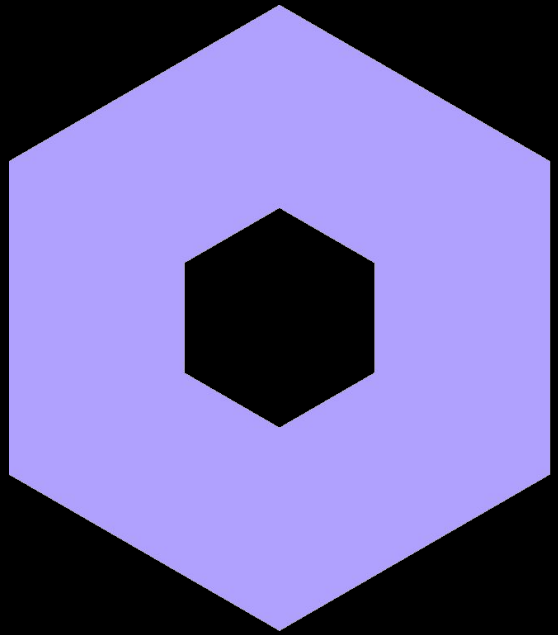


Forever Akpabio, Emmanuel Obu, Akintayo Salu

Use Case

- **Problem** : **Current navigation** options for bicycle riders can be distracting and **lack** essential **safety** features.
- **Solution: Safely navigate places** on bikes through **audio instructions** and vibration feedback for **blind spots**

Requirements:

- Blind spot detection: **95% accuracy rate**
- **Vibrational cue** within **1 sec** of object detected in user's blindspot (less than 5 feet)
- User should **receive audio instructions to make turns within 200-300 feet before a turn**.

Design Requirements

Easily Attachable

- Universal GoPro Mount for Rid3 on bike seat
- Wristband uses velcro straps

Accurate Detection

- **90% accuracy rate**
- Range up to 200 ft
- FOV 90 degrees

Weight

- Wristband approx. **80 grams**
- Main device approx. **950 grams (2 lbs)**

Precise & Real Time Navigation

- Google Maps API **90% accuracy**
- GPS tracking within **5-10 meters** of actual location
- Google Speech To Text and Text To Speech have **90%+ accuracy for speech system.**

Battery Life

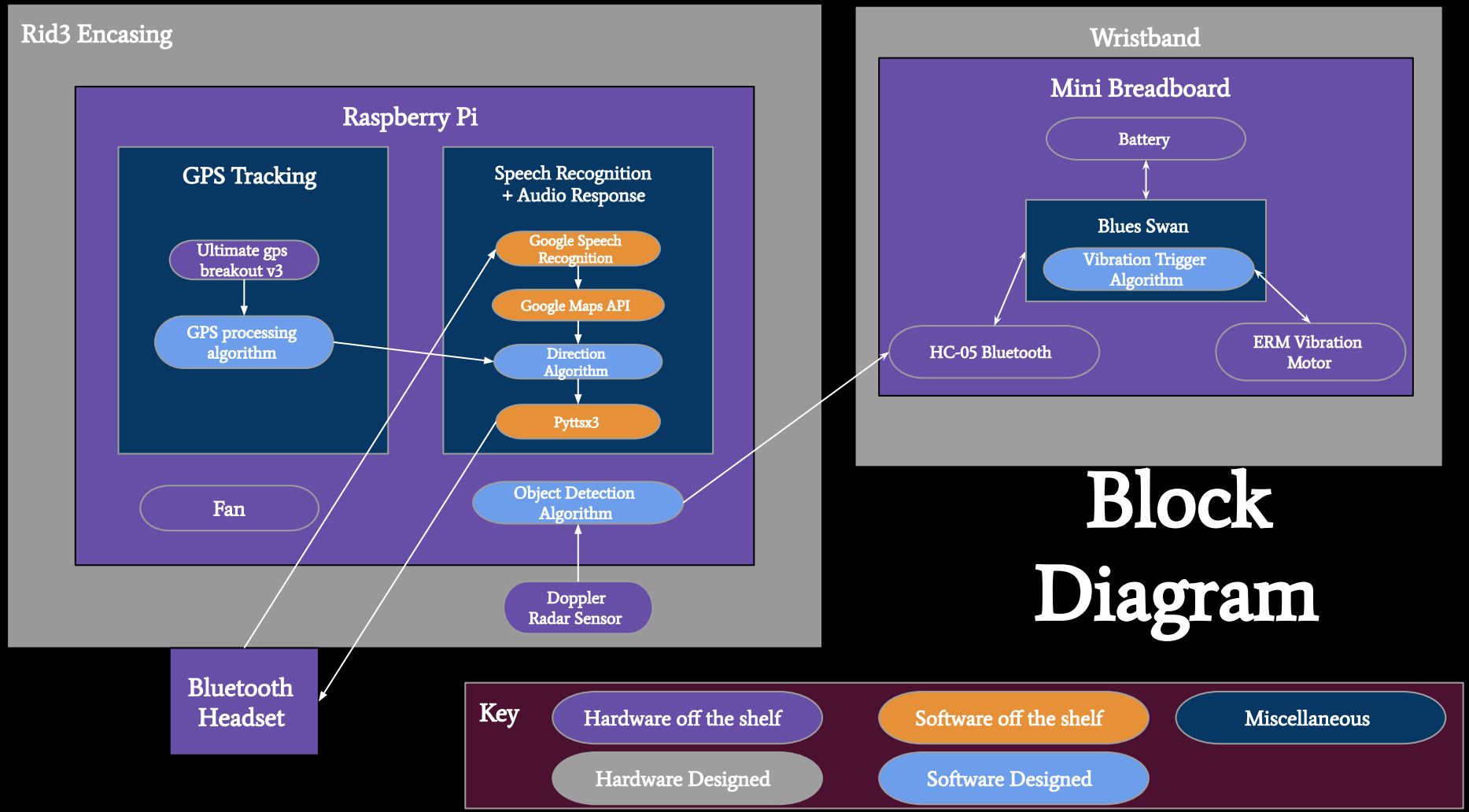
- **Wristband** has LiPo battery 2Ah, circuit draws 40mA (approx **50 hrs**.)
- **Main device** has 10000mAh battery, system draws 1,190 mA (approx **8 hrs.**)

Low Latency

- **1–2 seconds** to give instructions based on new updated GPS location
- **1 second** from object detected in sensors to vibration in wristband

Solution Approach

Solution Feature	Impact	Societal Concerns
Audio Input for designated location at start of journey.	- Simplifies process of starting journey and makes it hands-off.	- People have different vocal intonations. This concerned is addressed by google speech recognition.
Real time GPS tracking with audio output for direction correctness.	- Hands off - Allows user to focus on the direction that they are going.	- Audio cues can be muffled by outside noise.
Doppler Radar Sensors for detecting objects.	- Extra safety on the roads for bicycle users, and wider range for detection.	- A lot of dependence on sensors catching correct angles of objects in blind spots, so continuous testing with different ranges of objects, speeds, and angles is needed.
If object detected, send ping to haptic feedback wristband that sends a light nudge to the user while riding.	- No need to check blind spots by turning head. - Subtle but easy to notice.	- Strength of Vibration could be distracting to users, so continuous testing of different vibration modes w/ user feedback
Acrylic Encasing for main device	- Cheaper to create, laser cutting into heat bending to form case. - Can see directly into device - Sturdy encasing	- People might not like looking into the details of their device. - People could copy a similar hardware setup to ours. - Heavier, could potentially slow down bicycle.

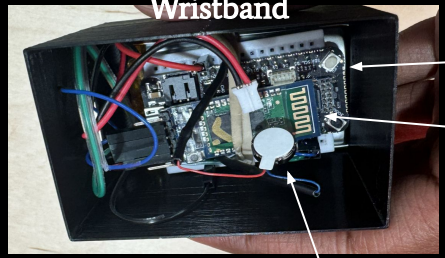

Rid3 Encasing
Raspberry Pi
GPS Tracking
Ultimate gps breakout v3
GPS processing algorithm
Speech Recognition + Audio Response
Google Speech Recognition
Google Maps API
Direction Algorithm
Pyttsx3
Fan
Object Detection Algorithm
Doppler Radar Sensor
Wristband
Mini Breadboard
Battery
Blues Swan
Vibration Trigger Algorithm
HC-05 Bluetooth
ERM Vibration Motor
Bluetooth Headset
Block Diagram
Key
Hardware off the shelf
Software off the shelf
Miscellaneous
Hardware Designed
Software Designed

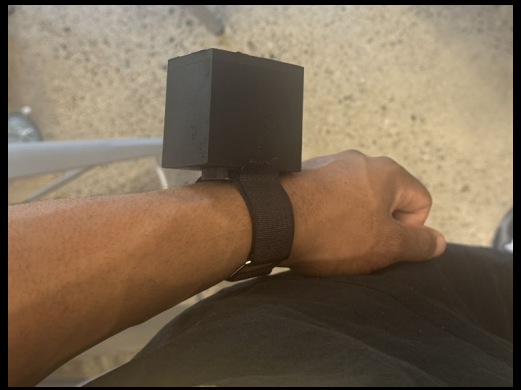
Complete Solution

Top View Rid3

Rid3 Mounted

Top View Wristband





Wristband on wrist

Blind Spot Detection System

Use Case Requirements	Test Specifics	Test Inputs	Test Outputs	Validation
95% accuracy rate for detecting object in blind spot	50 tests with different objects (e.g. other bikers, drivers, etc.)	Objects within range of radar sensor range.	Signal for incoming objects within 10 feet of the user	A valid test is when signal is correctly initiated when object distance is within 5 feet of the user. **45/50 correct test is the goal.**
Vibrational cue within **1 sec** of object detection	50 tests where object detection triggers vibration	Signal from object detection	Haptic feedback on wristband	A valid test is when latency between the signal and haptic feedback is less than 1 second. **Tests time average should be below 1 second**

BSPS Results

- 33/50 correct detections, **66% detection accuracy.** Doesn't meet use case.

- Average detection latency of **.979 seconds.** Meets use case.

Trade-offs

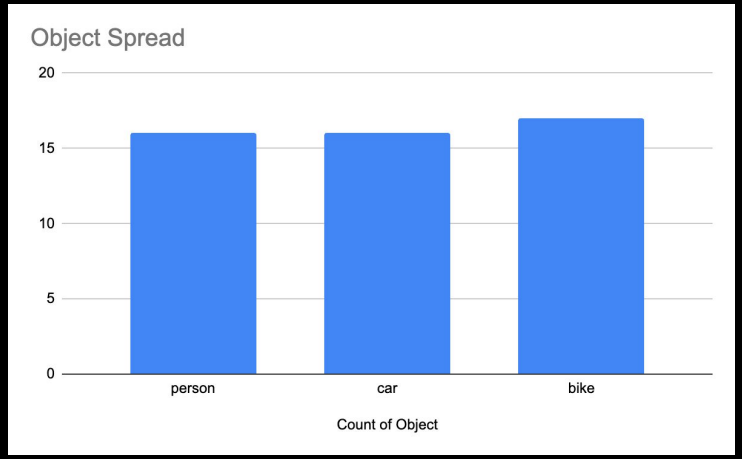
- Switched from ultrasonic sensor to doppler radar sensor
- Limited FOV but better accuracy
- Differentiates incoming and outgoing objects

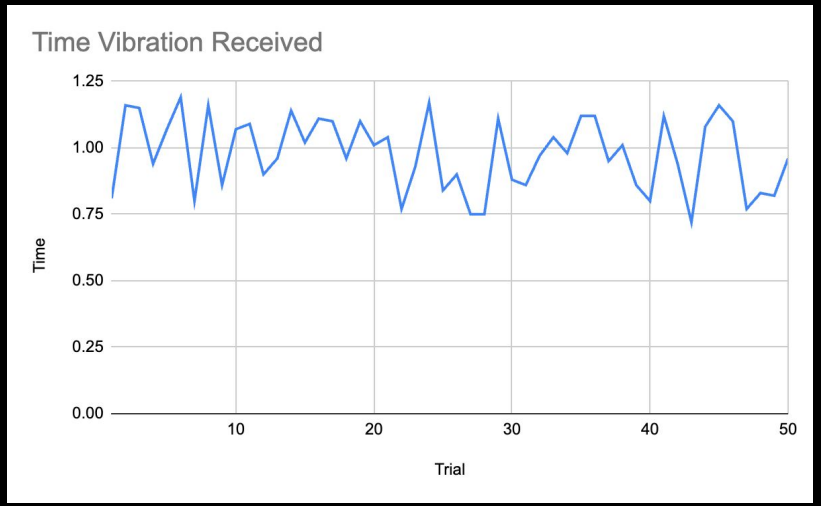
```
detection: {'speed': 65.3, 'dist': 96.2}

sent data

detection: {'speed': 97.9, 'dist': 40.3}

sent data
```





GPS and Audio System

Use Case Requirements	Test Specifics	Test Inputs	Test Outputs	Validation
Receive audio instructions to make turns within **200-300 feet prior to turn**	20 different routes are tested	GPS location of user	Audio instruction for next turn	A valid test occurs when the correct audio instruction is received within 200-300 feet before the actual turn
90% translation accuracy for extracting destination from user's voice command	50+ tests with different destination commands said by different voice types	Audio of user's command	Speech-to-text output	A valid test is when the speech-to-text output from the user's command matches the actual desired destination for journey

Test, Verification and Validation

Use-case requirements:
- **90% translation accuracy** for extracting destination from user's voice command

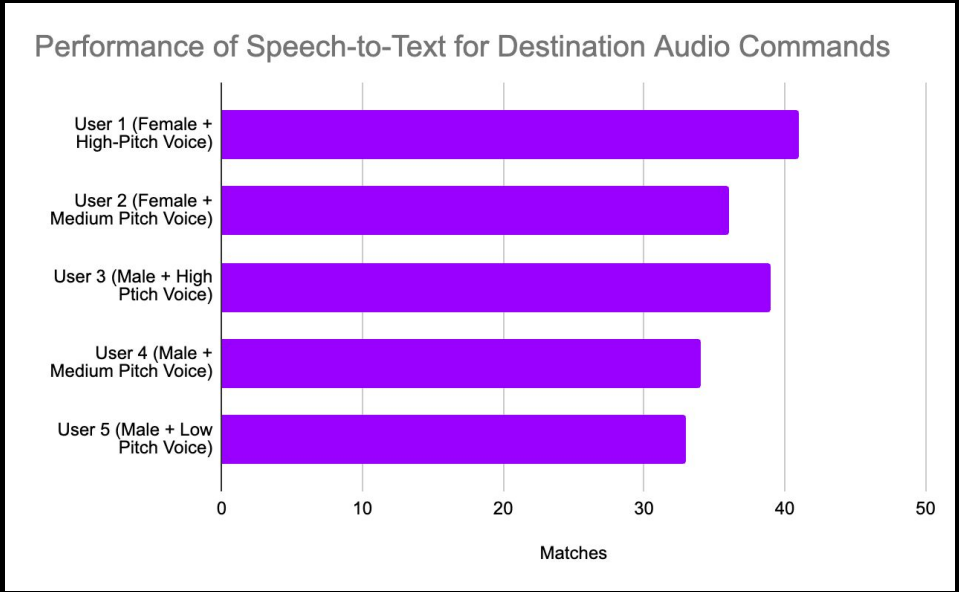
Test Specifics:
- Tests with different audio commands for **50 different destinations** said by **different voice types**

Test Inputs:
- Audio of user's command

Test Outputs:
- **Speech-to-text output**

Validation:
- Comparison of text output with desired location

Result:
- 73.2% accuracy

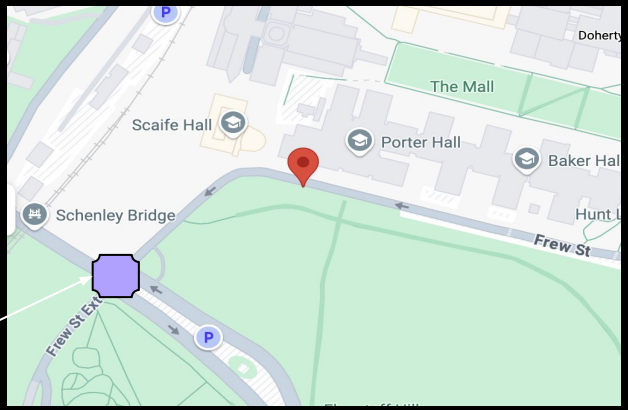



```
Listening for input...
Recognizing...
You said: Phipps Conservatory
```

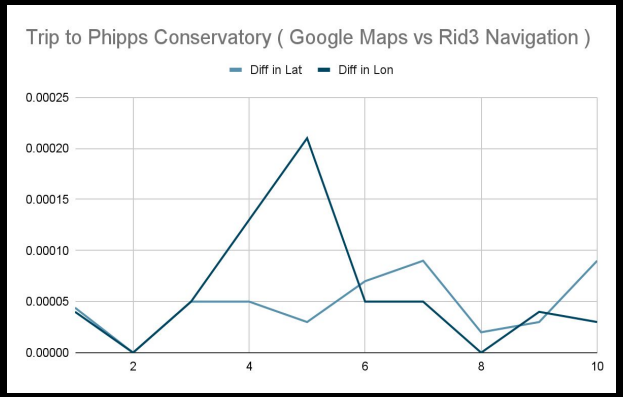
Sample Test for Phipps Conservatory

Test, Verification and Validation

Turning Point

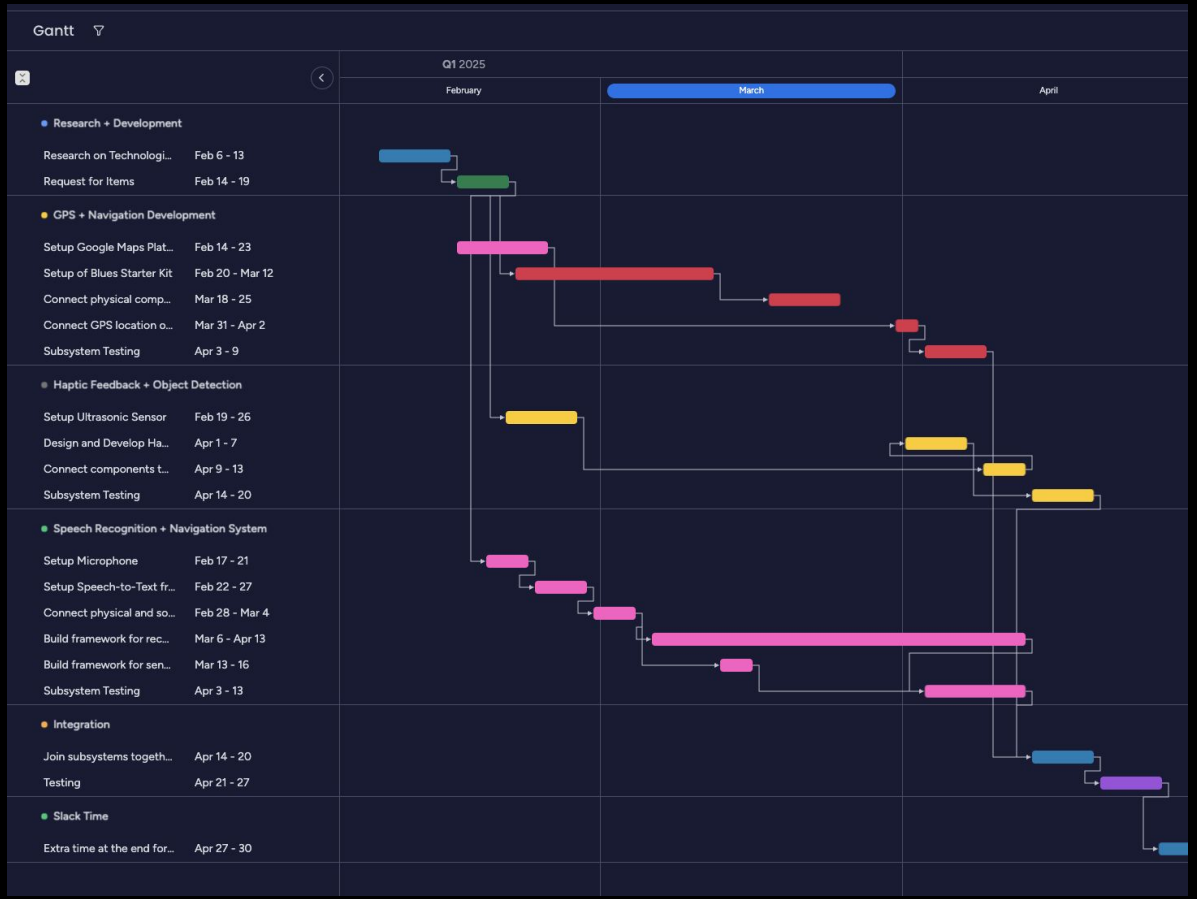


Individual Location Test




```
User's Location: Lat: 40.441403333333334, Lng: -79.94667666666666
Finding nearest point...
{'lat': 40.4414439, 'lng': -79.9467864, 'instruction': 'Head west on Frew St toward
Frank Curto Dr/Schenley Drive', 'destination': False}
Distance: 33.908580537923996
Valid instruction found:  Head west on Frew St toward Frank Curto Dr/Schenley Drive
Speaking: Head west on Frew St toward Frank Curto Dr/Schenley Drive
Finished utterance: None. Completed: True
Done speaking.
```

Project Management



Emmanuel

- Object Detection system
- Haptic Feedback system

Forever

- GPS Tracking System
- RPi Integration

Akintayo

- Speech recognition System
- (Audio) Navigation Response System