FriendlyEyes

Group 43

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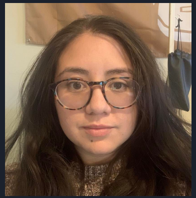
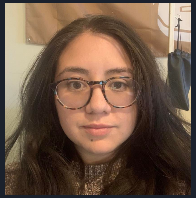


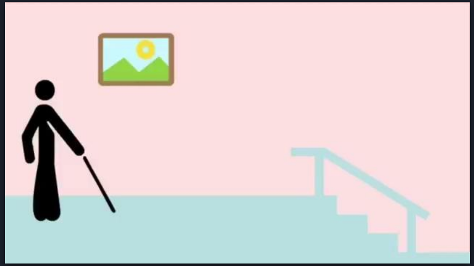
Contents

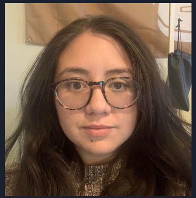
Motivation



- Apply knowledge of electrical design to the development of a navigation device.
- According to a 2015 study done by the CDC on the burden of vision loss, a total of 1.02 million people were blind, and approximately 3.2 million people in the U.S. had vision impairment (VI).
- There has been widespread latency on the development of navigation devices capable of guiding the blind through indoor and/or outdoor scenarios.
- Due to the nature of the wearable device, it can be used by non-visually impaired persons to help users navigate in the dark or in locations that have elevation changes.

Goals/Objectives

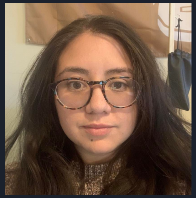




Our goals/objectives for this project were to create a wearable device that could:

- Detect objects in front of and to the sides of the user, as well as how far it is relative to the user;
- Detect objects coming in the direction of the user;
- Detect elevation changes in the terrain, which would reduce the possibility of falling by the user;
- All of these detections would trigger engagement of a state of alert when an object would cross the user's path.

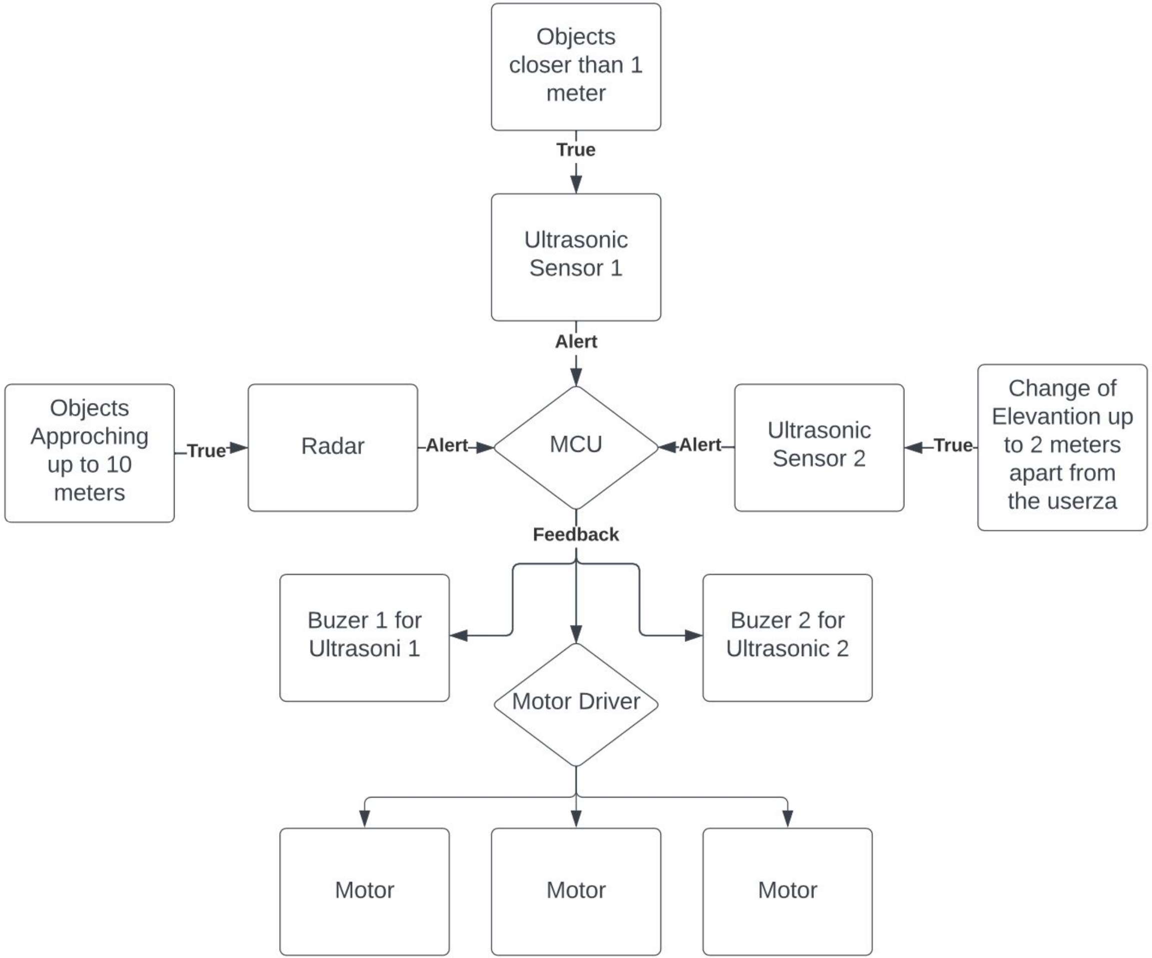
Requirement Specifications



FriendlyEyes must be able to scan user´s field of view up to 7 m away and produce a mechanical output.
FriendlyEyes must issue and prioritize alerts prompted by objects coming into 10 m from the user and doing so with speeds faster than 2m/s relative to the Earth.
FriendlyEyes must keep track of its distance from the background and alert the user of sudden changes in the level of the terrain ahead of an incident.
FriendlyEyes must produce all alerts within 1/8 seconds of sensing.

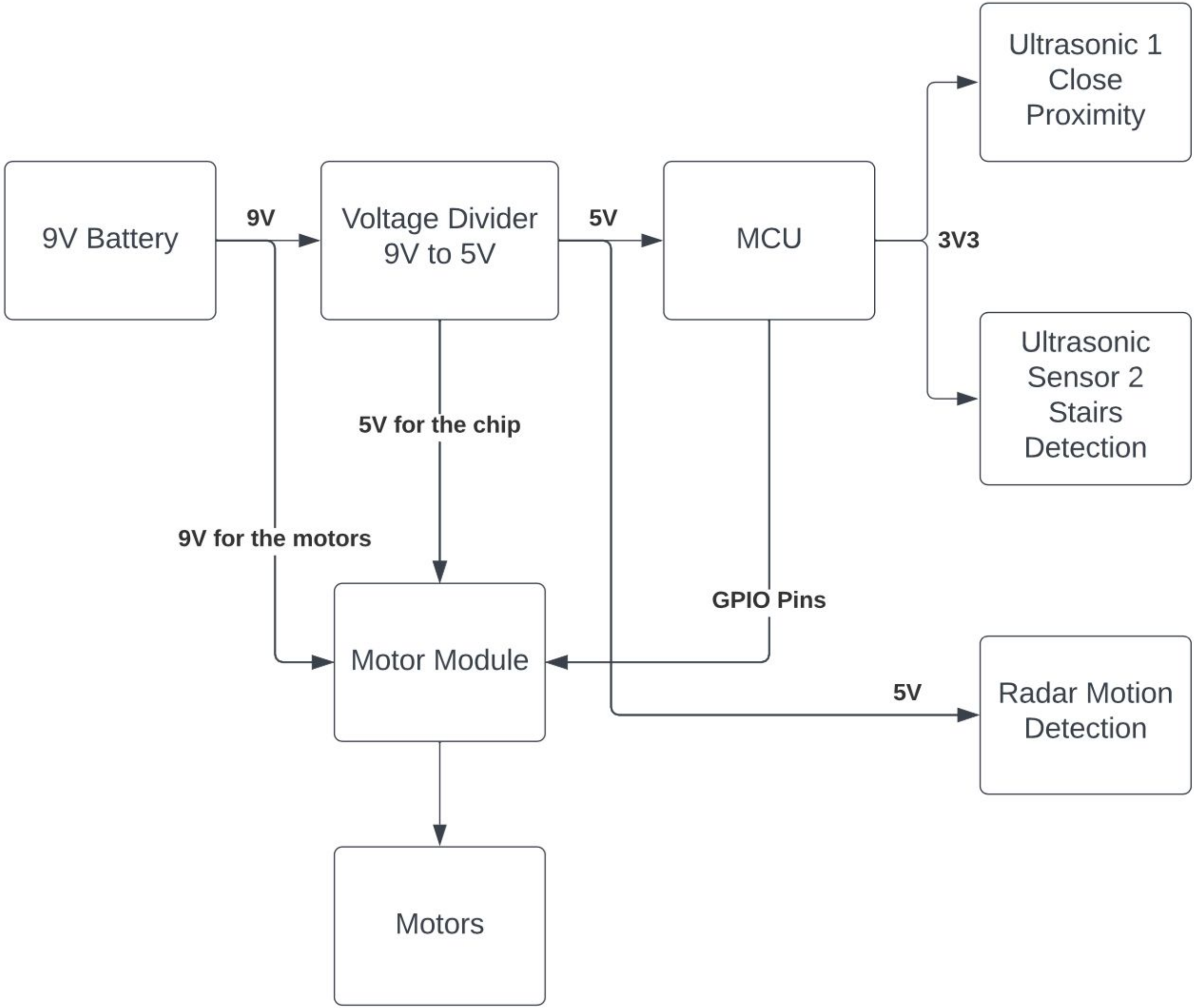
Hardware Block Diagram

No PCB Design



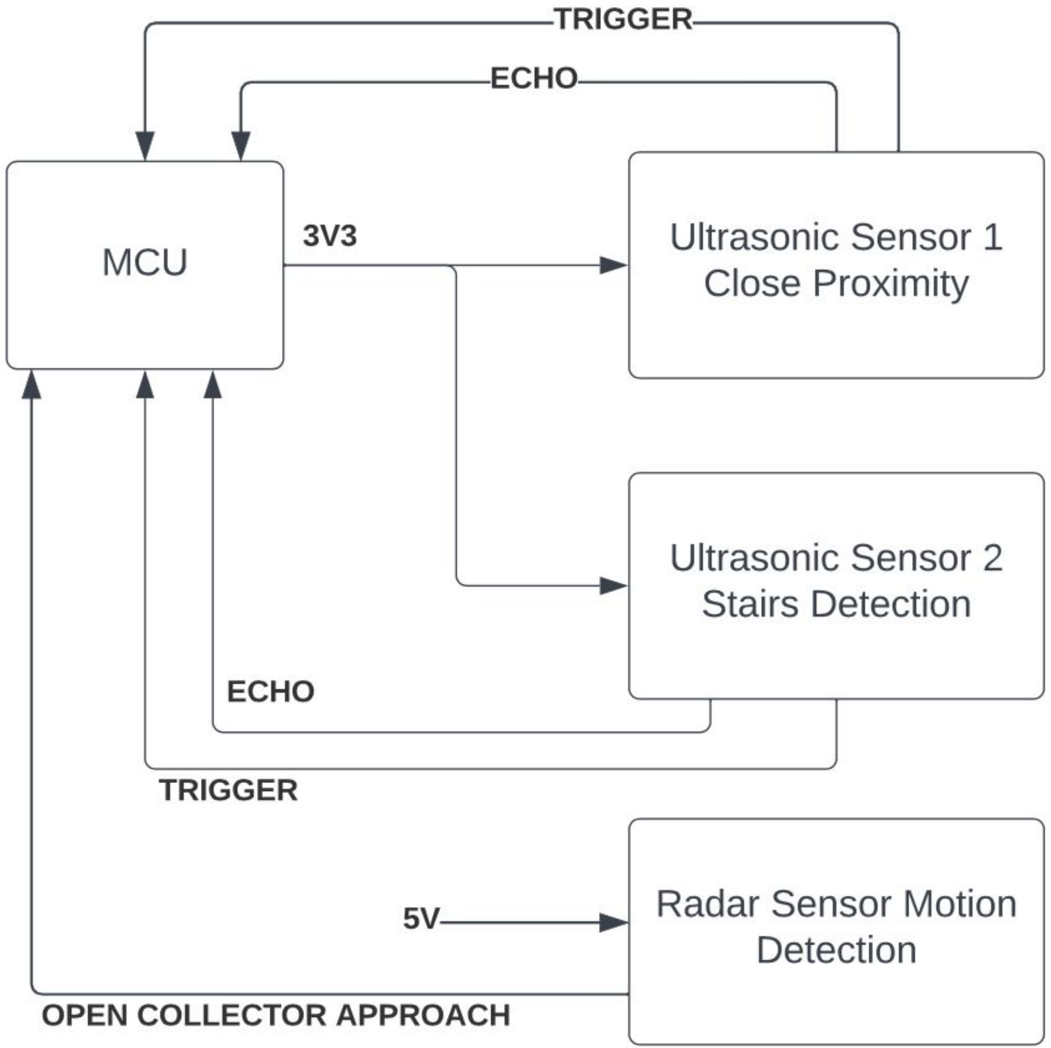
Power Block Diagram

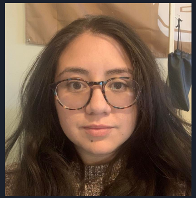
No PCB Design



Sensors Block Diagram

No PCB Design

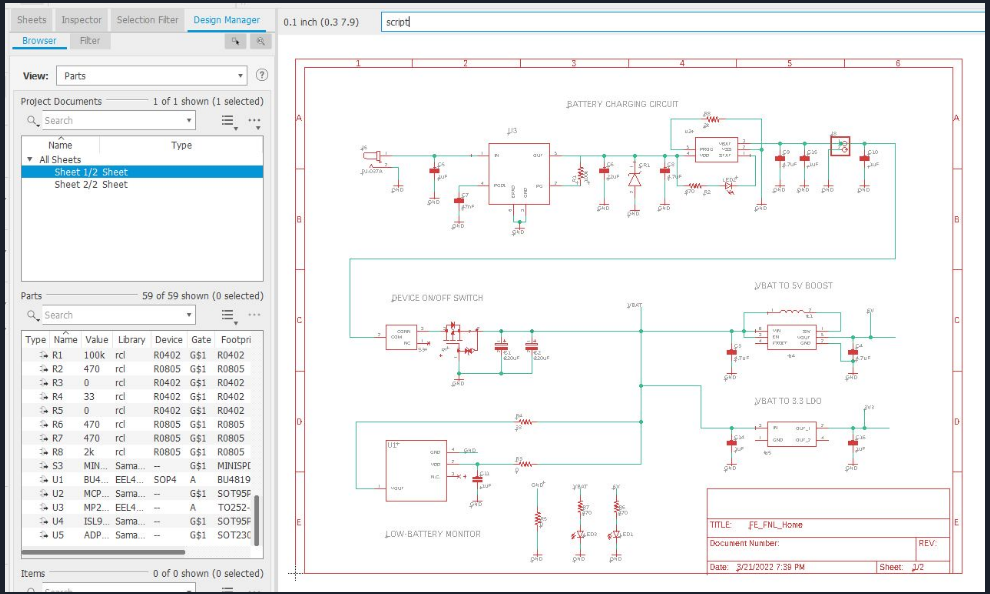


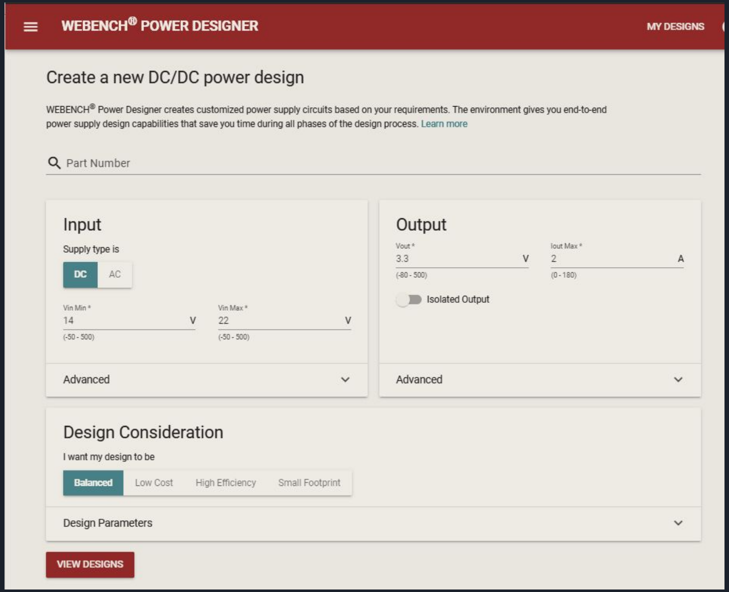


Schematic Design

All the individuals pieces were assembled into one large schematic in Autodesk Eagle.

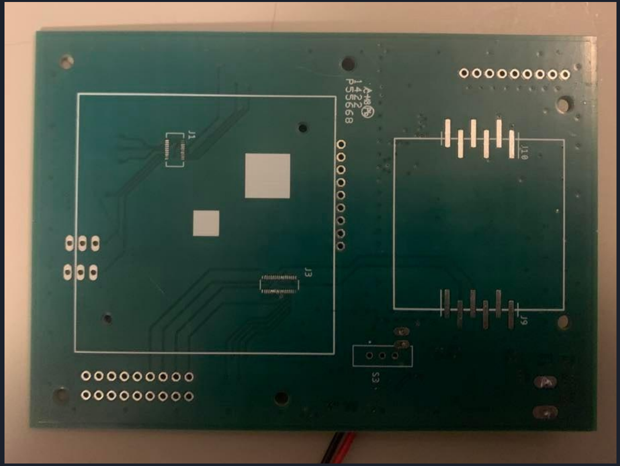
All voltage regulator circuits we used were predesigned in TI WEBENCH.

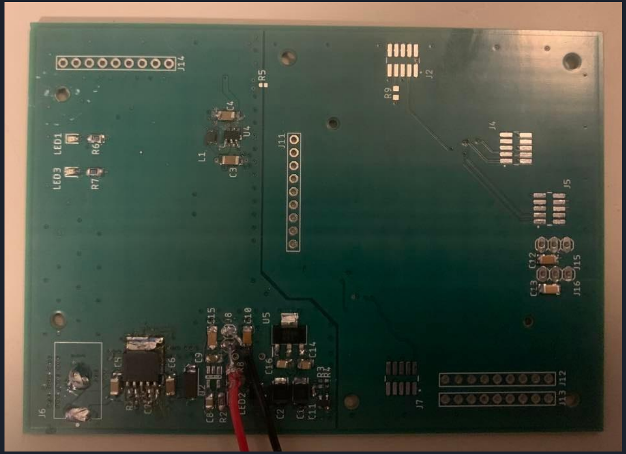


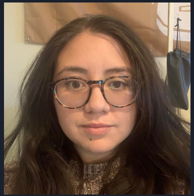


PCB Design

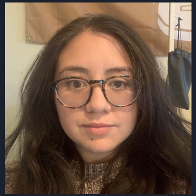
- 4 layer board
- Large GND plane on bottom layer
- Ordered from 4PCB
- Assembled with assistance from friend electrical engineer.



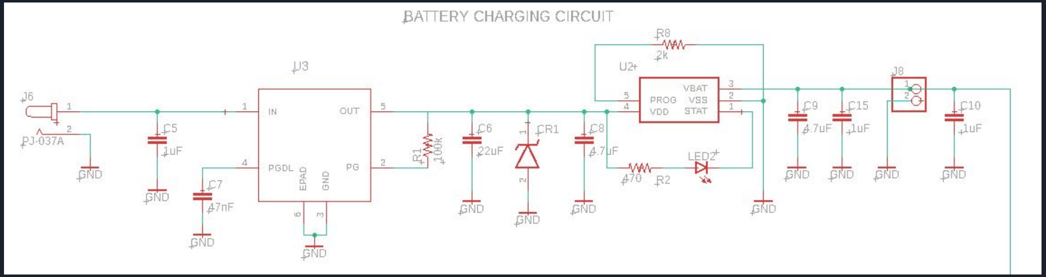


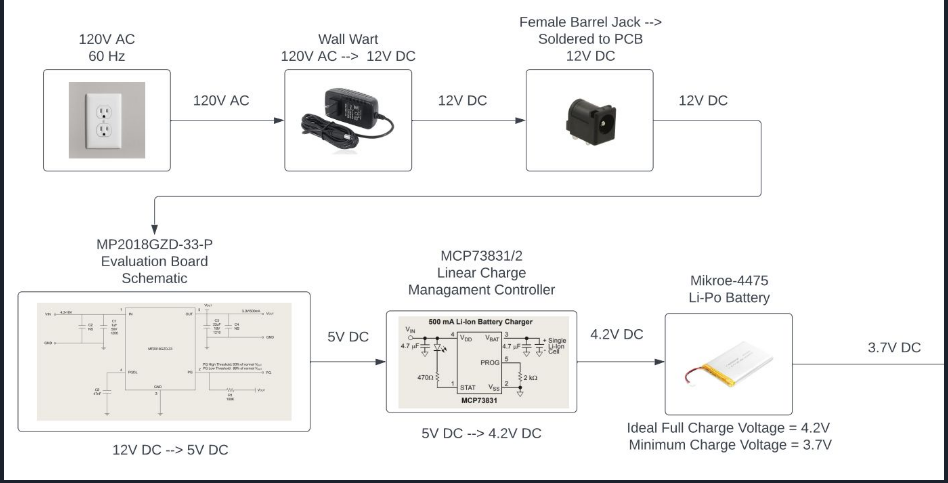


AC to DC Converters: Charging Station

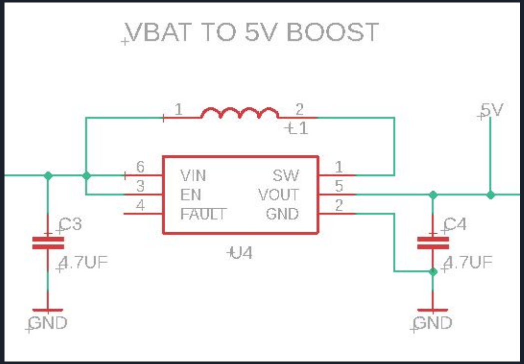


- Wall wart designed to accept 120 AC and convert to 12V DC.
- MP2018 linear regulator designed to step-down 12V DC to 5V DC.
  - Selectable 3.3V or 5V fixed output voltage regulator, 5000mA maximum output current
  - 3V to 16V input voltage range
- MCP7381/2 linear charge management controller designed to step-down 5V DC to 4.2V to charge the battery.
  - Fixed output voltage regulation options: 4.2V, 4.35V, 4.4V, 4.5V, 500 mA maximum output current
  - 3.75V to 6V input voltage range

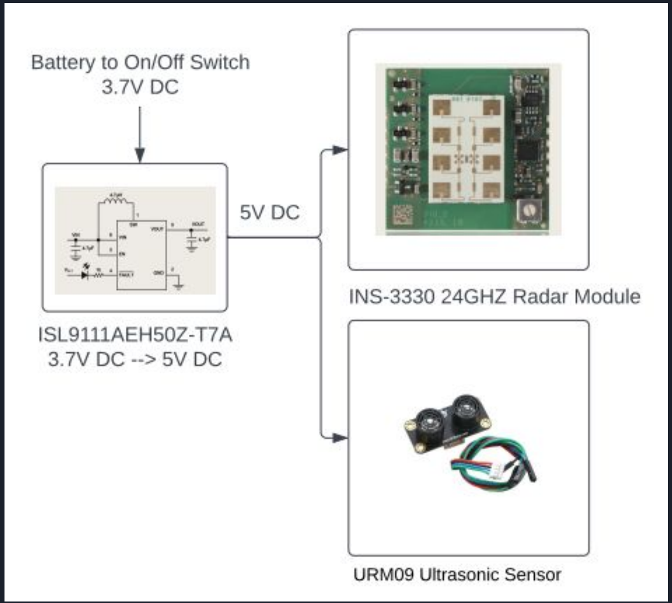


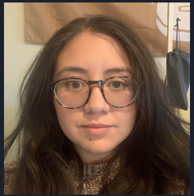


DC to DC Converters: INS3330 & URM09



- ISL9111 boost converter designed to step-up 3.7V from the battery to the INS3330 radar sensor and URM09 ultrasonic sensor.
  - 5V output voltage, 800mA output current
  - 0.5V to 4.8V input voltage range

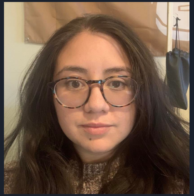


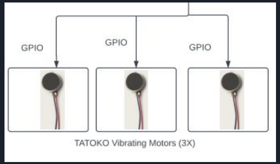


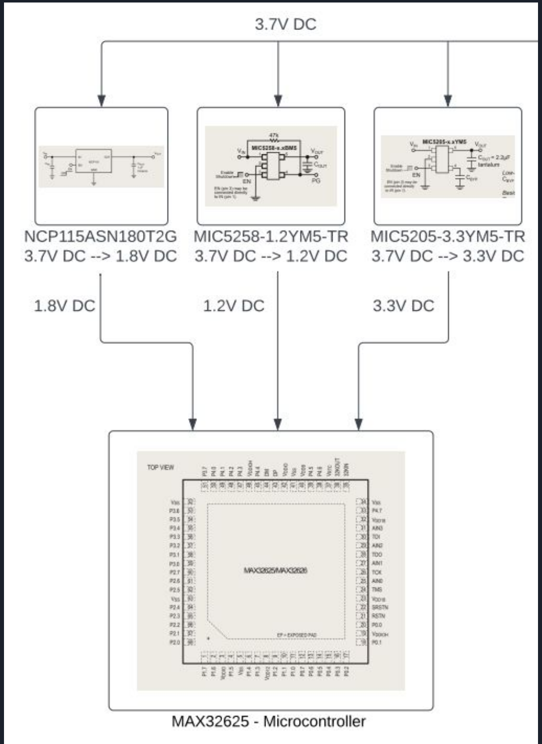
DC to DC Converters: MAX32625

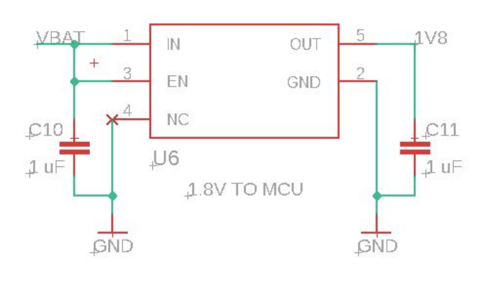
These three voltage regulators were designed to step-down 3.7V to power the MAX32625 processor.

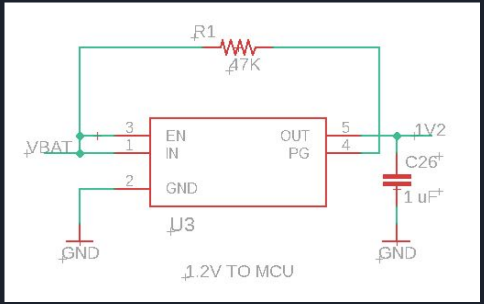
- NCP115ASN180T2G
  - 1.8V fixed output voltage, 300mA maximum output current
  - 1.7V to 5.5V input voltage range
- MIC5205-3.3YM5-TR
  - 3.3V output voltage, 150mA maximum output current
  - 2.5V to 16V input voltage range
- MIC5258-1.2YM5-TR
  - 1.2V output voltage, 150mA maximum output current
  - 2.6V to 6V input voltage range

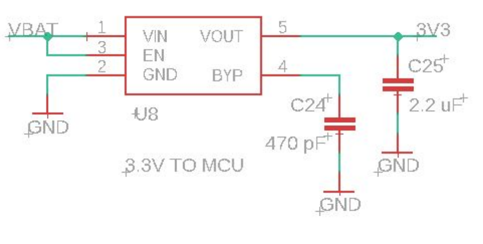




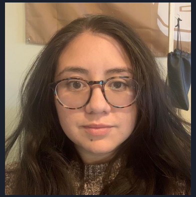






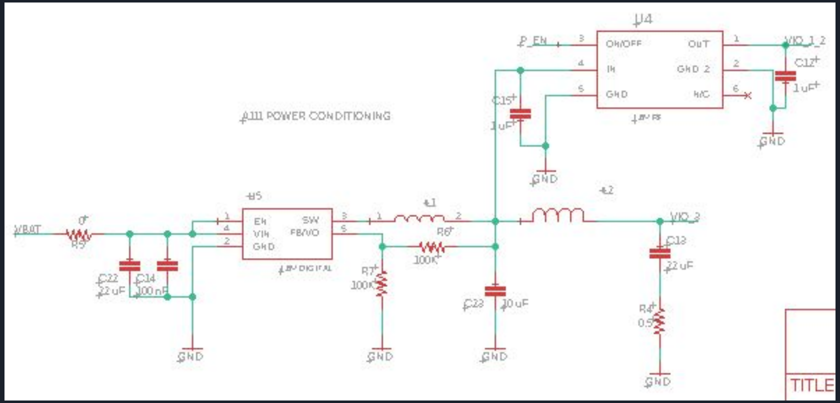


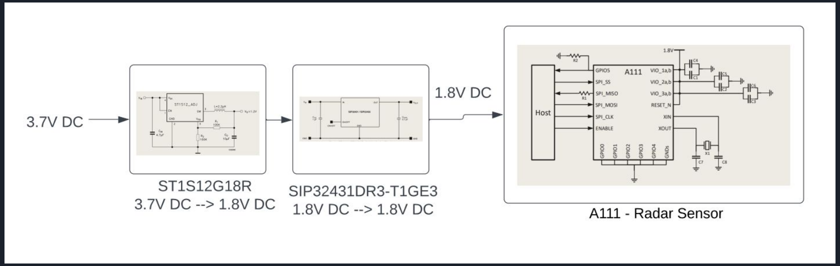
DC to DC Converters: A1111 Radar Sensor



These two voltage regulators were designed to step-down 3.7V to power the A111 radar sensor.

- **ST1S12G18R**
  - Selectable fixed output voltage of 1.2V and 1.8V, 700mA maximum output current
  - 2.5V to 5.5V input voltage range
- SIP32431DR3-T1GE3
  - High -enable logic load switch
    - Programmable voltage - 1.8V
    - 1400mA maximum output current
  - 1.5V to 5.5V input voltage





Power: What we needed vs. What we had

With PCB design

	A111	MAX32625	INS3330	URM09 - (2)
Voltage	1.8V	3.3V, 1.8V, 1.2V	5V	2.4V to 5.5V
Current Draw	300mA	100mA	55mA	20mA
Power Consumption	540mW	330mW	275mW	200mW
Powered By:	SIP32431DR3-T1GE3	MIC5205-3.3YM5-TR (3V3), NCP115ASN180T2G(1V8) and MIC5258-1.2YM5-TR (1V2)	ISL9111AEH50Z-T7A	ISL9111AEH50Z-T7A

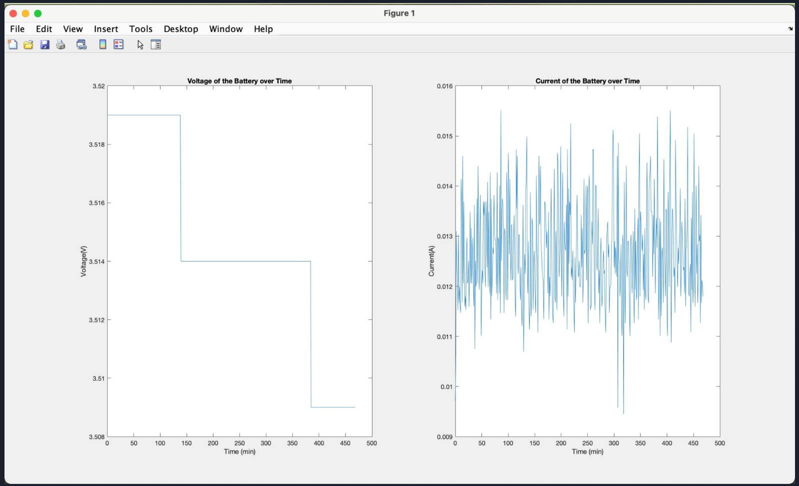
Without PCB design

9V Battery	Voltage	Current
MAX32625	5V	45mA
URM09*	5V	20mA
INS3330	5V	55mA
L2930	6V	60mA

* The URM09 is powered by the 3.3V pin of the MAX32625

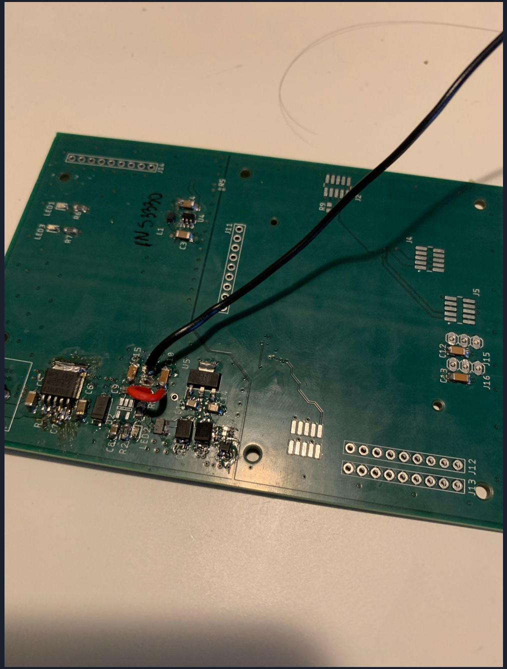
Battery Selection and Testing

- Li vs Li-Po
- Testing Set-up
- Results



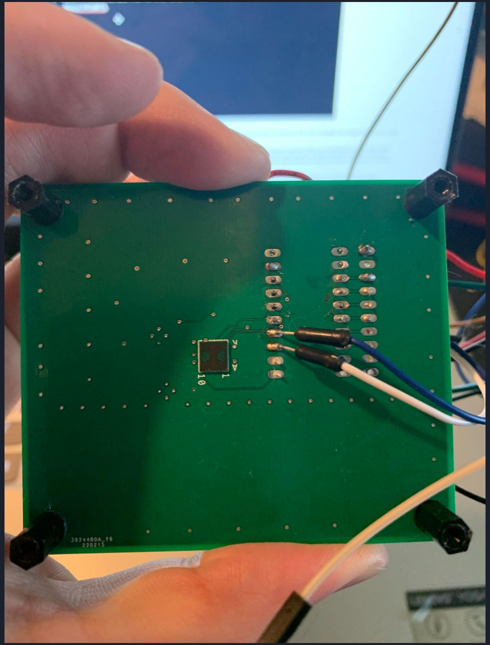
Custom PCB and A111 Sensor: What didn't make it

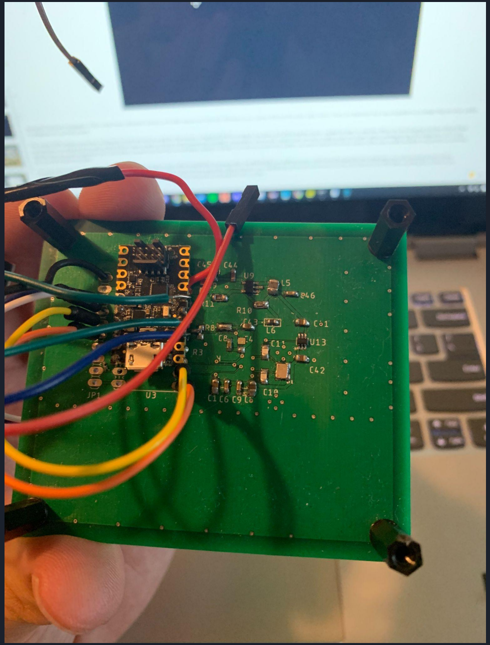
- Supply issues in obtaining components
  - Power system unable to complete integration
- Microcontroller issues in interfacing with Acconeer APIs
  - Flashing issues with the MAX32625PICO



A111 Sensor Issues

- Closed Source Libraries
- C++ functions in C
- Keil Conversion
- Flashing Issues
- Maxim Tool Chain





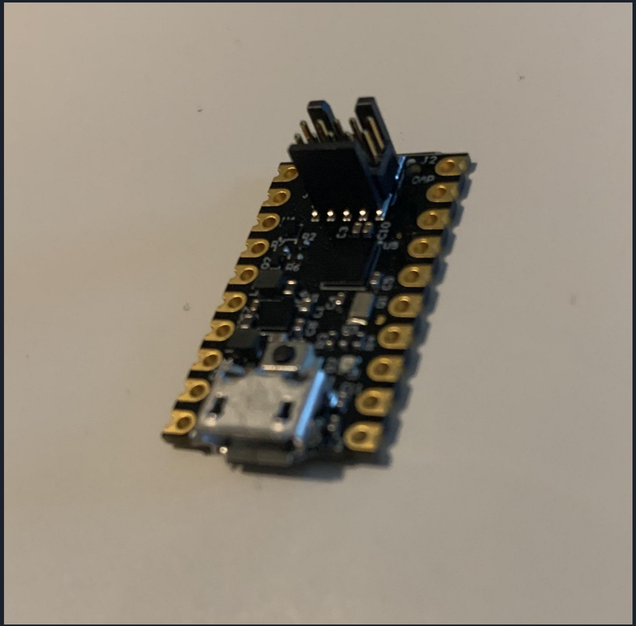
MAX 32625: MCU Overview

Arm Cortex M4 CPU - requirement for A111

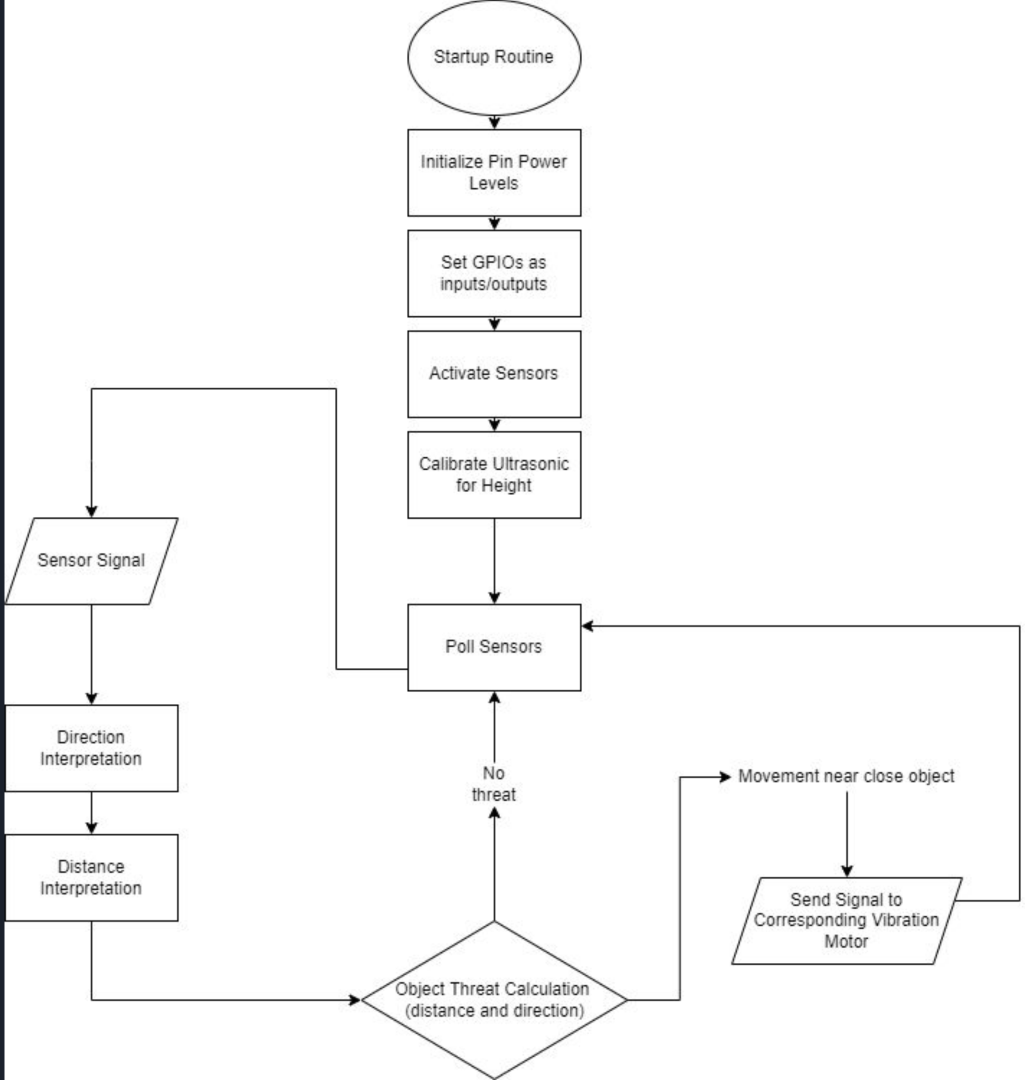
UART, and SPI interfaces - USB debugging and A111 interfacing

Low Cost - Cheap development board

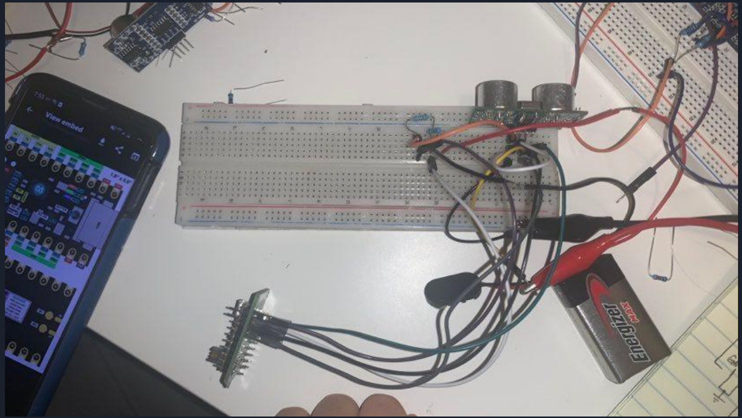
GPIO pins - Ultrasonic sensors, INS3330 radar module



Software Block Diagram

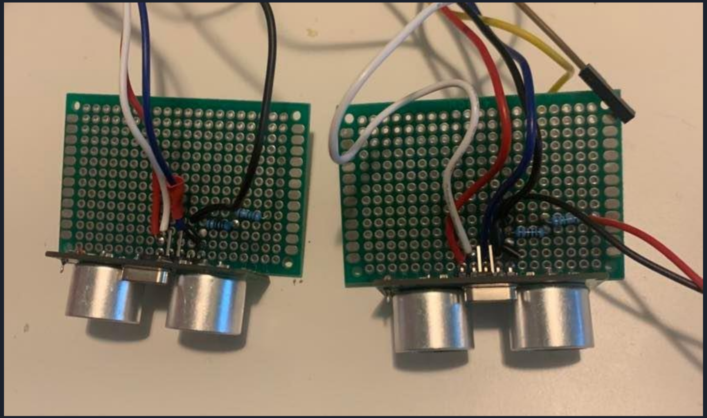


US100 Ultrasonic Sensors Integration



Prototyping and Testing

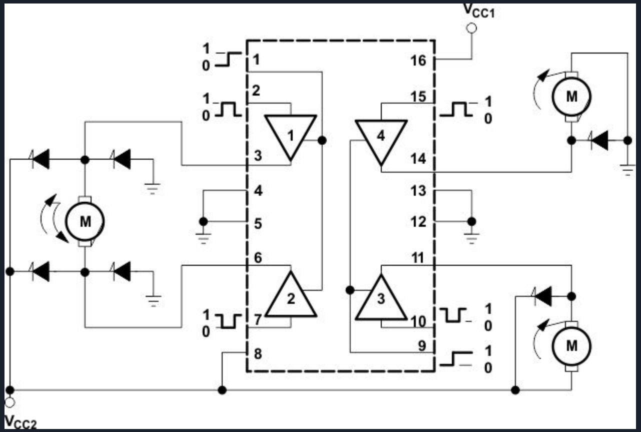
- A US100 sensor circuit was constructed on a breadboard in order to verify it could pick up close proximity objects and terrain elevation changes.
- This circuit was used in conjunction with the MAX32325 and a single vibrating motor to test functionality of the system before through-hole assembly.



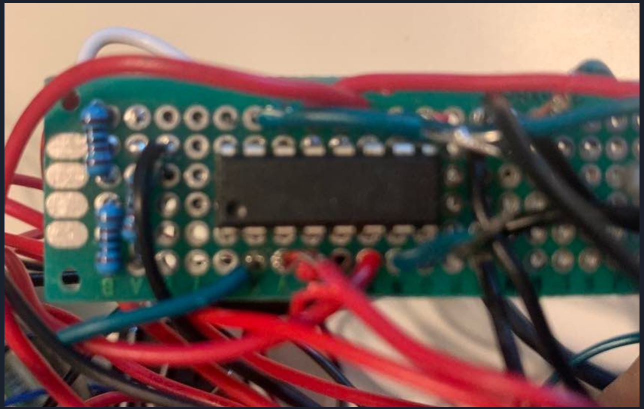
L293D Motor Driver Integration

Prototyping and Testing

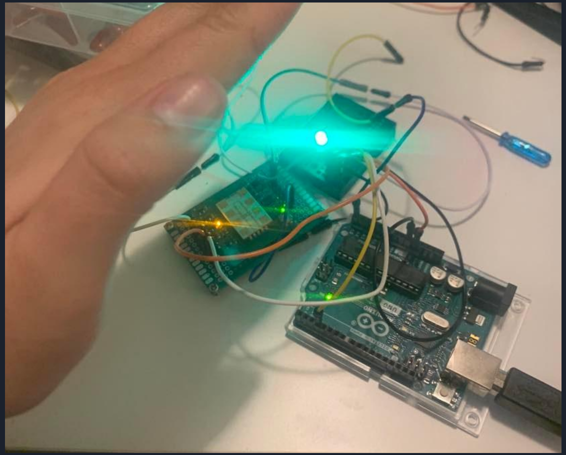
- A L293D motor driver circuit was constructed on a breadboard to control the motors.
- Once we verified that all three motors worked, this circuit was used in conjunction with the microcontroller and the sensors. We tested the functionality of the system before through-hole assembly.



L293D internal diagram

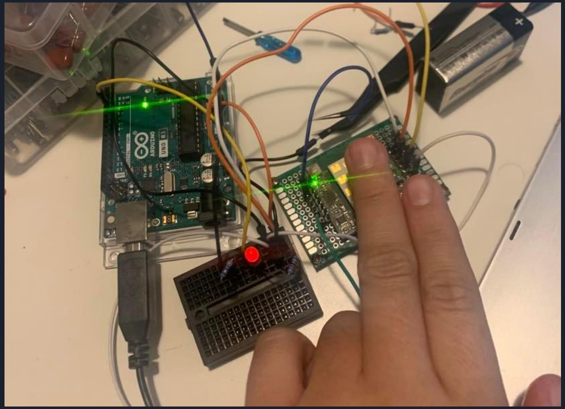


INS3330 Radar Sensor Integration



Prototyping and Testing

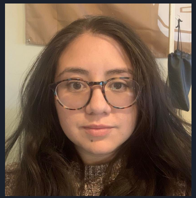
- A INS330 sensor circuit was constructed on a breadboard in order to verify it could pick up object approaching the sensor and therefore the user.
- This circuit was used in conjunction with the MAX32325 and a single vibrating motor to test functionality of the system before through-hole assembly.



Budget

Total Budget: $730

- $380 spent on PCB
  - $410 spent of 4 boards
  - $110 spent on express shipping
- $350 spent on parts
  - Primary 9V batteries, MCU, sensors, motors, surface mount chips
  - ICs, passives, connectors
- Other costs not factored into budget
  - Soldering iron, solder, pcb holder case, pcb holder bag, chest strap



Expected Budget

Component/Device	Budget
PCB	$200
MCU	$11
Sensors (Radar, Ultrasonic)	$80
Motors	$20
PCB Holder Case	$70
PCB Holder Bag	$25
Chest Strap	$15
DC-DC Converters	$50
Passive Components	$30
Voltage Regulators and active components	$50
Battery	$100
TOTAL	$638

Challenges and Pitfalls

Hardware

- PCB issues
  - Lack of test points on PCB
  - No ability to isolate hardware blocks for testing on PCB
  - Chain supply issues caused certain chips that would have help our prototype were out of stock.

Integration (No PCB)

- Right voltage inputs
- Sensors/Motors not working
- Problem with cables

Testing

Stair Detection using a 90-60-30 degree trinagle

Tester	Height	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
Victor	179	Work	Work	Work	Work	Work	Did NOT Work	Work	Did NOT Work	Work	Work
Michelle	172	Did NOT Work	Work	Work	Work	Did NOT Work	Work	Work	Work	Work	Did NOT Work

Work / Did NOT Work

Results Victor: 80% Michelle: 70%

Detecting objects closer than 1 meter

Tester	Height	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
Victor	179	Work	Work	Work	Work	Work	Work	Work	Did NOT Work	Work	Work
Michelle	172	Work	Work	Work	Work	Did NOT Work	Work	Work	Work	Work	Work

Work / Did NOT Work

Results Victor: 90% Michelle: 90%

Detecting objects approching up to 10 meters

Tester	Height	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
Victor	179	Work	Work	Did NOT Work	Did NOT Work	Work	Work	Work	Did NOT Work	Work	Work
Michelle	172	Work	Did NOT Work	Work	Work	Did NOT Work	Work	Work	Did NOT Work	Work	Work

Work / Did NOT Work

Results Victor: 70% Michelle: 70%