Visually Impaired Cane Optimization

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Background

The visually impaired are advised to use alternative methods to navigate through their day-to-day lives, such as an assistive white cane. An incident was reported on the University of New Mexico (UNM) campus when a student with visual impairment, who was using her white cane to guide her through the campus, sustained a head injury after running into the outstretched arm of a statue. As a result, the University of New Mexico School of Medicine reached out to the team in hopes of designing a wearable device that can be used with a white cane. The goal of the design would be to detect head-level objects and alert the user to avoid any injuries. In pursuit of the goal, a prototype device was then designed incorporating the use of ultrasonic and LiDAR sensors, As well as haptic feedback to alert the user of incoming head-level obstacles.

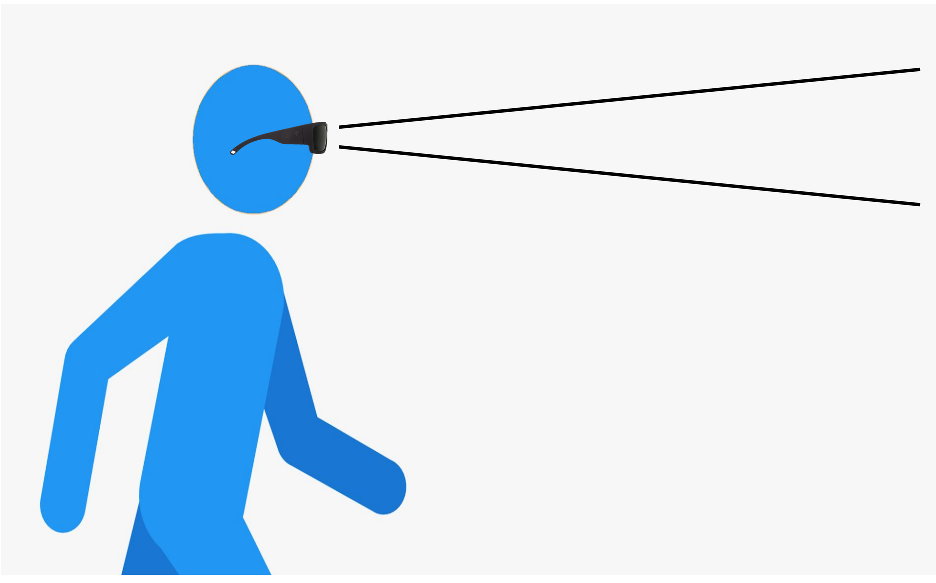

Figure 1: Field of view

Project objectives

- Design and fabricate a working prototype to aid the population with visual impairments in order to reduce head injuries.
- Test working prototype and work to increase accuracy and reliability.

Design Requirements

- Inconspicuous and low profile
  - ➢ All components must fit onto a pair of sunglasses
  - ➢ All components must be integrated into/around the frame
- Comfortable and ergonomic
  - ➢ Weight needs be evenly distributed across the frame
  - ➢ Weight needs to be kept under 1 lb
- Reliable and accurate
  - ➢ Must detect distances accurately and timely
  - ➢ False negatives and positives need to be removed
- Suitable range: works from 0 - 25 ft
- Rechargeable and long-lasting battery life: 6-10 hours life
- Affordable: cost <$1,000

Prototype Elements

To satisfy the design requirements of the project, electronic components were thoughtfully selected and tested to ensure their usability in the prototype. A microcontroller and motor controller were selected. The motor controller allows a variety of vibrations to be transmitted via the coin vibration motor to give feedback to the user. Two sensors were chosen as the most reliable and suitable for the project: one short-range ultrasonic sensor, and one long-range LiDAR sensor. All electronic components will be powered using two 5V 18650 Lithium-Ion batteries in series and controlled using an Arduino Pro Mini.

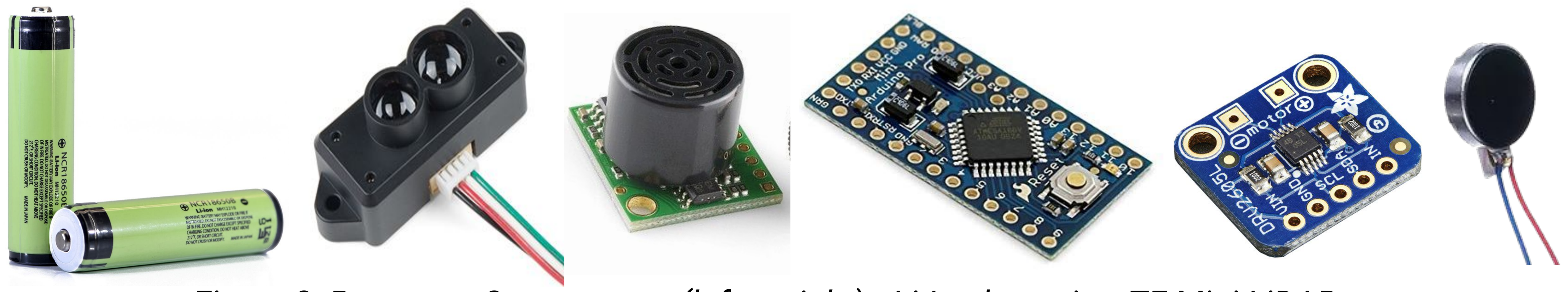

Figure 2: Prototype Components (left to right) - Li-Ion batteries, TF Mini LiDAR, LV-MaxSonar Sensor, Arduino Pro Mini, Haptic Motor Controller, Coin Vibration Motor

Electronics Housing Development

The housing designed for the prototype is made up of an open frame system. This allows for ease of assembly and electronics troubleshooting. The housing will be 3D printed and electronics will be installed. The figure shown displays how the electronic components will be assembled into the current housing.

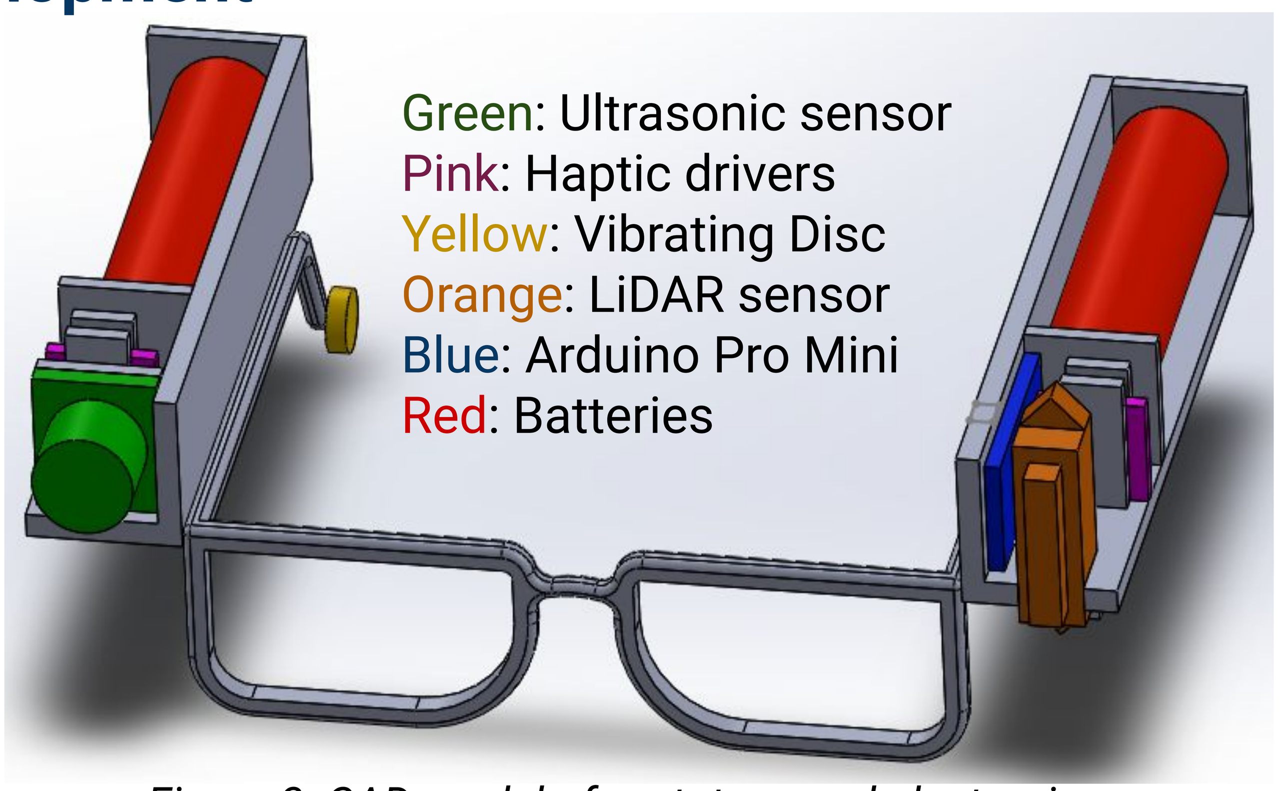

Figure 3: CAD model of prototype and electronics

Institutional Review Board Process

The Institutional Review Board (IRB) is an organization responsible for ensuring the safe experimentation on human-subjects pertaining to biomedical research in accordance with FDA regulations. The team filled out several IRB procedural forms detailing the experimentation and testing of the prototype on human subjects. A detailed consent form and survey were also required before sending in the IRB application. The consent form was used to ensure that the participant was aware of the procedure and safety hazards during experimentation. The consent form also allowed the team to collect videos of the participant during testing. The survey was used to ensure there are no underlying health conditions for the participant that could be potentially dangerous to test the prototype in the obstacle course. After a few weeks, the team had received approval from the IRB committee, which allowed the team to begin preparing for human-subject testing with the prototype.

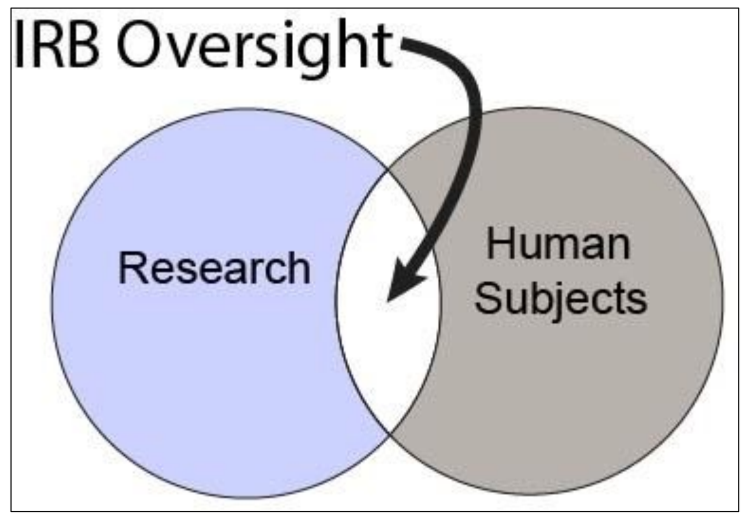

Figure 4: IRB Oversight diagram

Spring 2020 Progress

The team worked on optimizing and finalizing their prototype. New TF Mini LiDAR and Maxbotix Ultrasonic LV-EZ1 sensors were ordered and rewired due to complications with the previous sensors. Furthermore, the sensor and haptic codes were debugged and combined for optimal use. Along with this, all the components were modeled leading to a new electronics housing being designed and printed. The prototype code from Fall 2019 was also built upon to create a theoretical code for this semester's product.

The team also filled out an IRB application and received approval. However, due to COVID-19, the team could not conduct human-subject testing with the prototype. Because of this outcome, the team wrote a White Cane Workshop and IRB procedure to use next semester. The White Cane Workshop would be used to familiarize and instruct participants on how to properly use a white cane. Once the workshop is completed, the IRB testing procedure will have instructions detailing the different obstacles that participant will encounter to test the functionality, reliability, comfortability of the prototype.

Future Work

- Prototype assembly and wiring with all components
- The future team members will have to re-apply for approval from IRB committee to conduct human-subject testing
- Human-subject testing once IRB application is approved
- Further electronics housing refinement and redesign
- Software optimization to increase accuracy and reliability
- Additional testing and refinement

The images below show prototypes for past semesters which have been refined and will continue to be with future testing.

Figure 5: Past prototypes (left to right) - Fall '18, Spring '19, Summer '19

Acknowledgements

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