Synth**Sense**

Team

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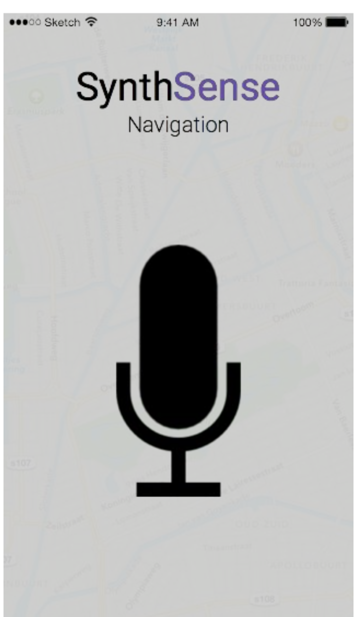
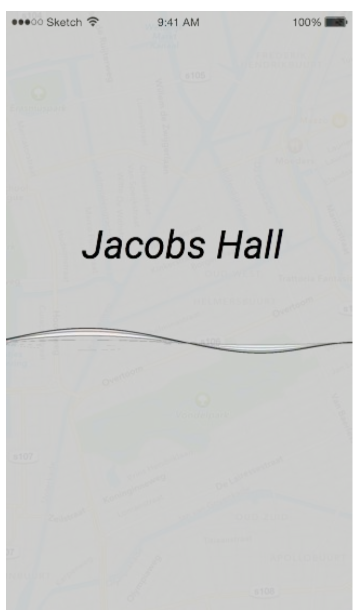
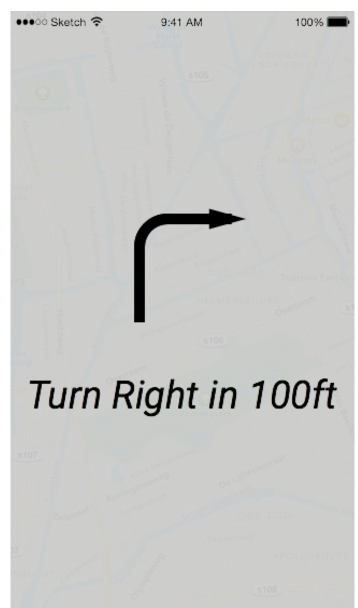
- Adithya Murali
- Frank Lu
- Tomás Vega
- Krishna Parashar

User Interface

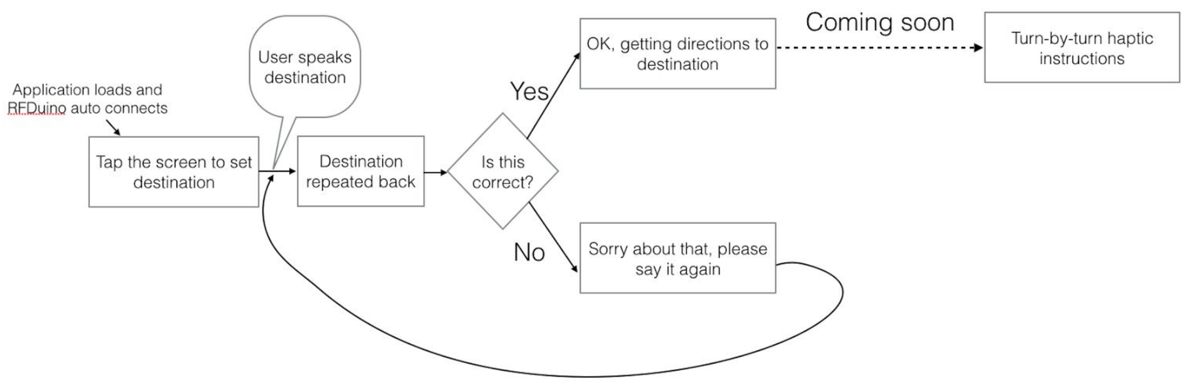
Given that our target user group consists of blind people, the user interface of our app becomes auditory instead of visual. The user flow thus consists of **(1)** the user opening the app (currently a native iOS app) using the voice control system built in on to the phone. The app then loads **(2)** up to a view that has the entire screen as button that **(3)** when pressed the microphone to allow the user to **(4)** speak the place they would like to navigate to. The app then calculates a turn by turn navigation to the desired destination, **(5)** using the navigation band as feedback system that alerts the user to their destination.







The screenshots on the previous page are what we would like this to look like in the end. By having information on the screen it allows for non-visually impaired people to look at the screen and see where the user is planning on going if they need assistance. Since we are still on an early prototyping phase, we wanted to focus on the interactions that a blind person has with our application. Specifically, we worked out how to prompt a user for additional vocal input to confirm commands. This could be extended further to allow for deeper navigation through the application. A diagram of the current interactions a user can have with our system is as follows:

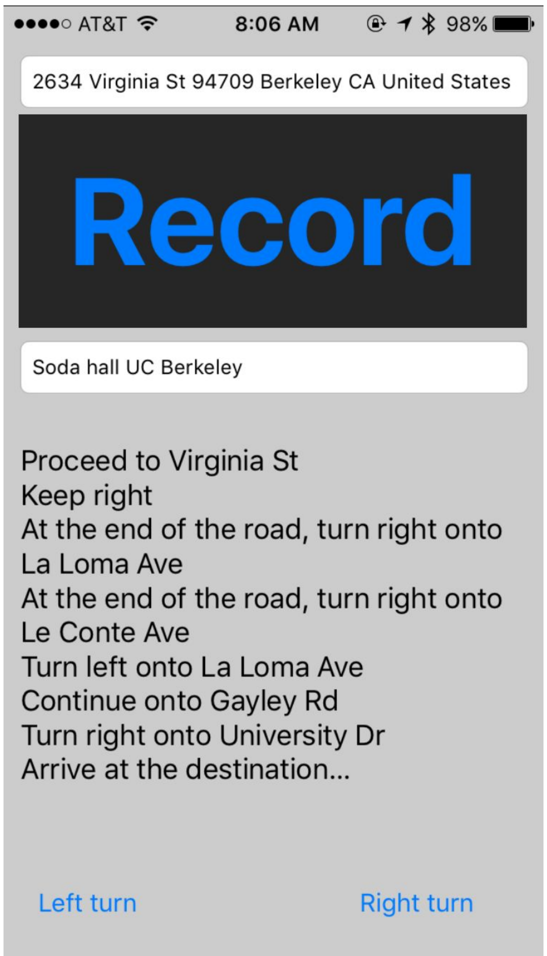


Here is a video of this UI in action: https://youtu.be/xAxwXTHDW_s

Since most of the feedback to the user is through the vibration motors in various parts of the project, we also consider that to be a user interface. More details on updates to those to follow.

BLE Integration

The sensors and obstacle detection feedback systems on the augmented white cane are designed to be completely operable without any wireless data communication, making BLE or WiFi inappropriate for the white cane. However, the navigation band requires a positioning and routing system. It seemed natural to use an iPhone to provide this data to the strap. Since we didn't want to create a new wifi network for only our devices (since they will be used outside where existing wifi networks may not exist), we went with Bluetooth low energy. We chose an RFDuino for this since it has an adequate number of IO pins, is cheap, and relatively easy to set up with a lot of documentation and sample code available. We integrated this functionality into the app we have been working on by adding a “Left turn” and a “Right turn” button to the bottom of the screen. Since we have not yet determined how we want to approach turn-by-turn navigation, this was the simplest way to test the system. It also means we don’t have to walk in the rain just to see if the motors turn. A screenshot of the app is on the next page. We are expecting multiplexers to arrive this week which should allow us to connect all of our sensors and actuators to a single RFDuino. Because of this we held off on trying to merge the wrist band with the white cane components until we could do a more permanent job.



Video of the left/right turn in action: https://youtu.be/LLXPSRZTLPM

Code

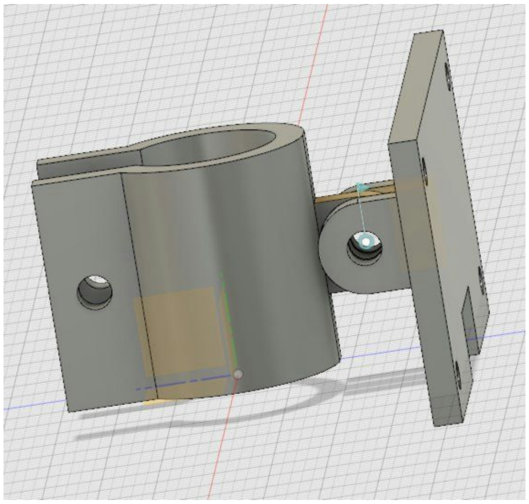
[Augmented White Cane]

[Tactile Navigation System]

iPhone Navigation App

Code for RFDuino **https://gist.github.com/craighiller/327b23b3422128313613**

Enclosures



Sensor Casing
http://a360.co/1MhXdb1

Handle
http://a360.co/1GTbvlA

For iteration 2 prototyping, we're trying to make each component modular for the ease of adjusting for user testing and replacing faulty components/ sensors. The sensor casings mount onto the white cane and the handle snaps to to the rear end of the cane while mounting 3 coin motors. Given that the power system and the breakout board of electrical components are still being tested, we decided to leave that out of the handle for now. Our final design will integrate all the components (sensors, MCU, PCB, batteries, motors) into different compartments of the handle.

Current Prototypes

Demo Video

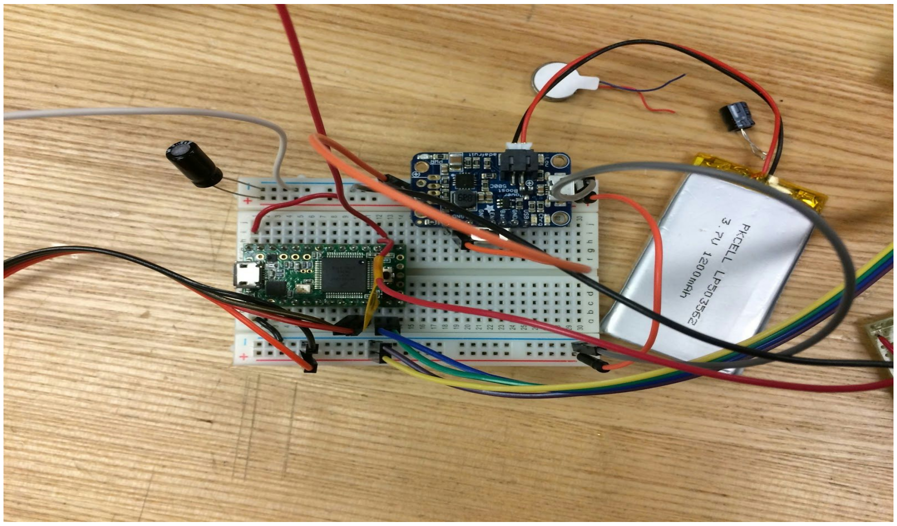
Sensor Mount

Wrist Strap with Coin Motors

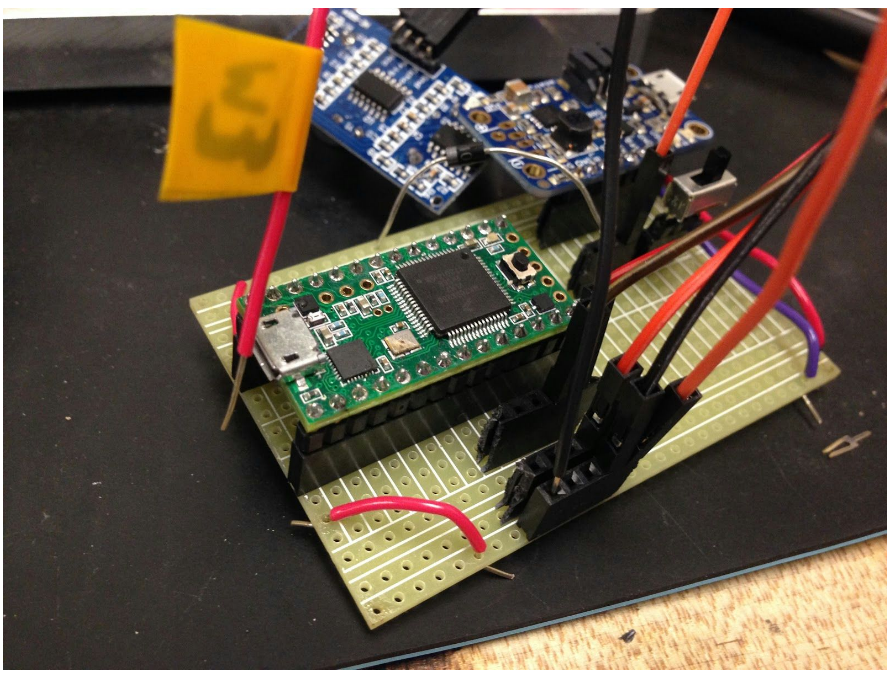
For the wrist strap, we iterated heavily in the past two weeks going through four different models of how it should work before arriving at what is shown above. We began with a simple watch strap, but after attaching some vibration motors to that, we realized it would be the same jumbled mess that we had in the previous iteration. Additionally the strap didn't close very well, so a lot was left to be desired. We then made a paper look-and-feel prototype with motors and a magnetic enclosure. This (shown below) gave us the confidence in that design to proceed with a fabric version. After many trials with the sewing machines, we decided to stitch it by hand so we wouldn't keep burning time. For future iterations we are looking into sewing the band on a machine. With this first fabric version, we learned that in order to have the vibration motors not interfere with human skin, we should have them on the inside of the band, with the masses covered so they wouldn't jam. However, the motors slid forward after the band was stitched shut and all of them jammed. This led us to our final design with coin motors on the interior of the band, these don't have any externally facing rotating parts and are much thinner which actually made them ideal for this situation. We twisted the cable together to keep all of the wires together and put it on. The magnetic clasp is made from a neodymium magnet on one end and five small strips of metal in the other.

Top row: Paper look-and-feel prototype of the magnetic closure wristband.
Bottom left: ERM motor inside a 3D printed housing to allow it to spin inside the band (worked until the glue slid)
Bottom right: the metal strips that form the other side of the magnetic clasp

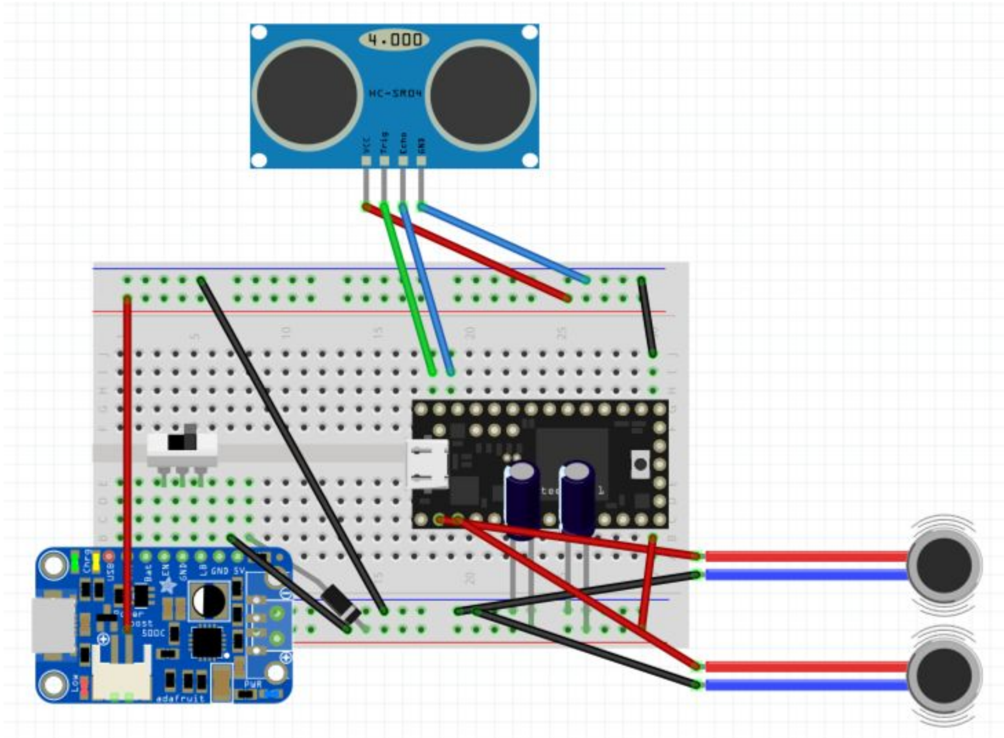
We implemented the same state machine we described in P3 for this prototype. Compared to P3 where we powered the microcontroller and electronics (motors, ultrasonic sensor, etc.) with a USB cable, we had the P4 prototype powered by a 3.7V LiPo battery. However, there were several challenges when implementing the powering. We had to use a boost converter for the battery and implement a PI filter for the input voltage. Furthermore, we attempted to house all the electronics on the protoboard for fitting inside the handle enclosure. Unfortunately, there turned out to be some loose connections with the header pins, so we reverted back to the breadboard for the P4 prototype. For the final project, we aim to start early with multiple iterations of the PCB manufacturing process.



Circuit on Breadboard



Circuit on Protoboard



Circuit Diagram on Fritzig

Work Plan

Major Steps

Task	People	Description	Estimated Time
Integrate Components	Team	Integrating the Navigation App and hardware and ensure overall functionality. Integrate electrical components and test and ensure there is no abnormal behaviour.	Throughout
iPhone Navigation App	Craig	We have the basics of the app down so far, we can get voice input from the user and get directions. The problem now comes from making this into a navigation app. Starting today, I have a call with Nokia about their mapping APIs, hopefully that will give a good starting point. The rest could just be a lot of code to make this work as we desired. There will be a small UI-prettifying aspect as well towards the later part of this.	15 Days
PCB Design	Tomas, Krishna, Frank	Design and mill a custom breakout board with Eagle to include surface-mount components and connect the microcontroller.	6 Days
Enclosure Design	Frank	Refining current enclosure design for the handle to include compartments that house the PCB, battery, and microcontrollers. Adjust sensor mount so that it has a full enclosure around the ultrasonic sensor.	6 Days
Power Systems	Tomas, Adithya	Source enough power with a boost converter while preventing rippling effect using filters to the cane's handle to power the ultrasonic sensors and motors.	6 Days
User Testing	Krishna, Frank, Adithya	Show and discuss prototypes with our users to ensure functionality. Additionally get feedback on improvements to try and implement them.	4 Days
Project Poster	Adithya, Krishna	Make a poster that showcases the user story, the design process, prototyping iterations, user feedback, as well as the finished product.	6 Days

Final Assembly	Tomas, Frank	Integration the software and hardware platform and combining power systems, PCB and fit it inside the enclosures and make sure it still works.	6 Days

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<tr><td colspan="8">iPhone Navigation App</td><td></td><td></td><td></td><td></td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Project Poster</td></tr>
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Risks to Successful Completion:

- **Risk 1**: Integration between application software and the two hardware components (both the cane and wrist strap)
- **Contingency Plan 1**: Combining the cane and wrist strap into one hardware component and use the RFduino and multiplexer and make sure BLE is functioning properly.

- **Risk 2**: If we are unable to match user’s current location to a position on a route step and track their position along the route as they navigate, we won’t be able to provide turn by turn directions.

- **Contingency Plan 2**: We could add a button that allows for the user to ask for directions at a given point in space, which circumvents the need to track user position.

- **Risk 3:** Hardware failure (MCU getting fried, capacitors/ transistors blown, tracing fried on PCB)
- **Contingency Plan 3**: CAD spare parts, print extra PCB's, and buy more spare parts. Design the enclosures so that it's easy to swap out parts and reuse.

- **Risk 4:** Not being able to fit all the electrical components (power system and micro-controller especially) inside the handle.
- **Contingency Plan 4:** Create a small enclosure housing for all the electrical components and connect it to the handle.