheless, when we discussed with the interviewers they all preferred a navigation system that gave haptic feedback on the wrist (as a wearable device). While Trekker provides audio feedback and instructions, the interviewees mentioned that they would rather be listening to music on their headphones or would faced noisy environments where it would be hard to hear.

5 | Advanced Augmented White Cane with Obstacle Height and Distance Feedback

http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6650358&tag=1

Target User Group The target user group for this paper/solution is blind or visually impaired people who have the ability to walk around on their own, this is the same group of people that we are targeting.

Usability: This competitor appears to have a good user experience for obstacle avoidance although the sensors may have trouble performing in all environments, specifically hallways and sloped roads, we would improve upon this experience by adding additional sensors and software to correct for these situations and add a navigation component to meet more of our user groups' needs.

Functionality: The main functionality of the device is a way for the user to tell what obstacles are in their path at different levels, our proposed idea will extend this by providing a way to receive navigation instructions, which was one of the main requests from our interviewees.

Competition Summary

The competition is focused on augmenting existing solution or providing auxiliary products, that either solve A) Obstacle Avoidance or B) Navigation, but not both. We intend provide a modular system of devices that will augment the widely used cane, as well as provide haptic feedback for a turn by turn navigation system, that will provide on demand and unobtrusive guidance.