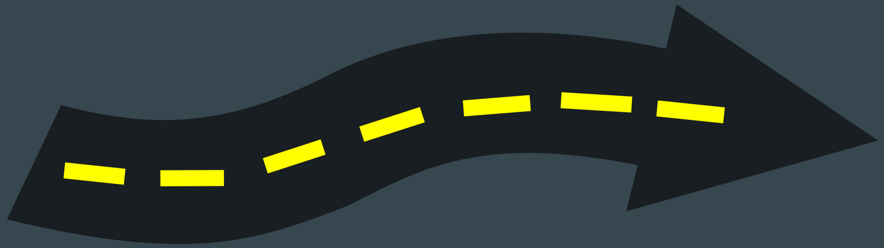


Rid3

Forever Akpabio, Emmanuel Obu, Akintayo Salu

Use Case

- ❑ Riders struggle to follow directions while operating bicycles or scooters
- ❑ Device will allow users to **safely navigate places** on bikes or scooters through **audio instructions** and vibration haptic feedback that **protects blind spots**
- ❑ Reduce looking away from road
- ❑ Easier to follow directions
- ❑ ECE Areas: Software, Embedded Systems, Senors, Computer Vision

Use Case Requirements

- **90% destination accuracy from speech recognition** when users start a journey verbally
- GPS capabilities to track the user's real-time location to give audio directions to the user
- User should **receive audio instructions to make turns within 200-300 feet before a turn**. Based on existing navigation systems and average street block size
- Vibrational cue for an object detected in user's blindspot (less than 4 feet) within **2 secs of the object being detected** by sensors
- **95% accuracy rate for blind spot detection** accuracy with 5% being false positives
- Vibrations if rider veers more than 10 feet from desired path
- Attachable/detachable to bicycles and scooters

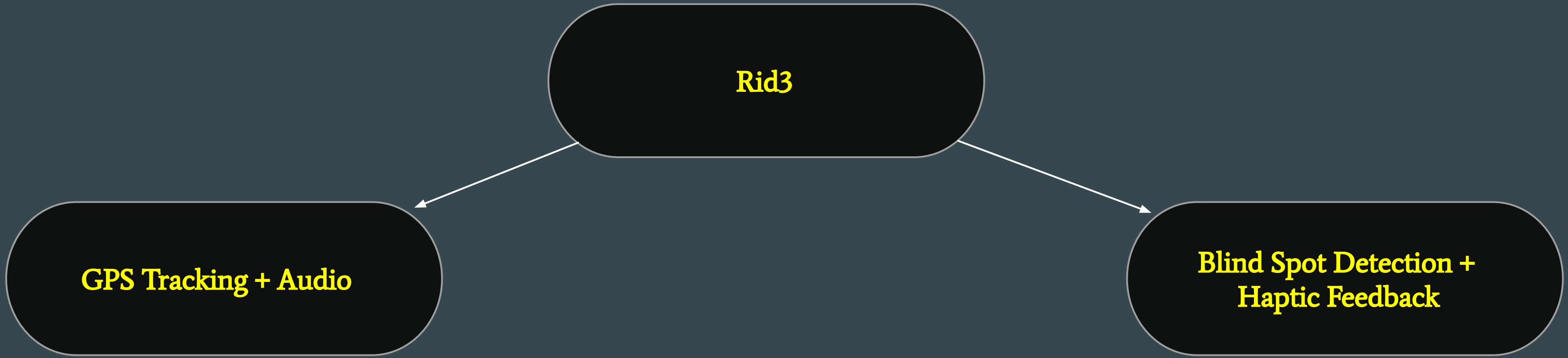
Technical Challenges

- Fast object detection that is quickly transmitted to user
- Object detection accuracy
- Accurate real-time GPS tracking
- Managing battery consumption

Risk Mitigation

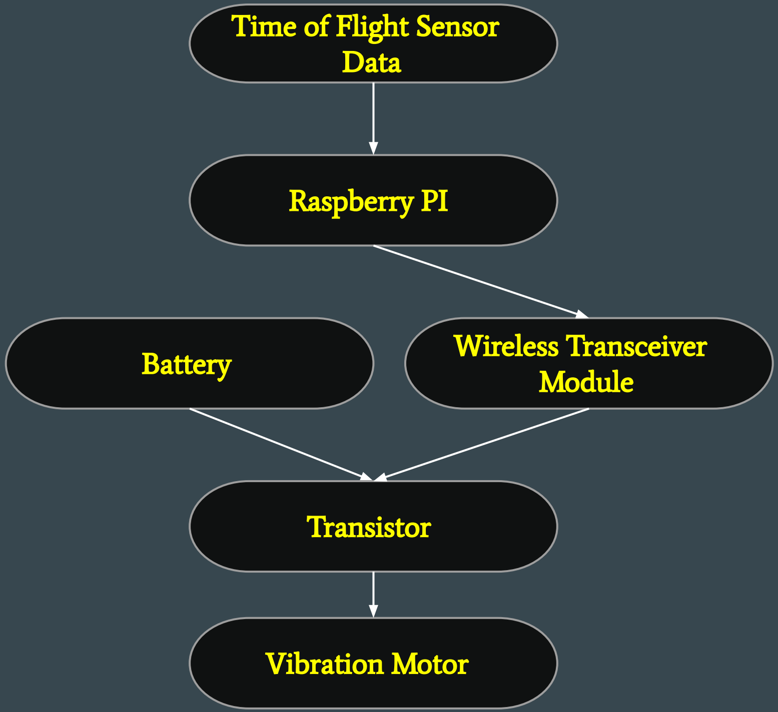
- Designing alerts to be subtle yet effective
- Filter false positives for blind spot detection
- Secure mounting of device to avoid falling off on bumps
- Low latency tools for fast user feedback

Solution Approach - Top Level



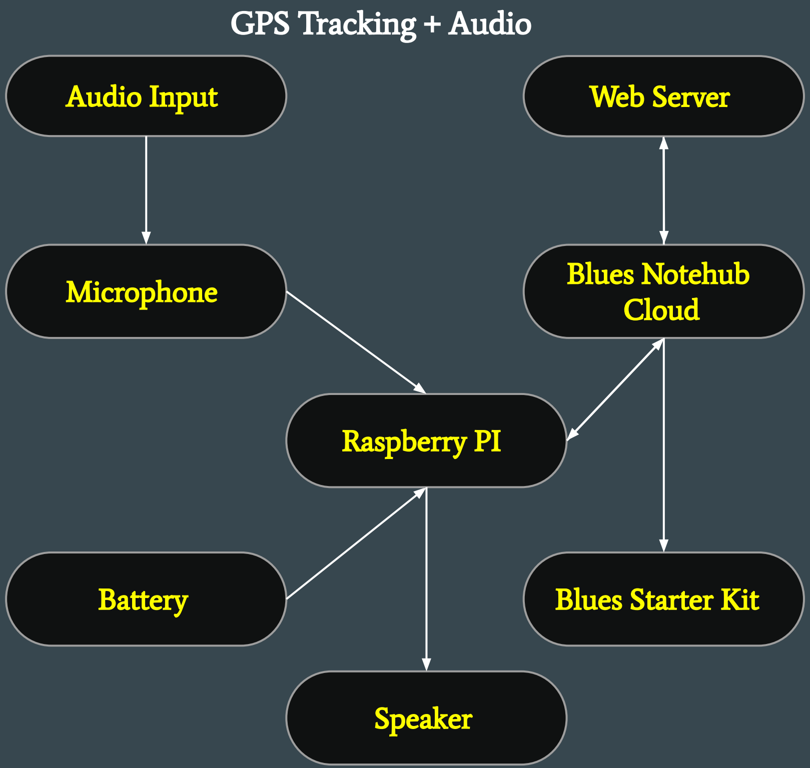
Solution Approach - Blind Spot Detection + Haptic Feedback

Blind Spot Detection + Haptic Feedback



Hardware	Reasoning
VL53L0X ToF Sensors	High Accuracy and decent detection range (~2 meters)
Raspberry PI 3A+	Power Efficient, small/compact, and sufficient processing power
HC-05 RF Wireless Bluetooth Transceiver Module	Wireless, simple framework, and low power consumption.
Adafruit Lipo Battery	Rechargable, compact, and sufficient power supply.
NPN Transistor	High/Low functionality and compact.
Adafruit Vibration ERM Motor	Vibration Sensor, with variation of vibrations

Solution Approach - GPS Tracking + Audio



Hardware	Reasoning
Adafruit I2S MEMS Microphone Breakout	Good microphone quality, compact, compatible with Raspberry PI, and relatively low power consumption.
Anker PowerCore 10000	High battery power, lightweight, and relatively compact.
Blues Notehub Cloud	Compatible with raspberry PI and blues devices.
Blues Starter Kit	Dual Cellular and GPS antenna,transmits GPS data to Blues cloud service.
Web Server	Utilizing Google Maps API + speech recognition libraries, Python libraries + networking protocols.
Adafruit STEMMA Speaker with Amplifier	Good sound quality, compact, compatible with Raspberry PI, low power consumption

Testing, Verification and Metrics

Speech recognition: testing will be done in varied noise settings (noisy, quiet, etc) and with a variety of voices (about 20 different test voices)

- Goal: **> 90%** match between output from speech system and actual destination

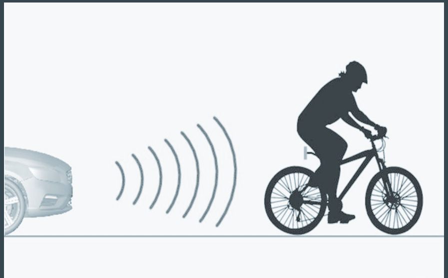
GPS system: measuring the latency of sending the user's location to the cloud compute system

- Goal: Ensuring latency **< 2 seconds**

Testing, Verification and Metrics

Collision avoidance system for user's blindside and Haptic Feedback for relaying the information:

1. The sensor's ability to identify accelerating objects in the user's blindside
   - Goal: **> 99%** accuracy in identifying objects from the sensor
2. Once an incoming object is identified, the haptic feedback system on the band needs to vibrate to inform the user of the incoming object
   - Goal: Time delay needs to be **< 2s**



Navigation (audio) response system for informing user to make turns : testing will involve recording the user's location at the moment they receive audio instructions from the system

- Goal: Audio instructions are received **within 200-300 feet before** the intended change in direction

Tasks and Division of Labor

Emmanuel

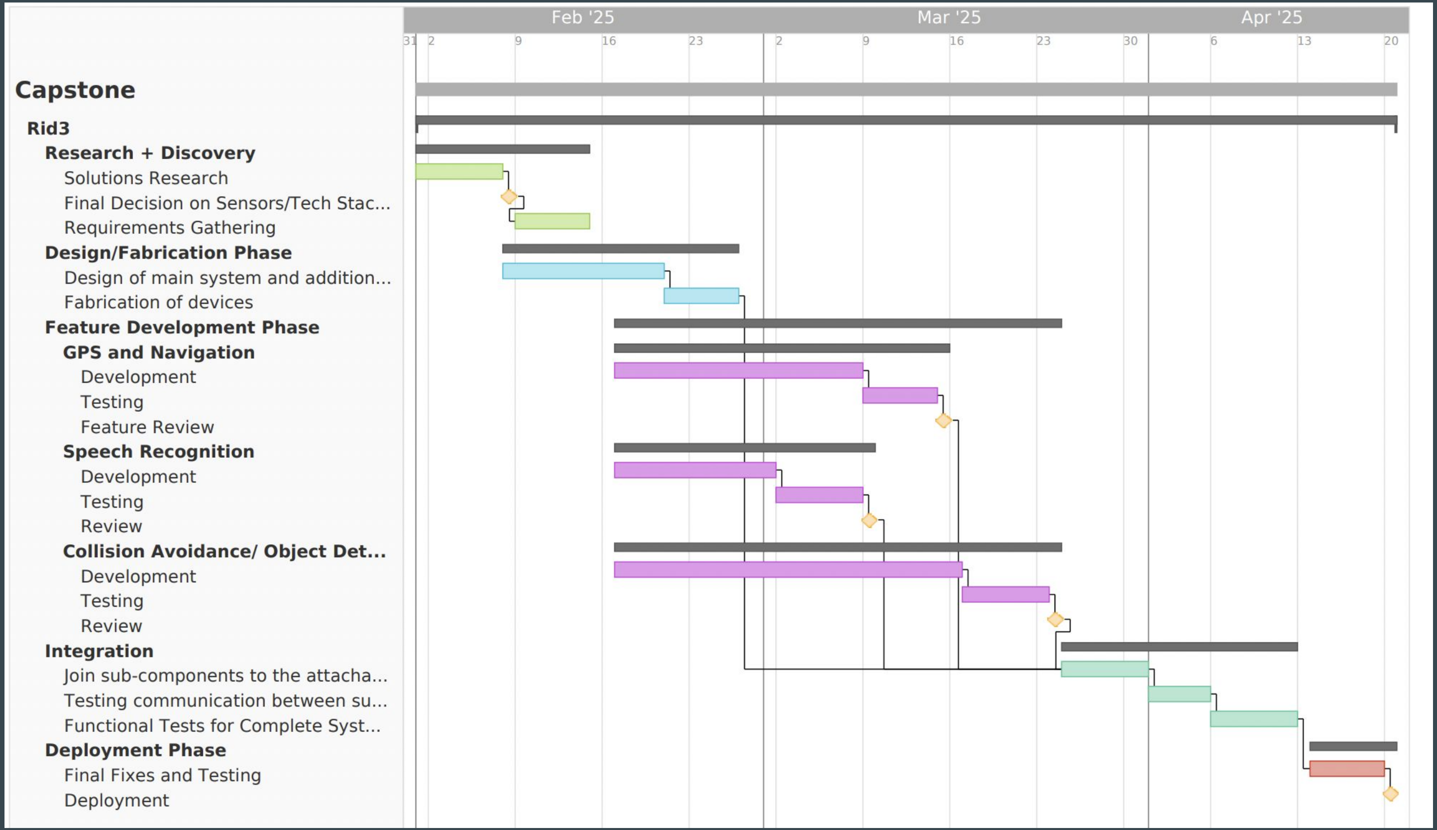
- Investigating Time-of-Flight (ToF) sensor technology.
- Exploring haptic feedback wristband options.
- Implementing vibration motor control and connecting with Raspberry PI using transistors and Bluetooth module.
- Evaluating the effectiveness of collision avoidance and haptic feedback.

Forever

- Examining the Blues framework (cloud and starter kit).
- Incorporating the Google Maps API into web server.
- Establishing data transfer of GPS information from the Blues Cloud to a web server using network protocols.
- Validating GPS location tracking accuracy and performance.

Akintayo

- Connecting microphone to the Raspberry Pi.
- Interfacing speaker with the Raspberry Pi.
- Developing a framework for utilizing Google speech recognition libraries.
- Assessing the performance of speech recognition and navigation audio.



Feb '25
Mar '25
Apr '25
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Capstone
Rid3
Research + Discovery
Solutions Research
Final Decision on Sensors/Tech Stac...
Requirements Gathering
Design/Fabrication Phase
Design of main system and addition...
Fabrication of devices
Feature Development Phase
GPS and Navigation
Development
Testing
Feature Review
Speech Recognition
Development
Testing
Review
Collision Avoidance/ Object Det...
Development
Testing
Review
Integration
Join sub-components to the attacha...
Testing communication between su...
Functional Tests for Complete Syst...
Deployment Phase
Final Fixes and Testing
Deployment

Schedule

Minimum Value Product (MVP)

- Device will take voice commands from the user to start a journey and give audio cues to direct the user while they navigate from their starting point to their intended destination.
- Device connects to a wireless wristband that provides vibration feedback when objects enter the users' blind spots