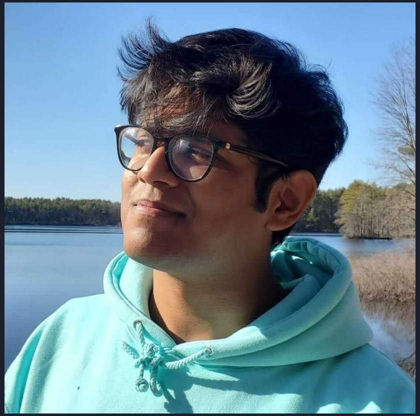
SafeX

Helping Riders Stay Safe

The Team



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Computer Engineer

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Computer Engineer

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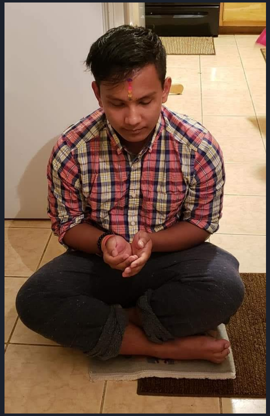


Siddhanta Shrestha
Computer Engineer

Our Project

Problem Statement

Majority of products for motorcyclists are tailored for convenience rather than safety.

Typically riders must manually check their blindspots via side-mirrors and shoulder checks.

This becomes a hazard for riders as they become distracted when doing so. After vehicle accidents, there is no efficient way contacting emergency services in products on the market.

Our solution will address these issues by notifying riders of necessary information while on the road and providing post-crash safety measures to better their safety.

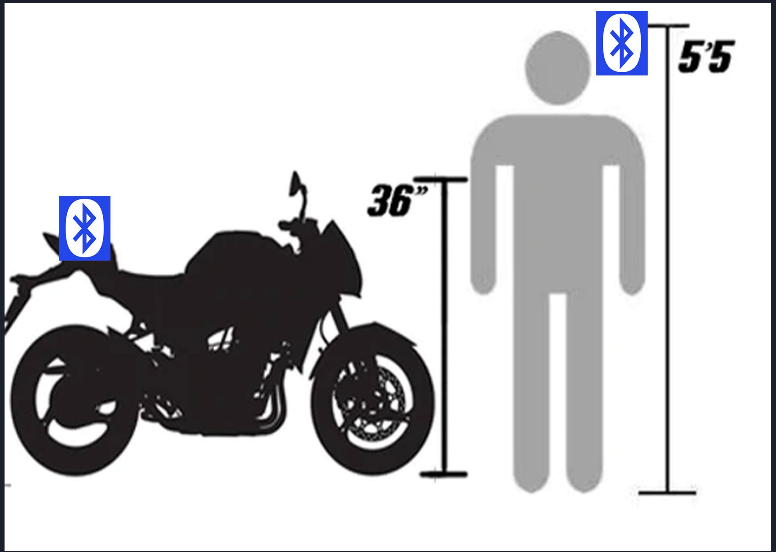
Project Goal

To create a two part device that is attachable to a motorcycle and helmet. The system should notify riders of oncoming vehicles within their blindspots to increase rider safety, and alert emergency services if the rider gets into a crash.

Specifications

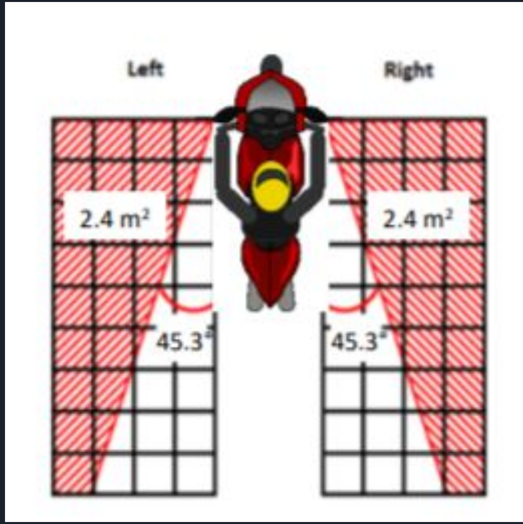
Specifications: Bluetooth

- Communicate data between motorcycle-helmet and helmet-phone interfaces
- Blindspot latency should be under 200 ms
  - Popular bluetooth latency for smartwatch
- Range of an at least 3 meters
  - To account for large motorcycles



Specifications: Blind Spot Detection

- The blind spot detection algorithm will process at least 9 frames per second.
- The blind spot detection system must detect all vehicles within the blind spot region with a detection accuracy of at least 91%.
- The blind spot detection system must identify the user of dangerous vehicles in the blindspot in highway scenarios, adjacent lanes and behind.
- If a vehicle is detected in the blind spot of the motorcycle, color LEDs will change to indicate how close the vehicle/object is to the motorcycle.
- If a vehicle is detected in the blind spot of the motorcycle, LEDs will be used to notify the rider on the correct side of the object detected – left or right or both.



Specifications: Fall Detection

- The true fall detection rate for 4 types [1] link of falls should be no less than 93% [2]link with no more than 10% error margin false fall detection for each type of fall.
- If a fall is detected, LEDs and phone app will be used to notify the rider.

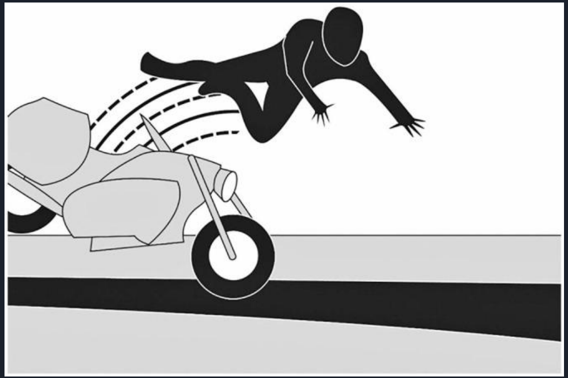


Figure. *Highside collision, one of four of the most common types of falls*

Specifications: Hardware

Helmet

- PCB size does not exceed 3.5”x3.5”
- Power consumption does not exceed provided 2A at 5V
- System will last for at least 2hrs

Motorcycle

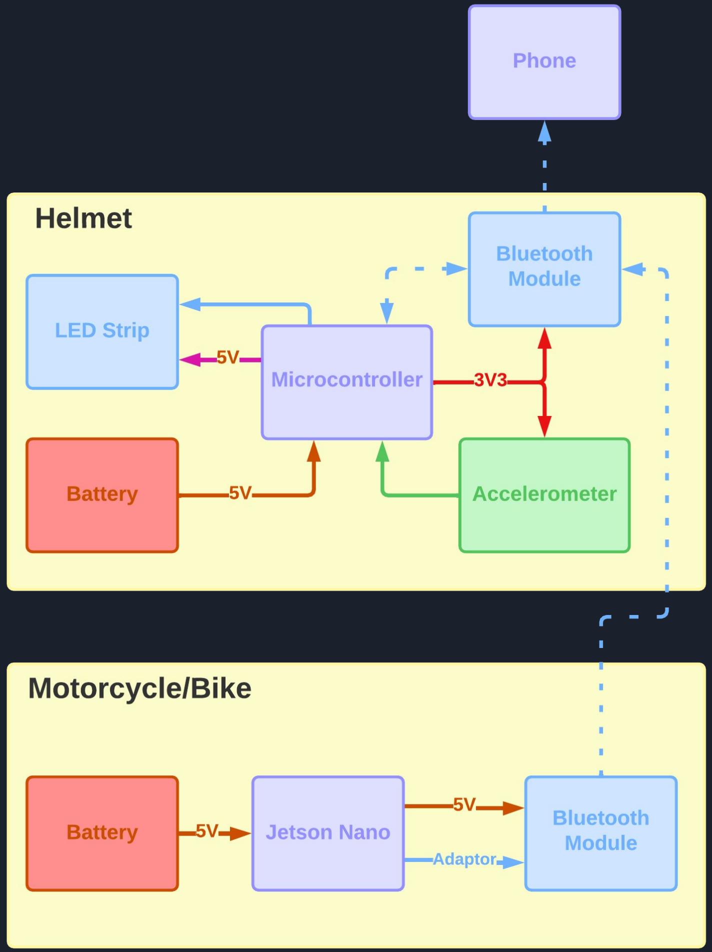
- Power consumption is within capabilities of a motorcycle port

System

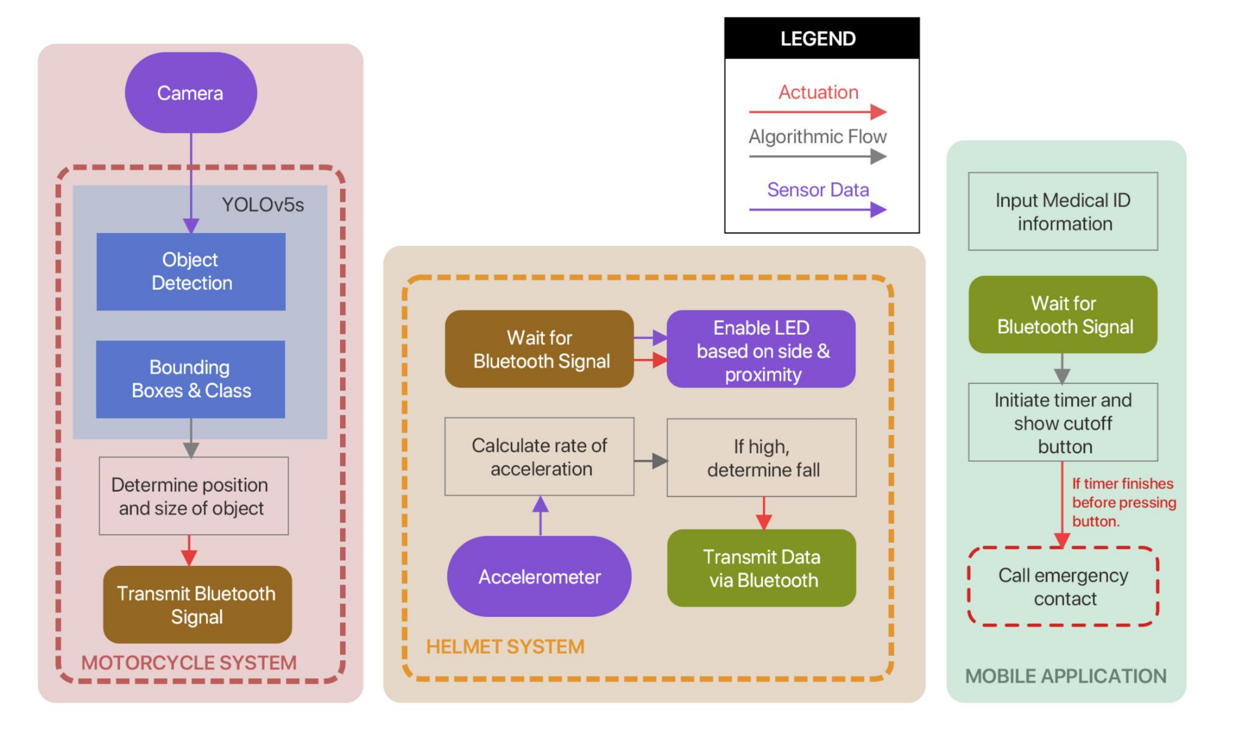
- System is portable and compact

Demo

Hardware Design



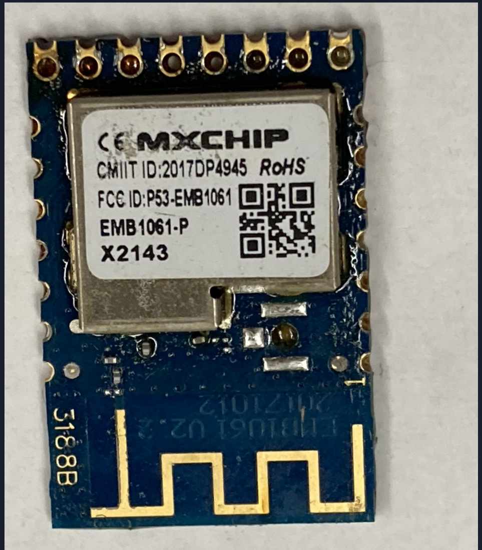
Software Design



Verification

Bluetooth Challenges

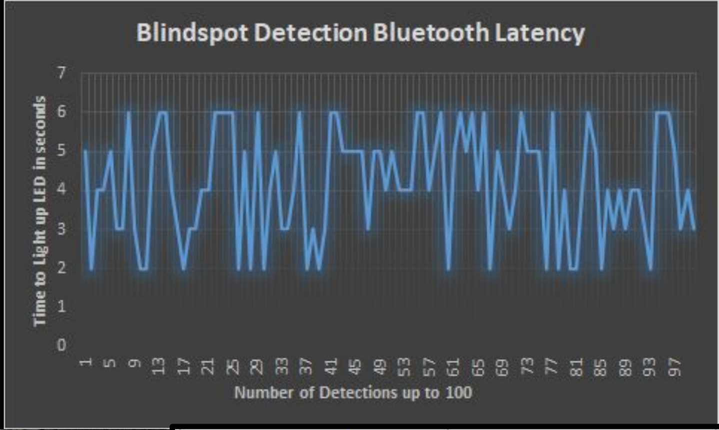
- Bluetooth Low Energy vs Bluetooth Classic
  - Designed our system to use BLE
  - Jetson Nano does not have BLE protocols
  - Changed our implementation to work using Bluetooth classic
- Jetson was not compatible with serial Bluetooth Classic protocol
  - Re-compiled kernel
  - Lost some functionality

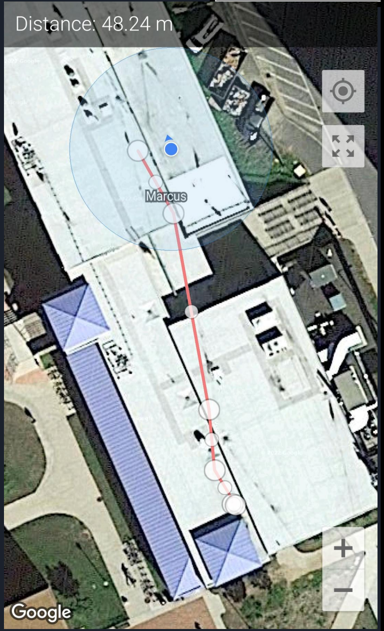


BLE

Verification: Bluetooth

- Time taken to send a signal from Jetson Nano to Helmet module is 4.11±0.28 seconds
  - System did not reach specification of <200ms
- Tested bluetooth range between helmet-motorcycle systems to be working for up to 48.24 m
  - System meets our specification of 3 m



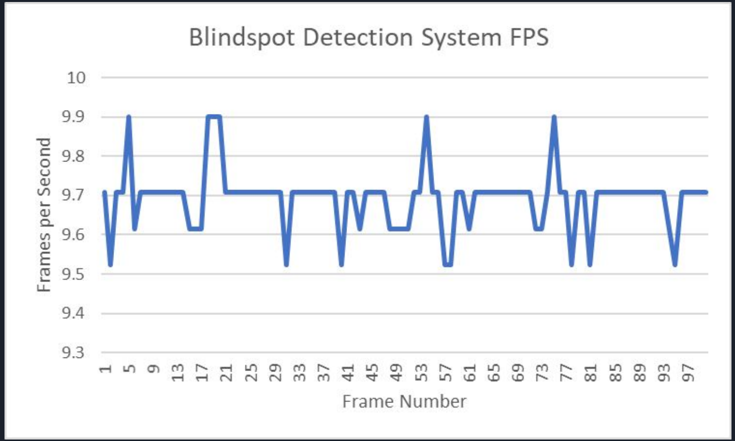


Latency of Blindspot Detection in Seconds	
Mean	4.11
Standard Error	0.139909783
Median	4
Mode	3
Standard Deviation	1.399097833
Sample Variance	1.957474747
Kurtosis	-1.329118045
Skewness	-0.041714127
Range	4
Minimum	2
Maximum	6
Sum	411
Count	100
Confidence Level(95.0%)	0.277611364
Upper CI (95.0%)	4.387611364
Lower CI (95.0%)	3.832388636

Verification: Blind Spot Detection

True Positives	True Negatives	False Positives	False Negatives
219	159	17	5

- Blindspot Detection system run on test footage for video with 4072 frames, out of which 200 random frames were selected, and the system's detections were compared to actual detections.
  - Using a 95% confidence level, the system reaches a 94.5 ±2.2% accuracy
  - This shows that our system meets our specification of 91%
- The blindspot detection system was run over 100 frames, to calculate FPS of each frame:
  - Average FPS = 9.69, with standard deviation = 0.076



Verification: Fall Detection

True Positives	True Negatives	False Positives	False Negatives
112	120	0	8

- Falls were simulated according to the four most common types of falls, Low and High falls for both left and left sides. By using the average motorcycle lean of 20° A total of 240 different crash simulations were conducted.
    - Using a 95% confidence level, the system reaches a 96.7±2.26%
    - This shows that our system meets our specification of 93%

Verification: Hardware

Helmet

- PCB size satisfies specifications
  - 2.66’’ x 3.12”
- Power consumption is satisfied
- System will last for at least 2hrs
  - Minimum of 4 hr
    - Battery: 2A at 5V; 5Ah

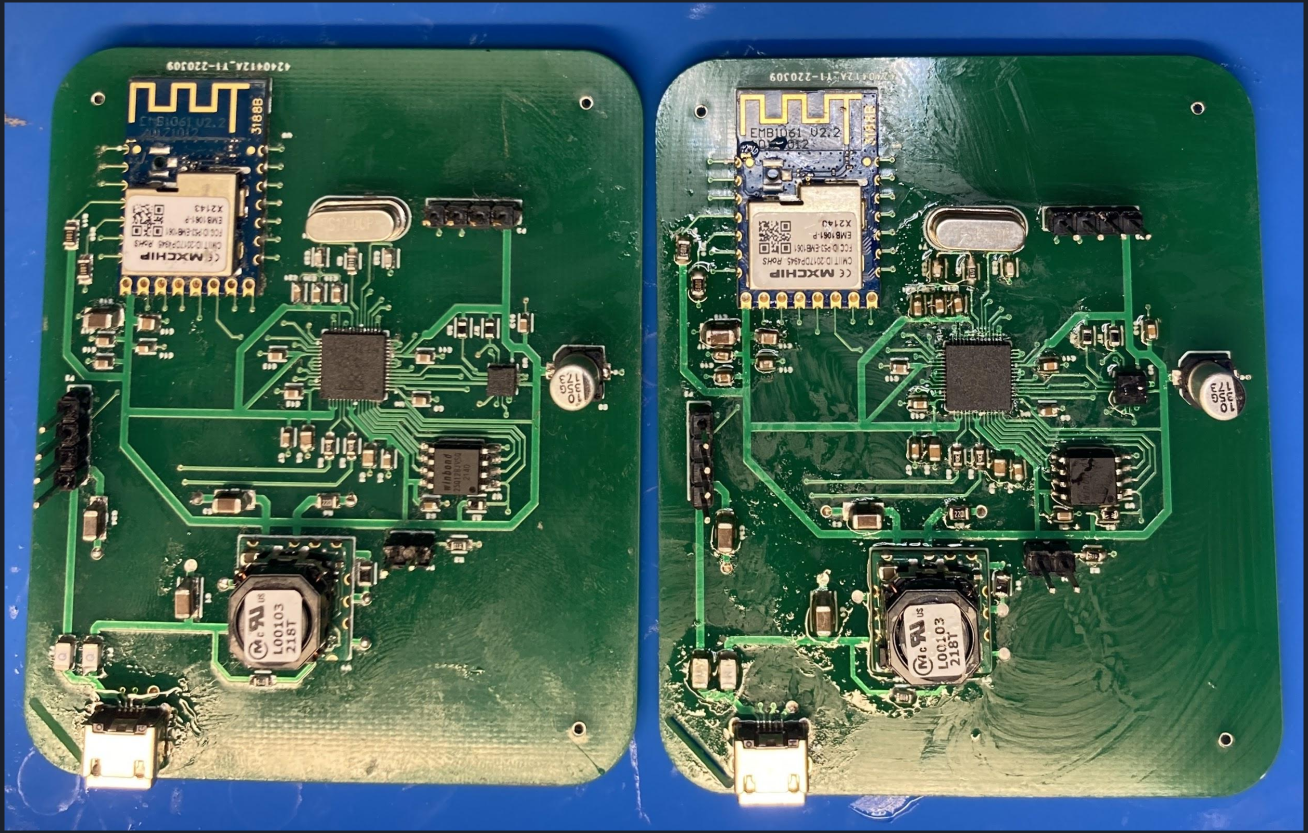
Motorcycle

- Power consumption is within range for a motorcycle port to use as the external 5V power source
  - 4A max at 5V

System

- System is portable and compact
  - *AC battery bank is only for demo*

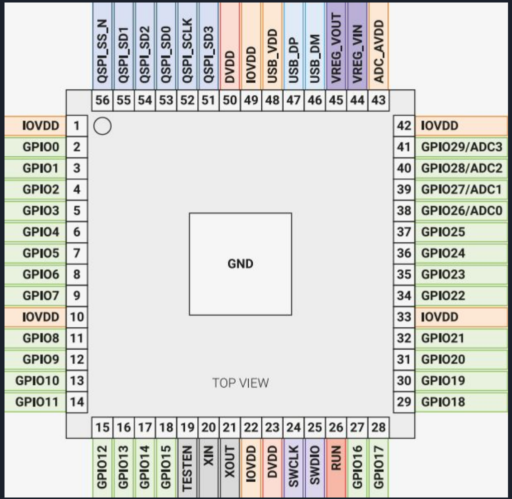
PCB

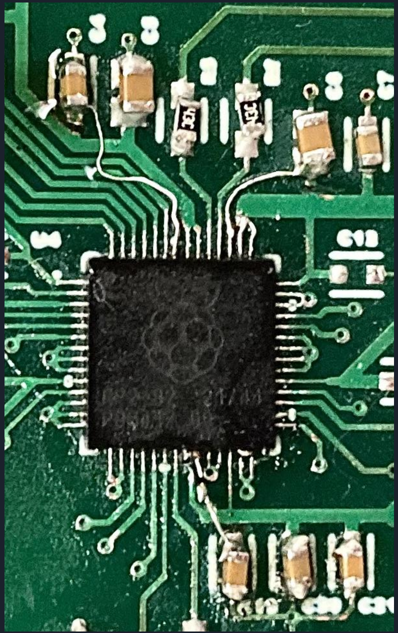


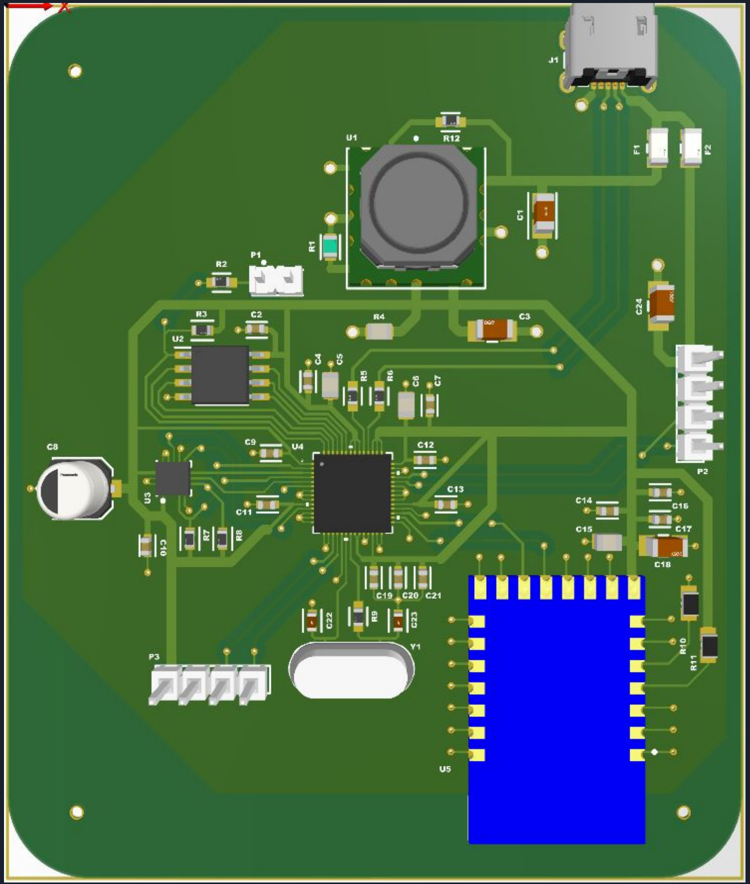
PCB Challenges

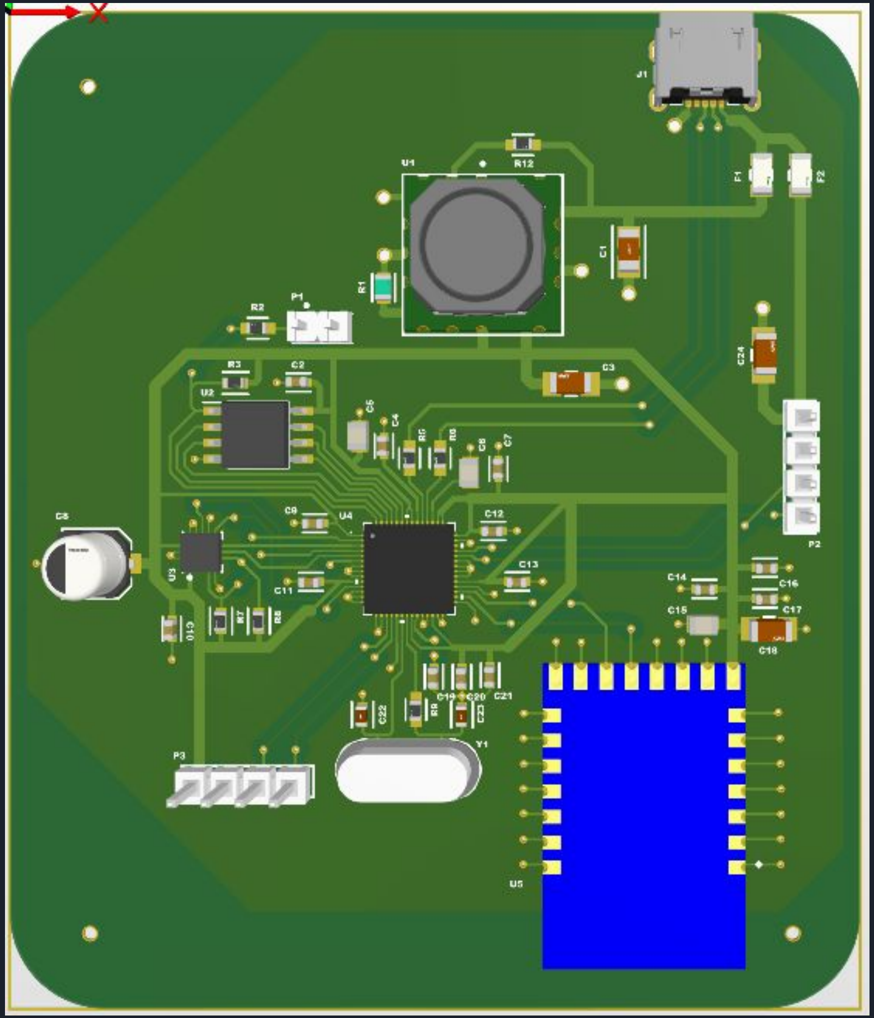
Microcontroller pin connections

- Pins connecting to the ARM core were incorrect
  - Connected to 3.3V power, but required 1.18V
- The jumper wires proved to not be thick enough to reach the needed 1.18V









PCB: Changes

Budget

Component	Development	Production
Accelerometer	$4.95	$1.53
Bluetooth Modules (2)	$18.98	$10.58
Capacitors	$7.28	$2.42
Microcontroller	$1.00	$1.00
PCB	$10.20	$3.15
Resistors	$6.30	$1.05
Battery	$19.99	$3.80
Jetson Nano	$150	$99.50
Camera	$24.99	$0.50
LED Strip	$19.95	$11.66
Flash/Crystal	$2.23	$0.74
	$265.87	135.93

Item	Cost	Quantity	Total
Motorcycle:			
HQ Camera	$50.00	1	$50.00
Wide Angle Lens	$25.00	1	$25.00
Accelerometer & Gyroscope (MEMS)	$6.95	1	$6.95
Raspberry Pi 3 A+	$25.00	1	$25.00
USB V4.0 Bluetooth Adapter	$13.95	1	$13.95
		M Subtotal	$120.90
Item	Cost	Quantity	Total
Helmet			
Light Sensor	$4.50	1	$4.50
Accelerometer	$4.95	1	$4.95
Raspberry Pi Zero W	$14.00	1	$14.00
SD Card	$9.99	1	$9.99
LED RGB Strip NeoPixel	$17.95	1	$17.95
Level Shifter	$3.95	3	$11.85
Helmet	$69.99	1	$69.99
Dot Star LED	$24.95	1	$24.95
113990637 Bluetooth Module	$4.00	1	$4.00
Raspberry Pi RP2040 Microcontroller	$1.00	1	$1.00
Adafruit LIS3DH Triple-Axis Accelerometer	$4.95	1	$4.95
PCB Parts	$97.94	Various	$97.94
		H Subtotal	$266.07
H & M Subtotal	$386.97		
Total Shipping Costs:	$123.67		
Total	$510.64		

Individual Responsibilities

Dhruv:

- Blindspot Detection Lead:
  - Detection and classification algorithms with proximity
- Enclosure Design
  - Motorcycle Enclosure
  - Helmet Enclosure

Sidd:

- Fall detection Lead
  - Detection algorithm
- Helmet interface Lead
  - Blindspot notification
  - Crash detection notification

Jeff:

- Bluetooth Interface
  - Motorcycle to Helmet
  - Helmet to Phone
- App Interface
  - Emergency Notification System
  - Cutoff Button

Paige:

- PCB Lead
  - Altium PCB design
  - Building/Soldering
  - Testing
  - Power considerations