Sensible Solutions

Visually Impaired Assistant (VIA)

Ahmad Ibrahim (Chief Financial Officer, Chief Information Officer)

Rob Sanchez (Chief Technical Officer, Chief Operating Officer)

Jessica Zanewich (Chief Executive Officer)

December 15th, 2014

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Outline

- Team Roles
- Motivation
- Background
- VIA Explained
- Component Explanations
- Integration Discussion
- Alternative Implementations
- Cost
- Financing
- Marketability
- Competition
- Budget
- Timeline
- What we learned.
- Future plans

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Team Members

- Jessica Zanewich (CEO)
  - Project Director
  - Head of the audio feedback system
- Ahmad Ibrahim (CFO and CIO)
  - Finances manager
  - Head of absolute orientation functionality
  - Case Design
  - Obstacle detection
- Rob Sanchez (CTO and COO)
  - Technical leader
  - Head of the sensors functionality

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Motivation

- Our motivation was of a curiosity nature
- Interested in surrounding area navigation
- Came up with a detection device for the visually impaired
- Great project for us because of interest in sensors and gyroscopes

Background

- Know there is a similar idea with GPS used for orientation
- However, very few technical products have true viability
- We wanted to use a different implementation method than was previously used

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Visually Impaired Assistant (VIA)

- The Visually Impaired Assistant is an alternative and more technologically advanced way for visually impaired people to navigate through an environment
- It is a remote-like device that “senses” an object, such as stairs or walls, in the area in front of the person and uses audio to relay that information back to the user.
- We hoped to make an affordable, yet better functioning, substitute (so they are not limited by their reach)
- Basic premise was to make it similar to a Wii Mote, so it is comfortable to hold.

Overview of Components

- Sensors used for distance
- Gyroscope used to detect orientation
- Audio used to give feedback to the user
- Communication protocol used for trinket communication

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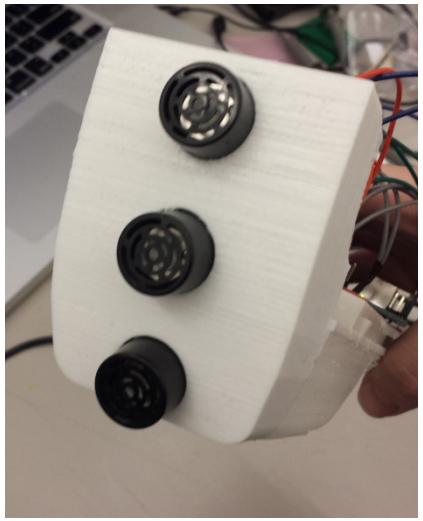
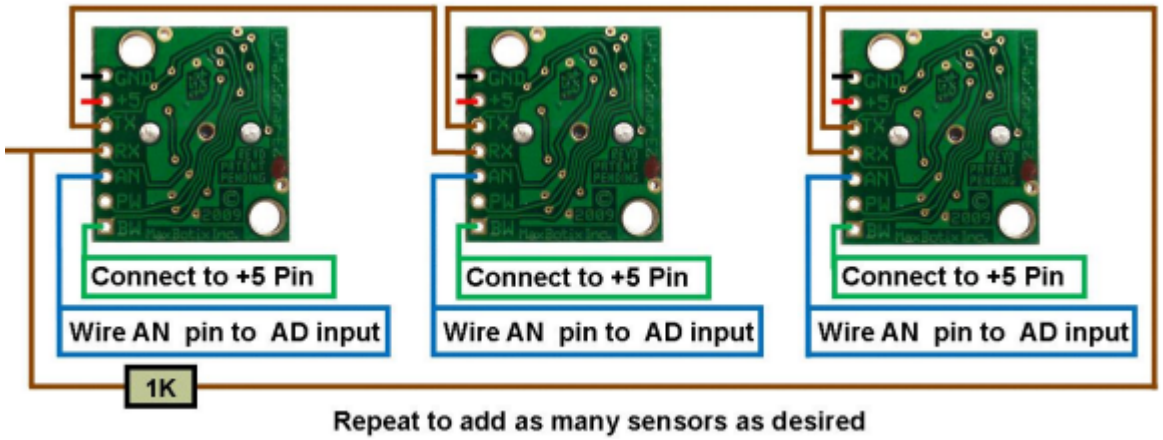
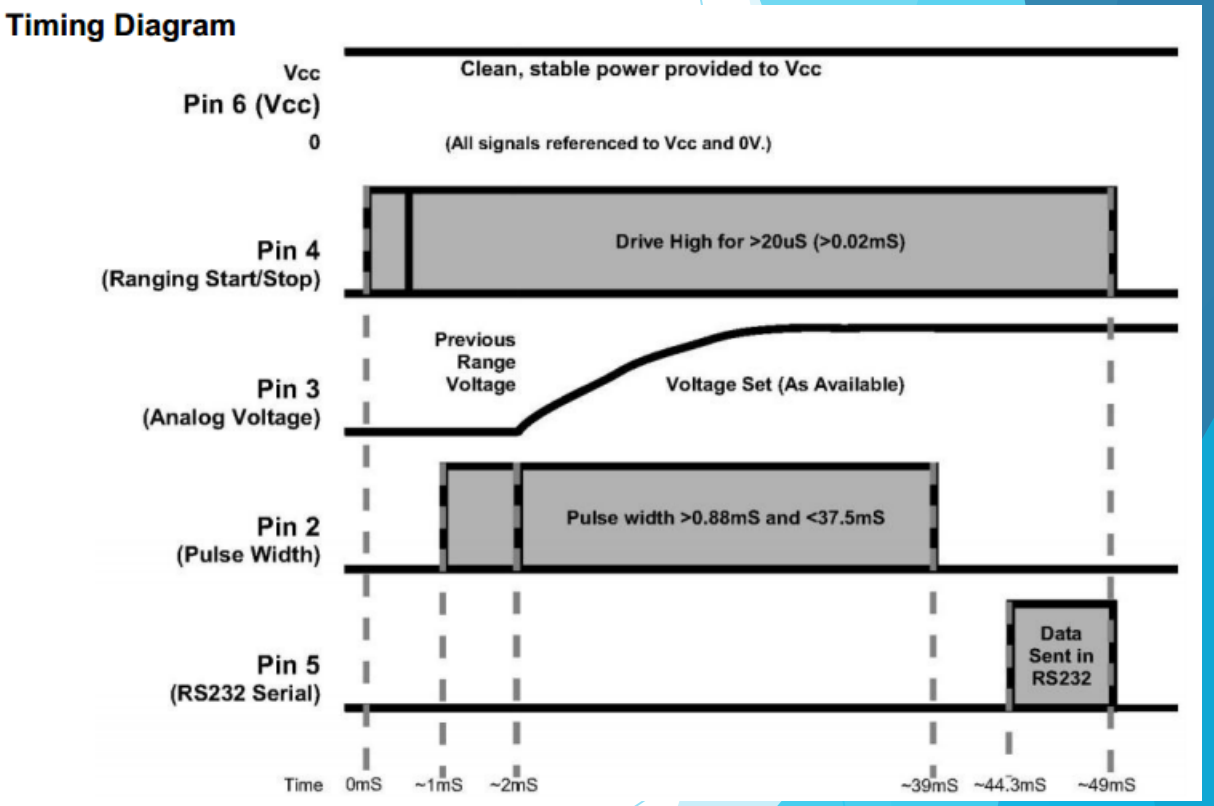
Sensors

- Methods used to synchronize sensors:
  - RX/TX series connection
  - Fixed delay between enables
  - Sequence and Delay
- Issues with sensor throughout process



Sensors (2)


Connect to +5 Pin
Wire AN pin to AD input
Connect to +5 Pin
Wire AN pin to AD input
Connect to +5 Pin
Wire AN pin to AD input
1K
Repeat to add as many sensors as desired


Timing Diagram
Vcc
Pin 6 (Vcc)
0
Clean, stable power provided to Vcc
(All signals referenced to Vcc and 0V.)
Pin 4
(Ranging Start/Stop)
Drive High for >20uS (>0.02mS)
Pin 3
(Analog Voltage)
Previous Range Voltage
Voltage Set (As Available)
Pin 2
(Pulse Width)
Pulse width >0.88mS and <37.5mS
Pin 5
(RS232 Serial)
Data Sent in RS232
Time
0mS
~1mS
~2mS
~39mS
~44.3mS
~49mS

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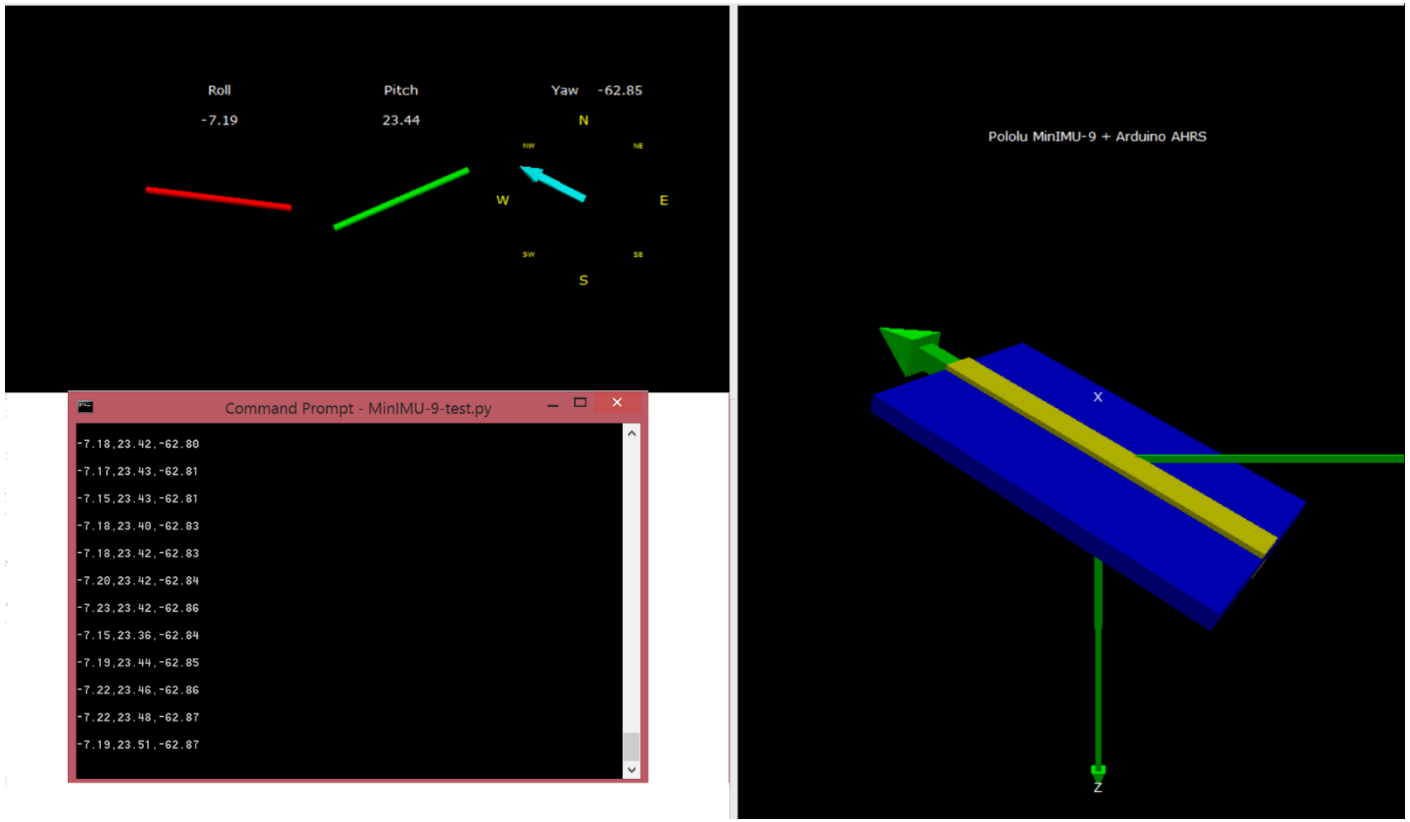
Device Orientation

- 9 degree of freedom chip
- Combination between the L3GD20H 3-axis gyroscope, LSM303D 3-axis accelerometer and 3-axis magnetometer
- Gets the velocity, acceleration, and magnetic field readings: finds absolute orientation
- Clear pitch, yaw, roll
- Yaw can drift occasionally, but does not matter for our product

Absolute Orientation Script



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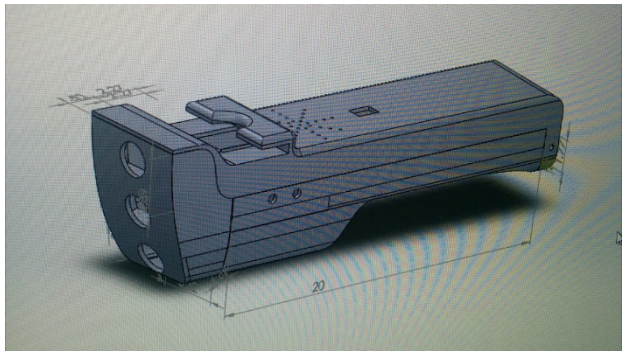
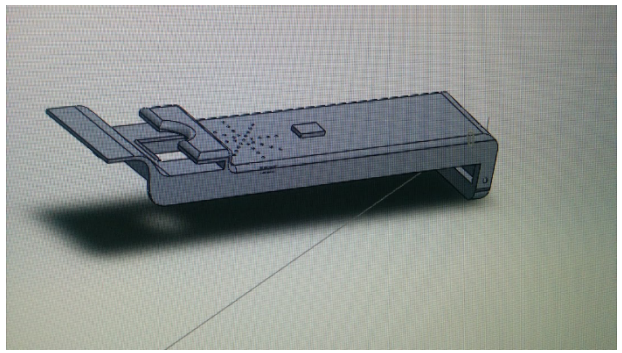
Case

- SolidWorks done in 3 pieces:
  - Front for the sensors
  - Bottom that holds the components
  - Top cover with speaker holder
- Used 3DHubs.com (special thanks to Lukas for the recommendation)





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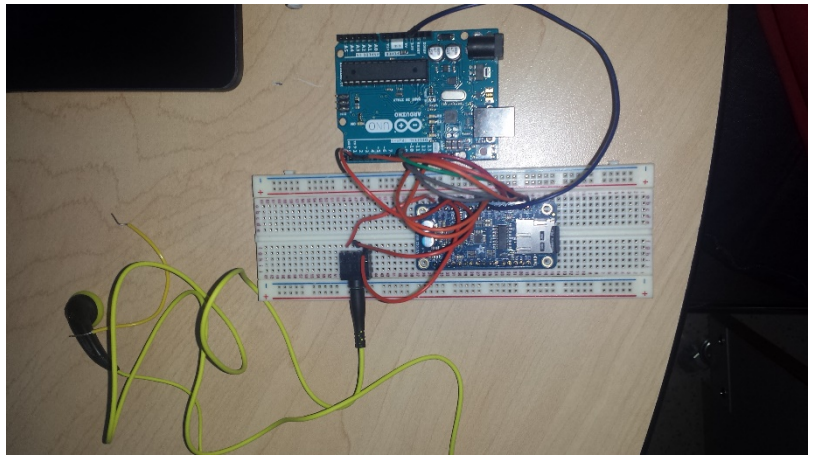
AUDIO FEEDBACK SYSTEM

- Has its own separate microcontroller
- Also use a VS1053 breakout board to help with the decoding of audio files (OGG format)
- Use a singular speaker with an amplifier at the input to produce quality sound (for the speaker used).
- Headphone jack as an option as well.



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Communications Protocol

- Transmitter sends 8 bits individually through a single digital pin
- Receiver takes in those 8 bits and distinguishes specific bits as “object” and “distance”
- The bits for each parameter are converted into integers.
- These integers are used to play a specified audio clip

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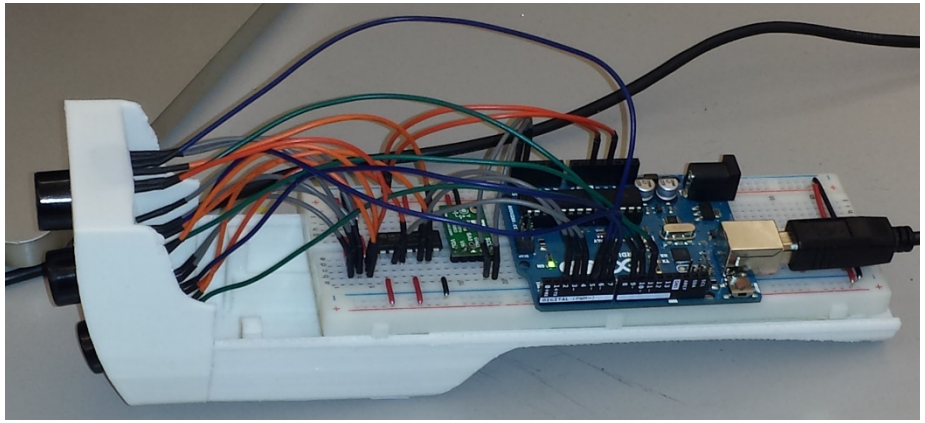
Integration

- Two Main Stages:
  - Sensors and gyroscope integration
  - Integrate audio with previous step
  - Obstacle detection



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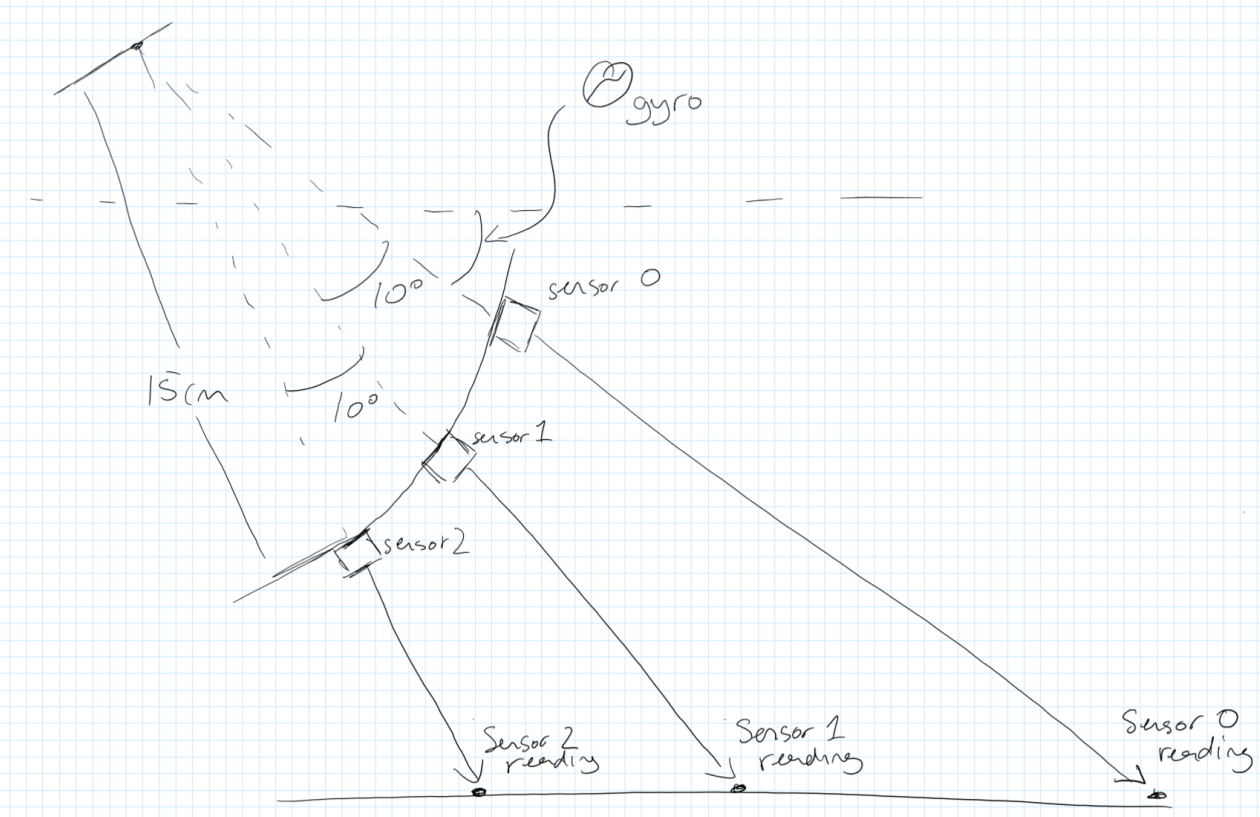
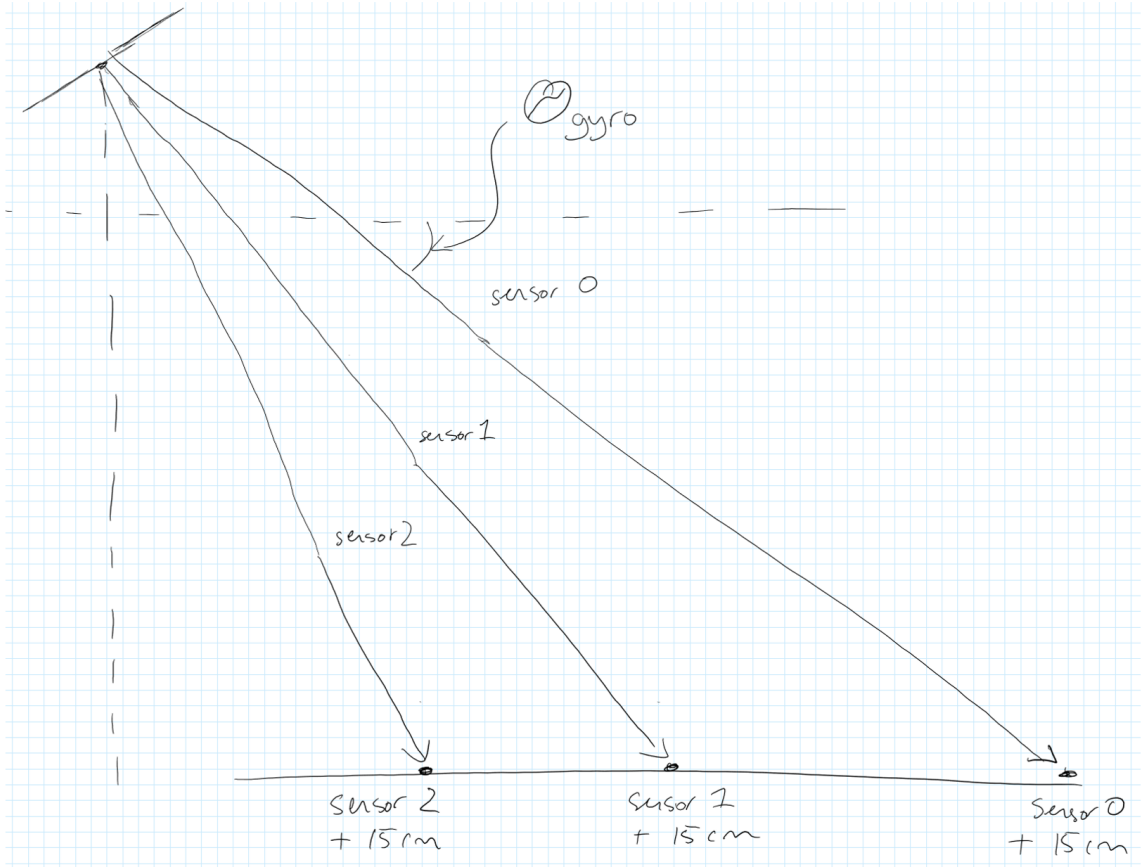
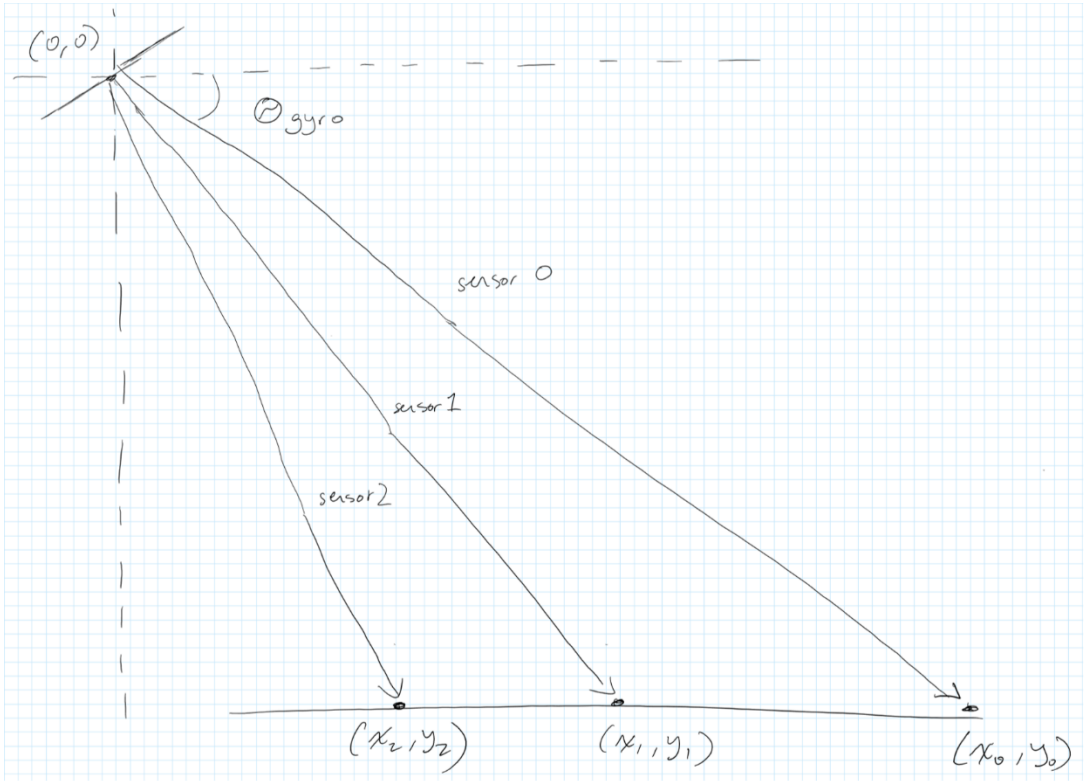
Obstacle Detection Algorithm



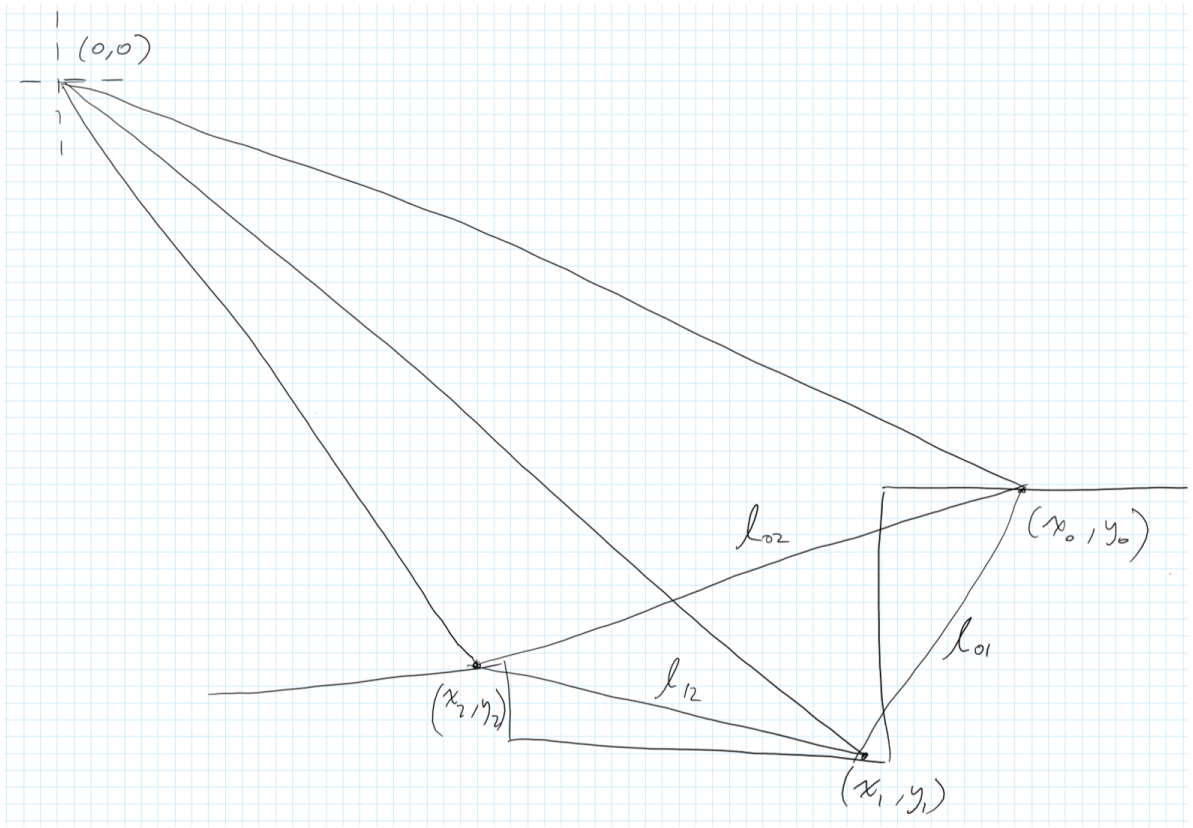
Obstacle Detection Algorithm (2)



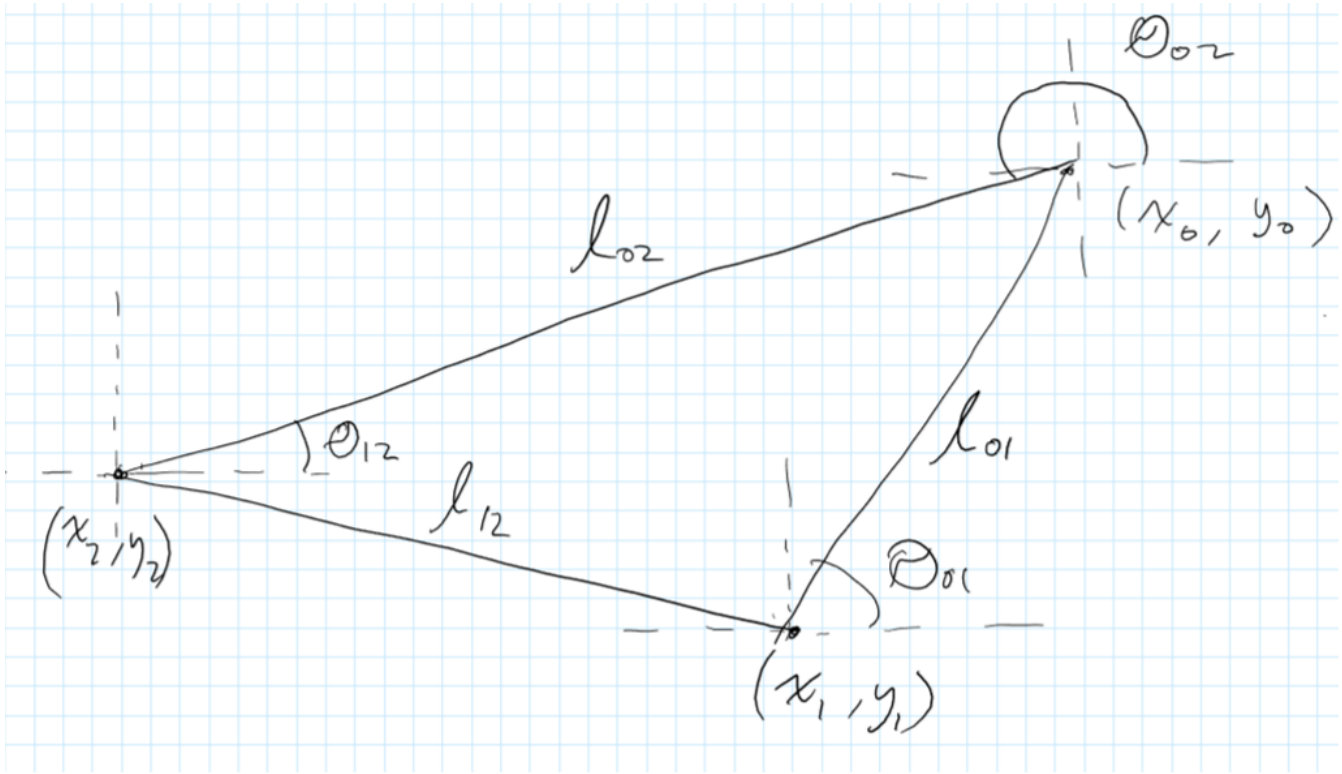
Obstacle Detection Algorithm (3)



Obstacle Detection Algorithm (4)



Obstacle Detection Algorithm (5)



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Cost and Financing

- Total Spending: $746.78
- Faulty 3d printing reimbursement: $139.38
- Total spent if reimbursed: $607.40
- Funding from the ESSSEF for $475.00
- Hoping for financing from the Wighton Fund

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Budget

- Initial budget estimate totalled $567.84
- Finished our product spending a total of $607.40
- Over budget by $39.56
- Should have increased our budget for more quality materials

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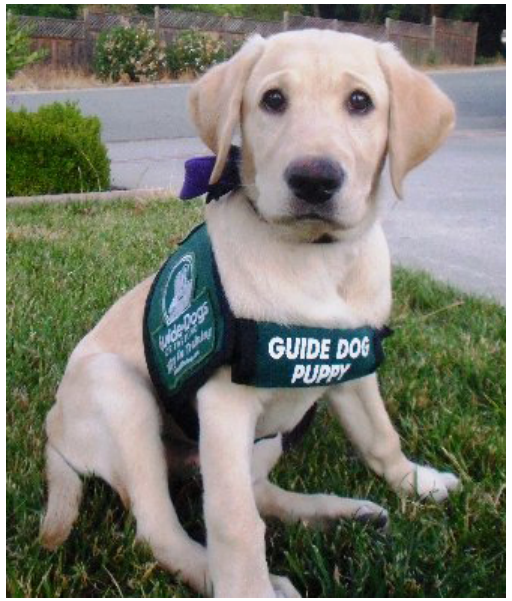
Competition

- The main competition on the market comes from the main stays of the visually impaired lifestyle
- White Cane
- Guide Dog
- GPS based systems



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Marketability

- Geared towards the visually impaired
- Technologically advanced
- Better range
- More accurate description (*Depends on sensors)

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Timeline

- Biggest discrepancy in our time line was the lack of time taken into account for documentation
- Sensors: Alternating between working and not working
- Hard to spread the work out over the term with the documentation used as a consideration for each portion

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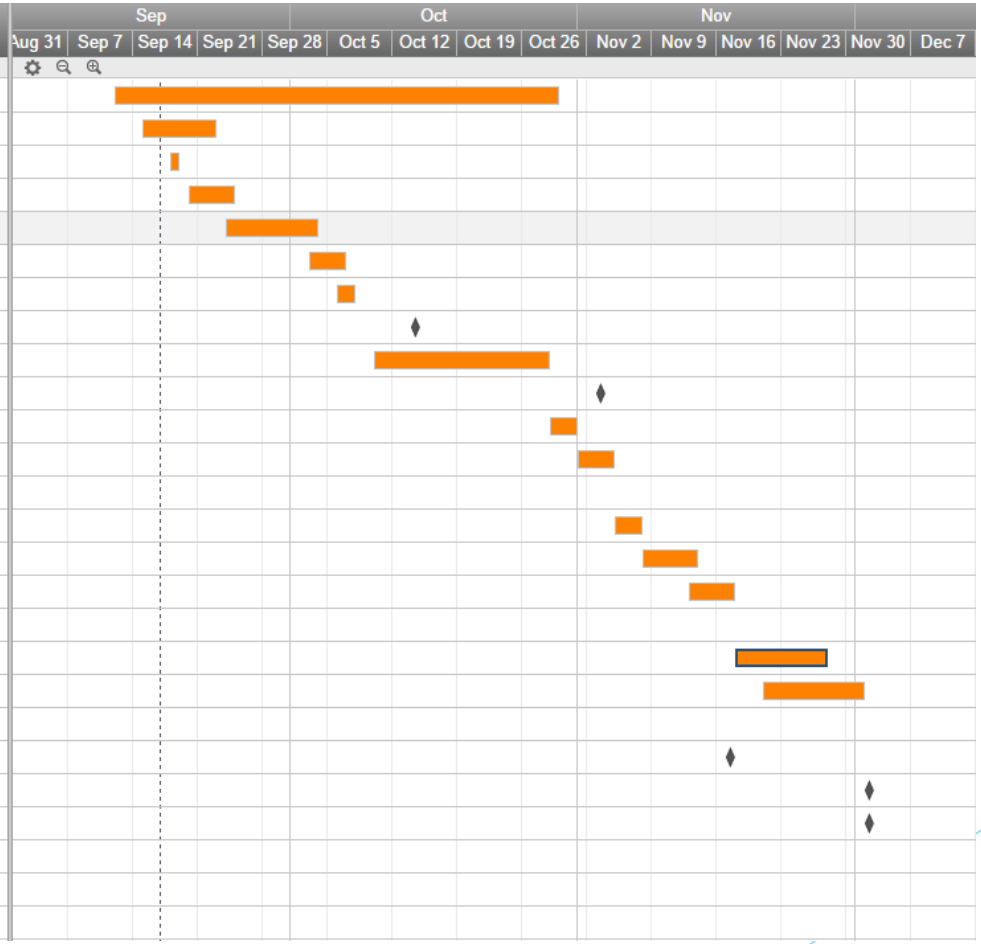
Initial Timeline

Task Name	Duration	Start	Finish
Arduino and Sensor Research	34	09/12/14	10/29/14
Project Proposal	6	09/15/14	09/22/14
Buy components	1	09/18/14	09/18/14
Get familiar with Arduino and test first sensor	4	09/20/14	09/24/14
Sensor Distance Measuring	8	09/24/14	10/03/14
Troubleshooting of sensors	2	10/03/14	10/06/14
Audible warning feedback for all 3 sensors	2	10/06/14	10/07/14
Functional Specification	0	10/14/14	10/14/14
Sensors able to distinguish different types of obstacles	13	10/10/14	10/28/14
Design Specification	0	11/03/14	11/03/14
Proper Warning System	3	10/29/14	10/31/14
Warning system troubleshooting	3	11/01/14	11/04/14
LEDs to indicate visually impaired system in use	3	11/05/14	11/07/14
Gyroscope	5	11/08/14	11/13/14
Speaker Implementation and volume control	3	11/13/14	11/17/14
Put into case (and final troubleshooting)	8	11/18/14	11/27/14
Integration and Final Unit Testing	7	11/21/14	12/01/14
Written progress report	0	11/17/14	11/17/14
Date to be ready for demo	0	12/02/14	12/02/14
Post-Mortem	0	12/02/14	12/02/14



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Learned

- Real World:
  - Should have not worried about money to such a great extent in favor of better quality sensors
  - Account for testing time and put a hard deadline for each component
  - Reassess the project as we go and be willing to change ideas and reconsider decisions
  - Team management (learning to deal with different personalities)
  - Accurate project timelines
  - Juggling work with school
- Technical
  - Strengthened soldering and de-soldering skills
  - Programming with Arduinos and Adafruit Trinket
  - Learned strong usage of SolidWorks

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Future Plans

- Get better sensors for better accuracy
- GPS
- Bluetooth (for a single headphone to listen through)
- Improved prototype (functionality, looks, ergonomics)
- Working with visually impaired for future testing and development

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Conclusion

- Wished the sensors would have cooperated better to truly develop our ideas to where we wanted
- Though we were only slightly over budget, should have spent more for quality
- Learned quite a bit both technically and working in real world through this project
- Hope to continue working on the aspects that could not come together to improve the product

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Acknowledgements

- Special thanks to: Steve Whitmore, Andrew Rawicz, Lukas-Karim Merhi, Jamal Bahari, Mona Rahbar
- Additional thanks to: ESSS, Oreo the dog, for keeping us sane through the night
- And, of course, to our friends and family supporting us along the way and today

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Questions?

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Visually Impaired Assistant (VIA)

Ahmad Ibrahim (Chief Financial Officer, Chief Information Officer)

Robert Sanchez (Chief Technical Officer, Chief Operating Officer)

Jessica Zanewich (Chief Executive Officer)

April 20th, 2015

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Outline

- VIA Overview
- Reflections
- Adaptations
- VIA Changes
- Future Plans
- Conclusion
- Questions

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Visually Impaired Assistant(VIA) Overview

- Utilizes three I2CXL-MaxSonar–WR/WRC ultrasonic sensors for obstacle realization
- Device orientation is done with the Pololu MinImu-9 nine degree of freedom chip
- Audio feedback is done using the BlueSMiRF Silver Bluetooth adapter and an Android application

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Reflections

- Previous iteration:
  - Too ambitious
  - Lacked technical experience
- Current iteration:
  - Focus on proof of concept

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Adaptations

- Work re-allocation with two members
  - Ahmad: Detection algorithm, CAD
  - Robert: Component integration, audio feedback
- Product simplification
- Worked more independently

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VIA Changes

- Focused on device simplification
- More reliable ultrasonic sensors
- Using a Bluetooth modem instead of a standalone audio component to reduce circuit size and system complexity

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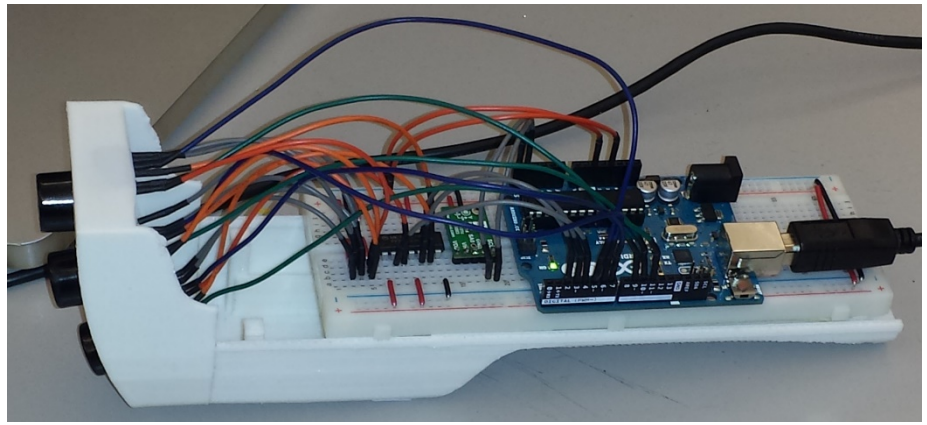
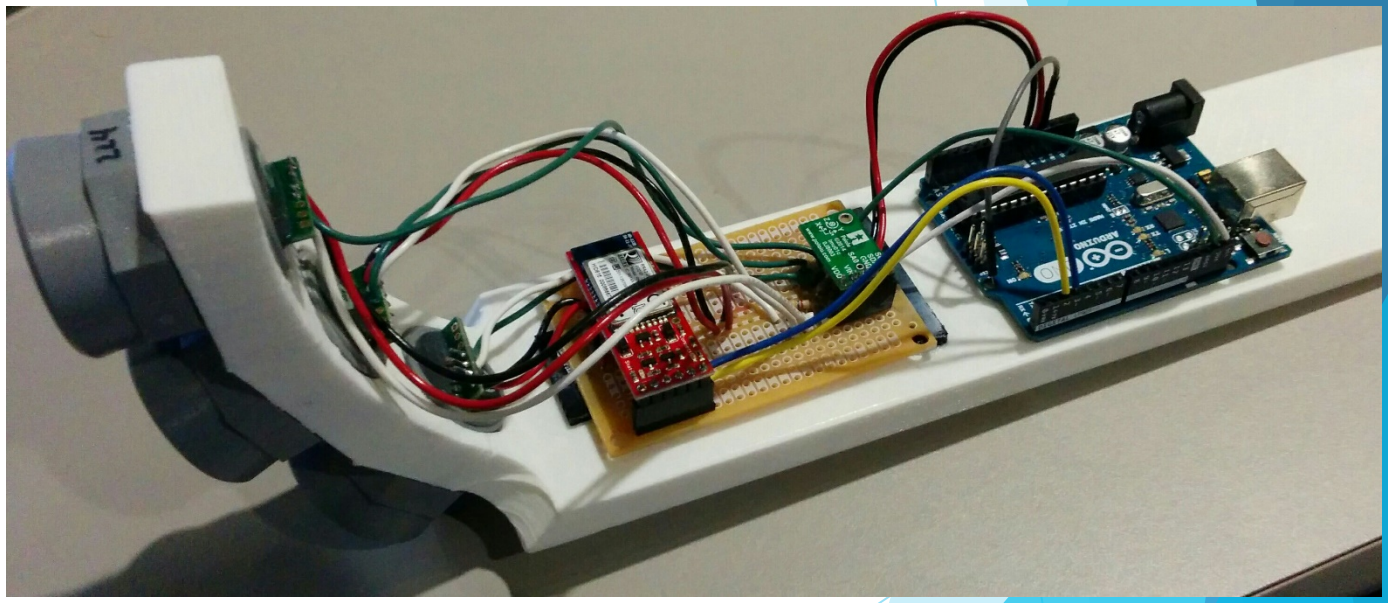
VIA Changes – Device Simplification

- Much simpler circuit can be made ever smaller by using a Trinket instead of an Arduino





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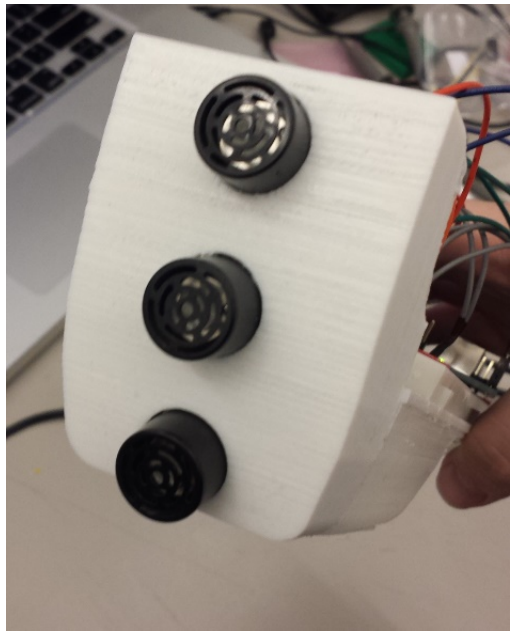
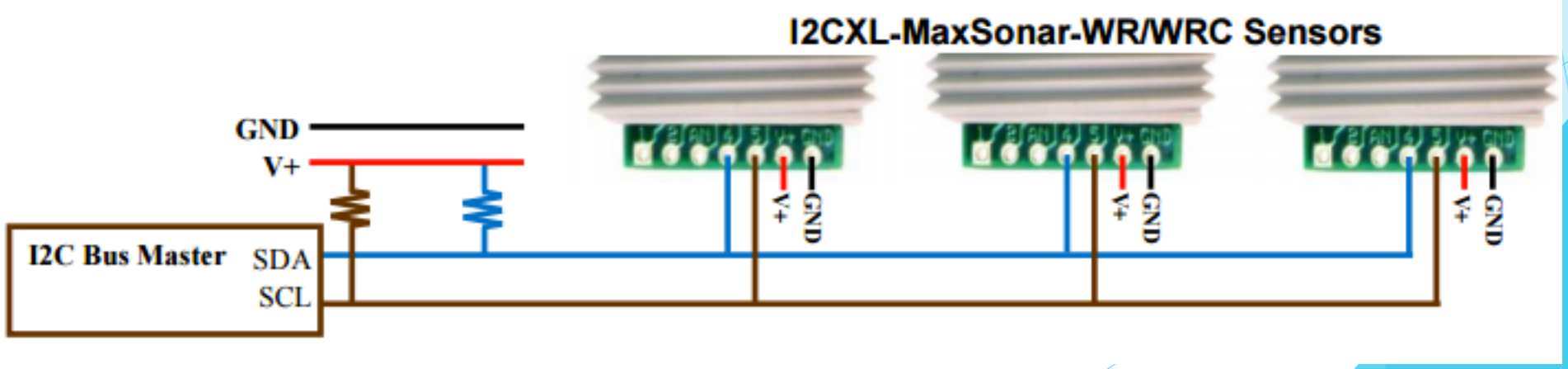
VIA Changes - Sensors

- As we learned unfortunately late into the previous semester, our issues were due to incapable sensors





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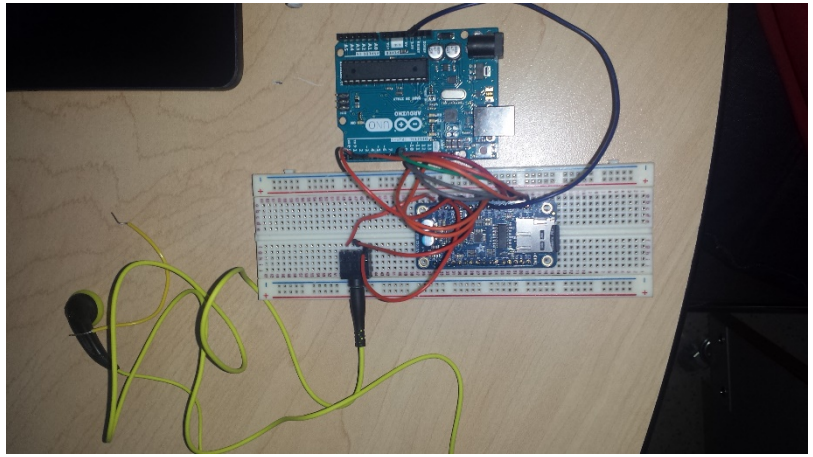
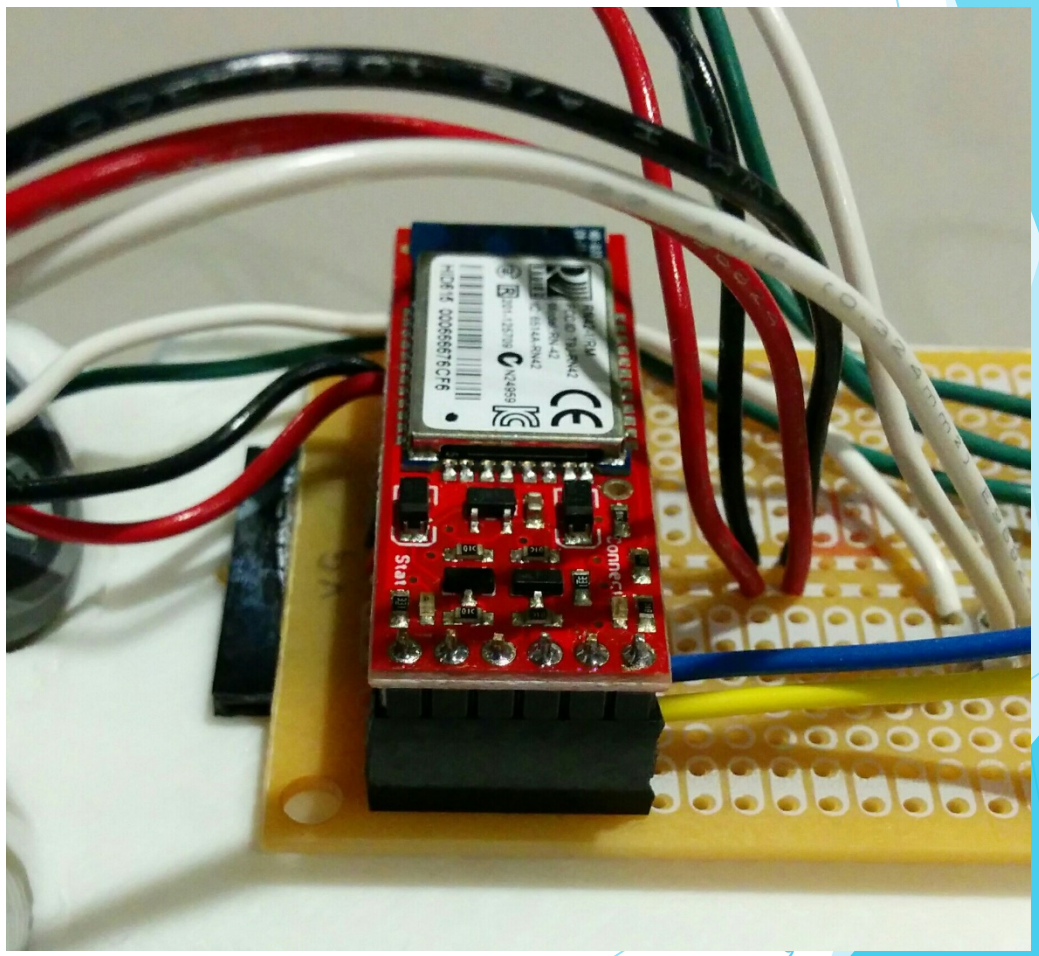
VIA Changes – Audio Feedback

- Utilizing a Bluetooth module instead of a separate microcontroller allowed us to simplify the circuit, and remove the extra overhead of the microcontroller-to-microcontroller communication





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Future Plans

- Previous iteration goals:
  - ~~Get better sensors for better accuracy~~
  - GPS
  - ~~Bluetooth (for a single headphone to listen through)~~
  - Improved prototype (functionality, looks, ergonomics)
- Current iteration goals:
  - GPS
  - Improved product(functionality, looks, ergonomics)
  - Working with visually impaired for future testing and development of the Android App

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Conclusion

- Create a working prototype before worrying about optimizations
- Focus on one goal at a time
- Design tasks to be independent

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Questions?