Autonomous Indoor Navigation Assistance for Blind Users

Team G: Carnegie Malones

Jennifer Isaza, Chris Song, Divya Kulkarni, Andrew Wong, Yanda Huang

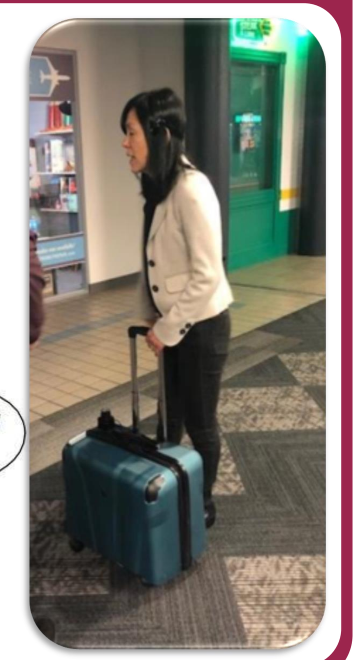
The Robotics Institute, Carnegie Mellon University

Motivation

Most blind users use guide dogs and canes for navigation assistance. However, these methods do not communicate essential information about the path or surroundings needed to travel to their final destination. CaBot is an assistive robot designed to help visually impaired users autonomously navigate through a new environment through voice feedback on the user's smartphone.

Use Case

CaBot can be used by the visually impaired to traverse crowded, unfamiliar environments, such as an airport or an university. In this particular scenario, the user is able to issue an command to CaBot, such as "add stop, Chili's ToGo", the Robot will then announce the new destination and tell the user how long it would take her to get there. Along the way, CaBot will also tell the user about the terrain as well as any obstacles in the way.



Validation Experiment

- Start from NSH 4524 and navigate to different locations on NSH 4th floor. Possible locations include:
  - Sarah Conte's office, 4th floor front desk, backdoor to Personal Robotics lab, etc.
- Obstacles, stationary / slow-moving pedestrians placed in CaBot's path
- Simulated blind user (team member) chooses destination on smartphone and is led by CaBot

Auditory Feedback

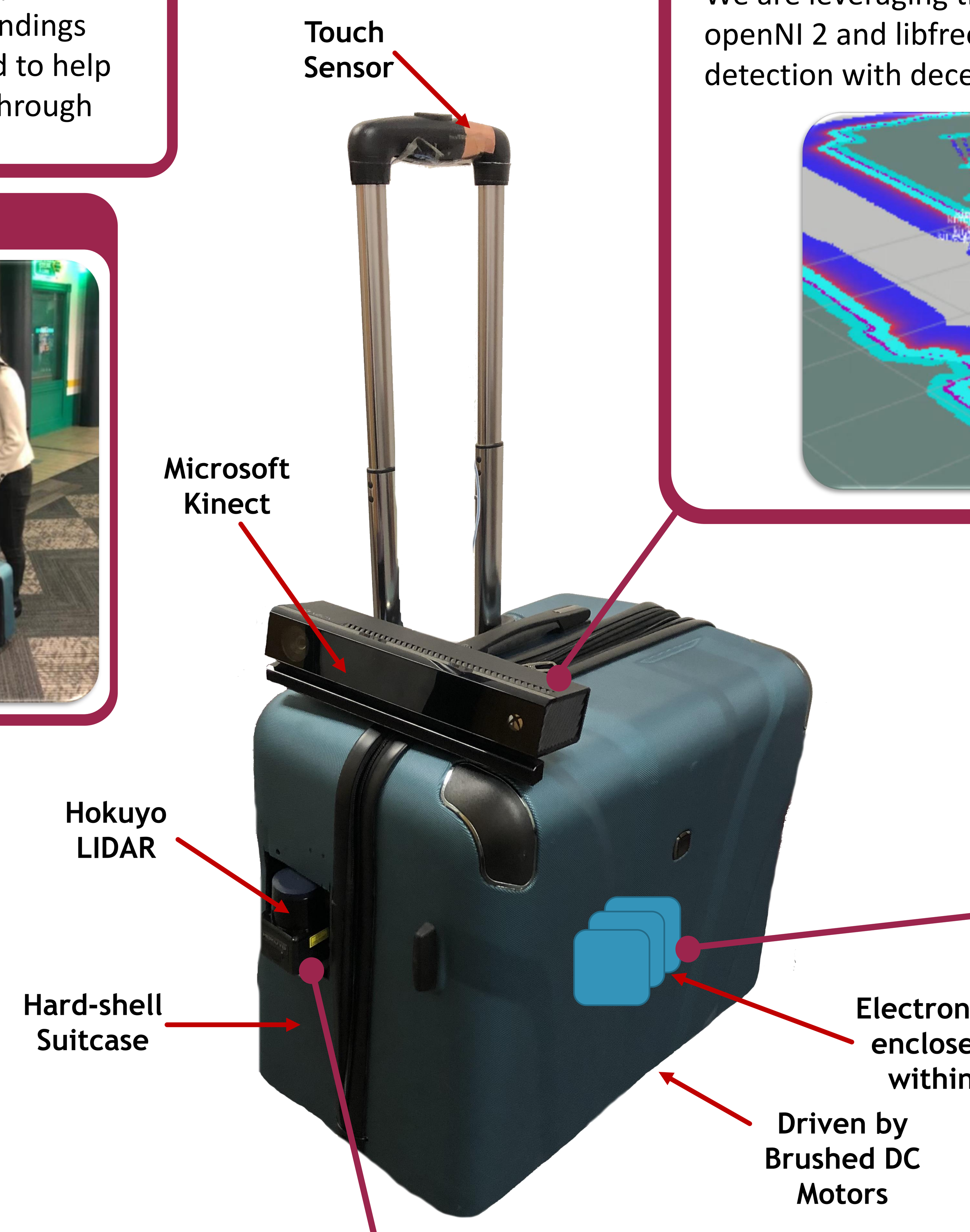
- User is warned at least 2 meters before sharp (90 degree) turns
- CaBot warns user of pedestrians at a range of 2 meters or less, and decreases its speed if user is less than 1 meter away

Metrics

- CaBot successfully led the user to within 1.5 meters of their final destination

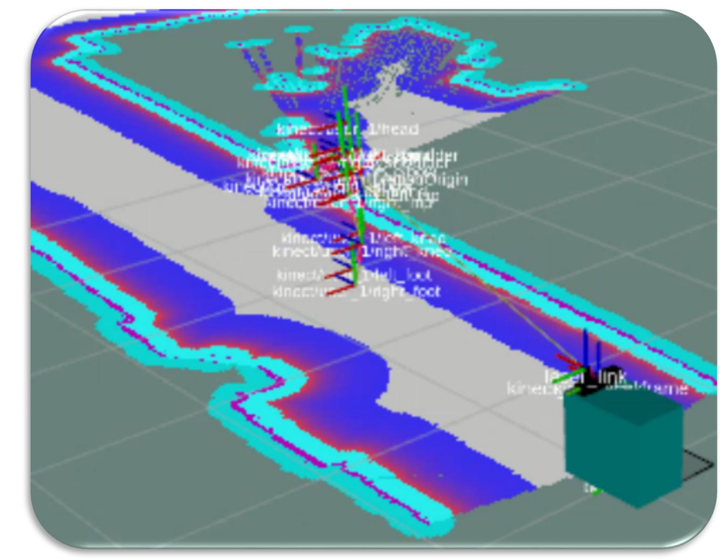
Future Work

- Improve planner's obstacle avoidance speed
- Integrate haptic feedback into handle



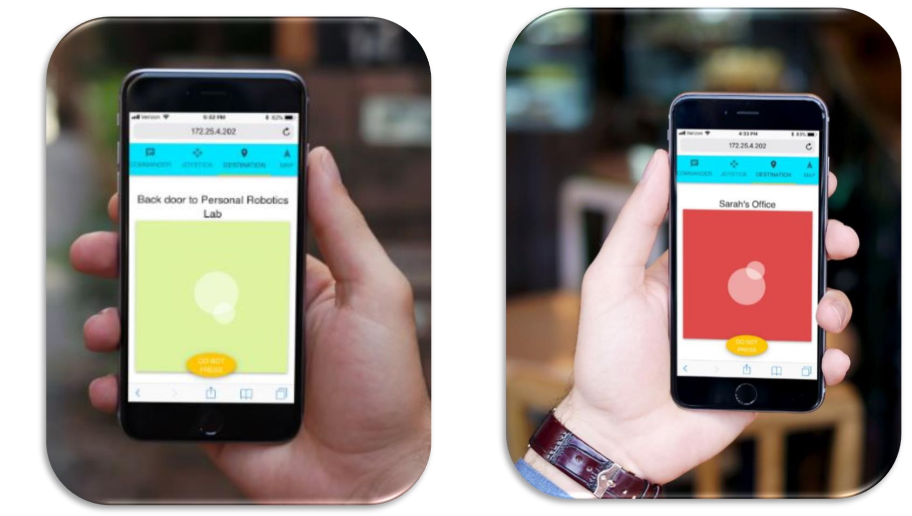
Pedestrian Detection

We are leveraging the MS Kinect and packages like openNI 2 and libfreenect2 for pedestrian detection with decent accuracy.



User Interface

The user interface was created specifically for the visually-impaired user by combining touch and voice feedback. The user can drag the circle to their desired destination, and CaBot will begin navigation.



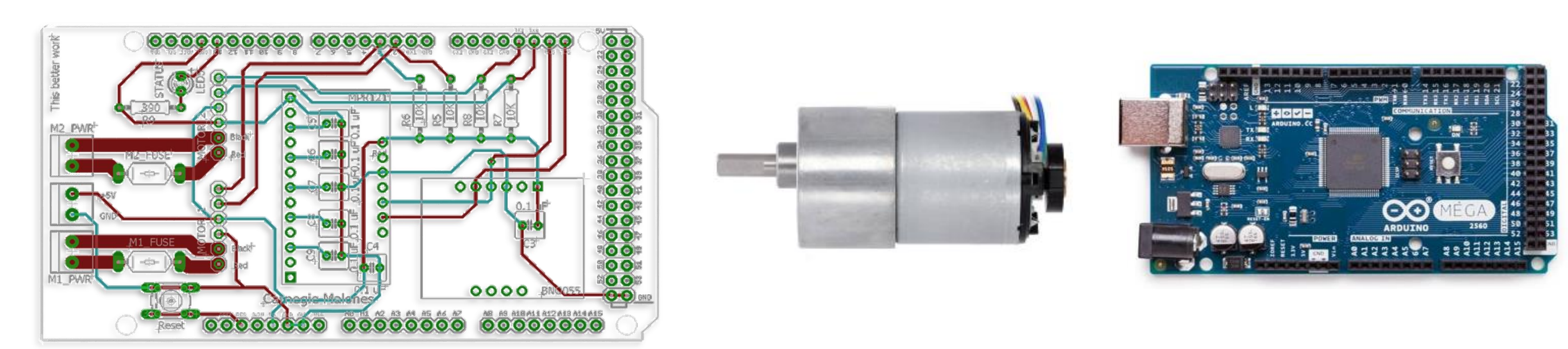
Drive System

Hardware Setup:

- 2 brushed DC motors, controlled by the Sabertooth Motor Controller and Arduino Mega
- Encoders attached to the shaft of the motor

Implementation

- PID speed control was implemented to maintain accurate odometry
- Controls issued from onboard laptop through Rosserial



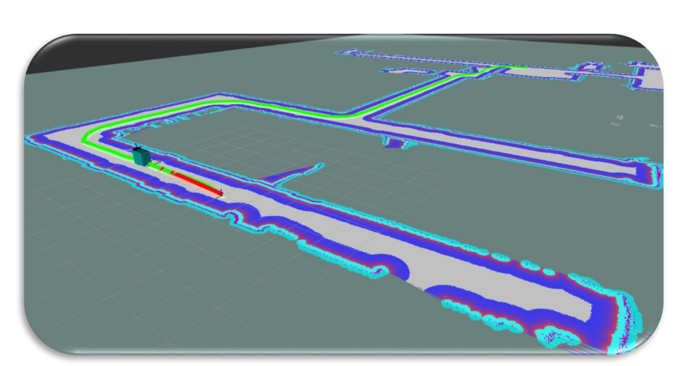
Mapping + Navigation

Hardware

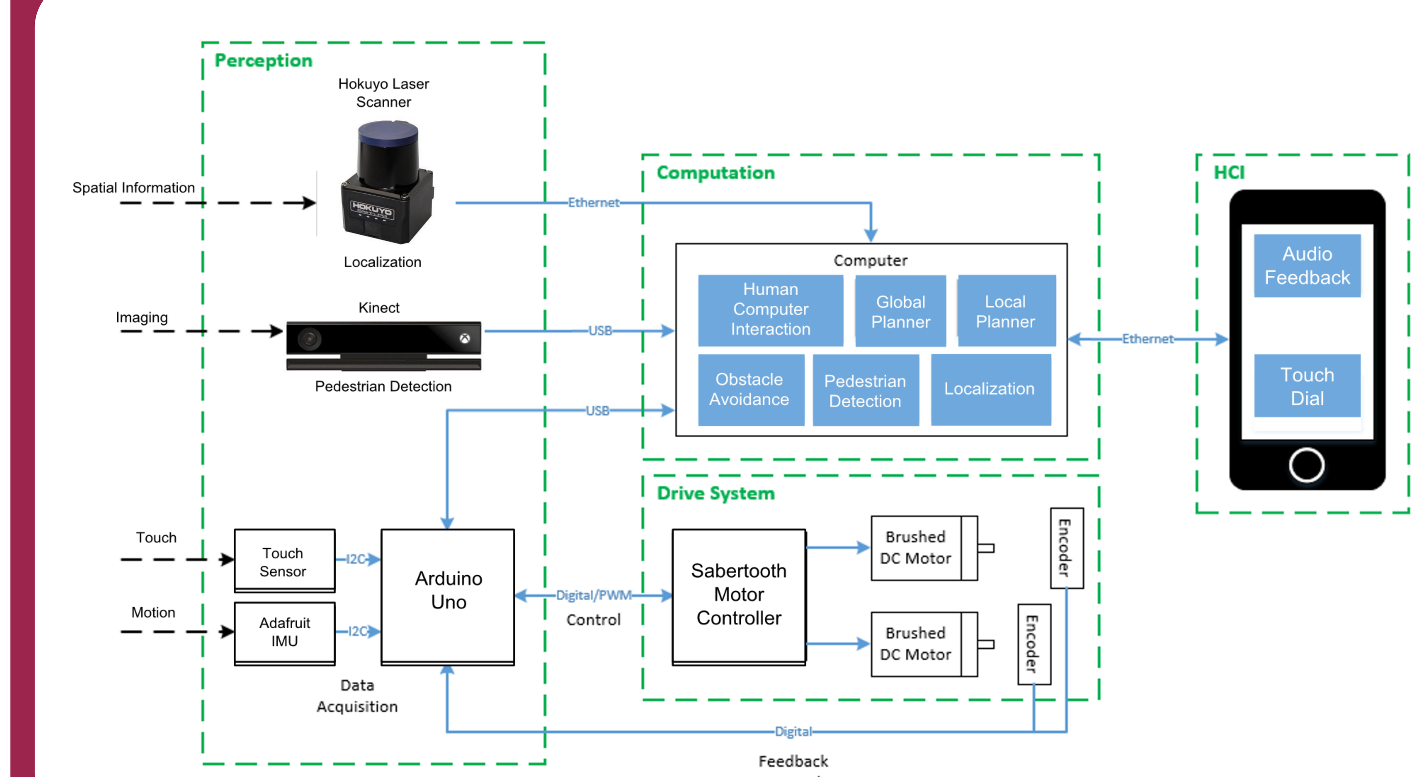
- CaBot uses a LIDAR, IMU, and encoders to localize itself

ROS Navigation Stack

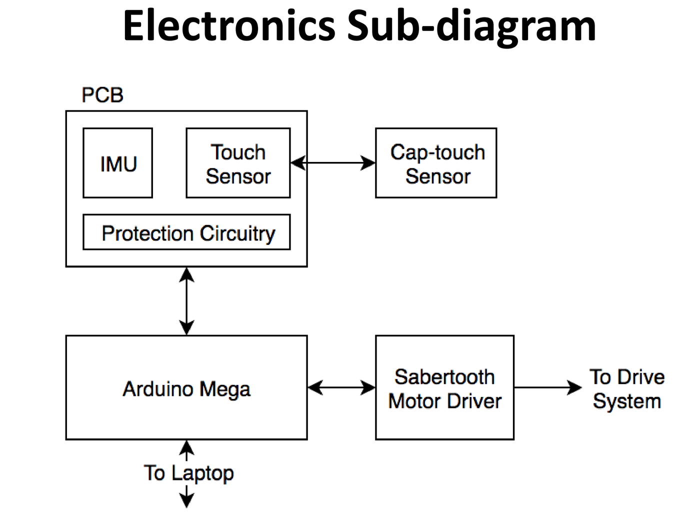
- Used DWA planner for local planner and AMCL particle filter for localization
- Size of CaBot tuned so that user can fit on left hand side of robot



Cyberphysical Architecture



Electronics Sub-diagram



Contact

Divya Kulkarni, MRSD, dpkulkar@andrew.cmu.edu
Chris Song, MRSD, qsong1@andrew.cmu.edu
Jennifer Isaza, MRSD, jennifei@andrew.cmu.edu
Yanda Huang, MRSD, yandah@andrew.cmu.edu
Andrew Wong, MRSD, awong2@andrew.cmu.edu
Website: https://mrsdprojects.ri.cmu.edu/2017teamg/

Divya Kulkarni Chris Song Jennifer Isaza Yanda Huang Andrew Wong