Cycling Assist System with Rear Object Detection

Team #12

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Introduction

- 130,000+ people injured in biking accidents every year
- Warning system needed for cyclists

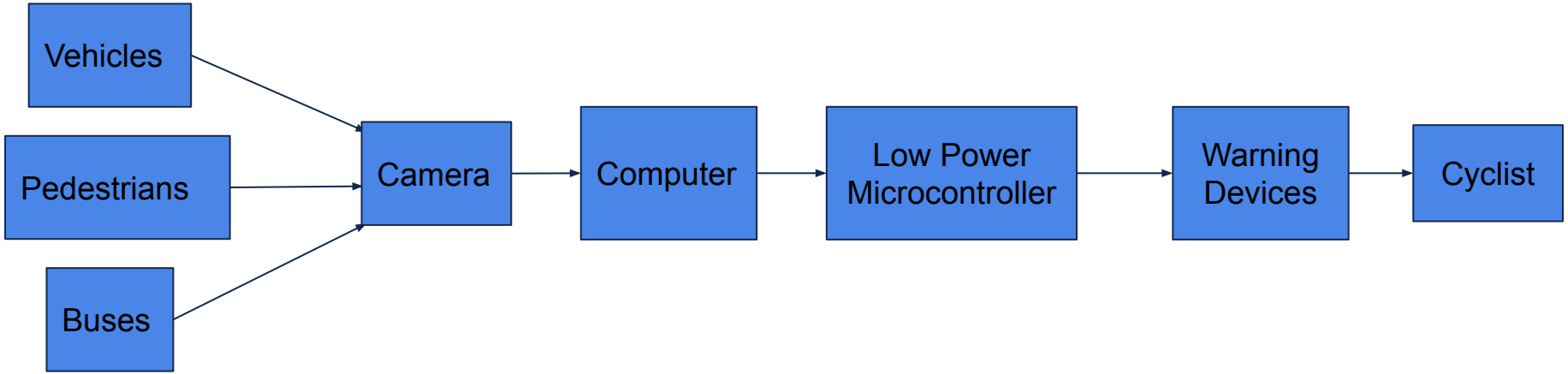
Objectives

- Capturing live video feed
- Alerting cyclist about approaching objects

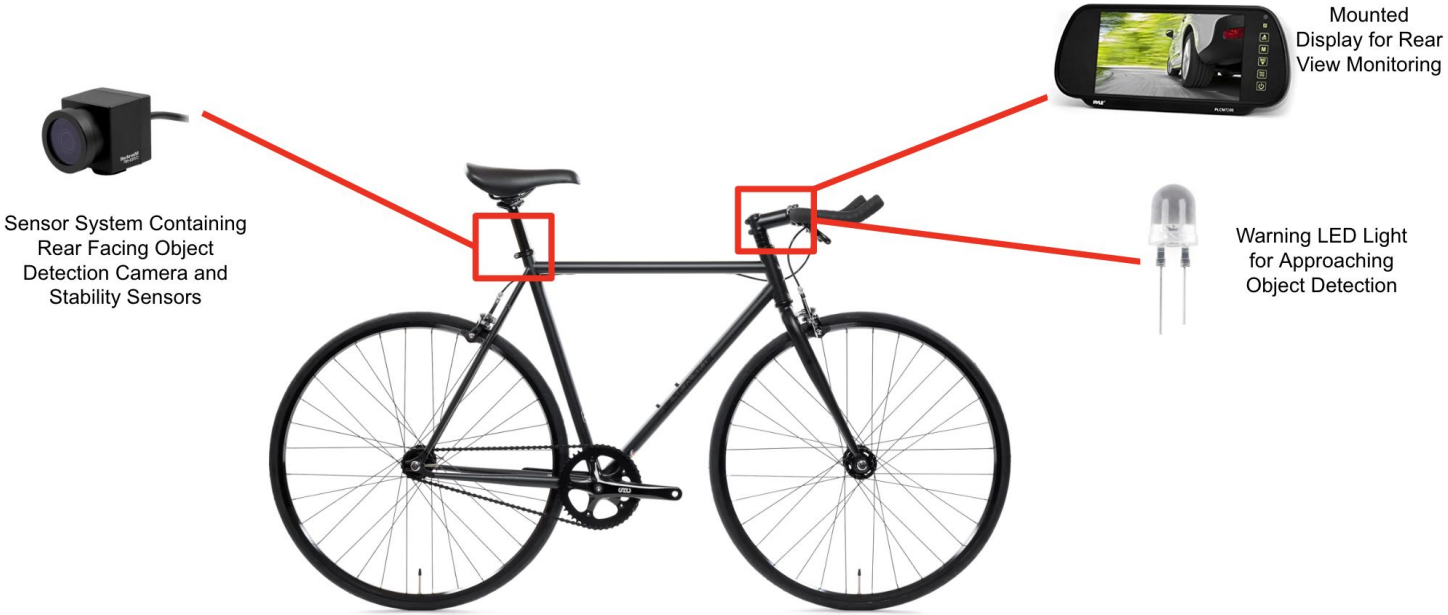
High Level Requirements

1. Use camera and display to show a rear view of bicycle
2. Detect rear approaching objects within at least 10 meters
3. Inform user about how close a vehicle is to the cyclist using LEDs and a buzzer

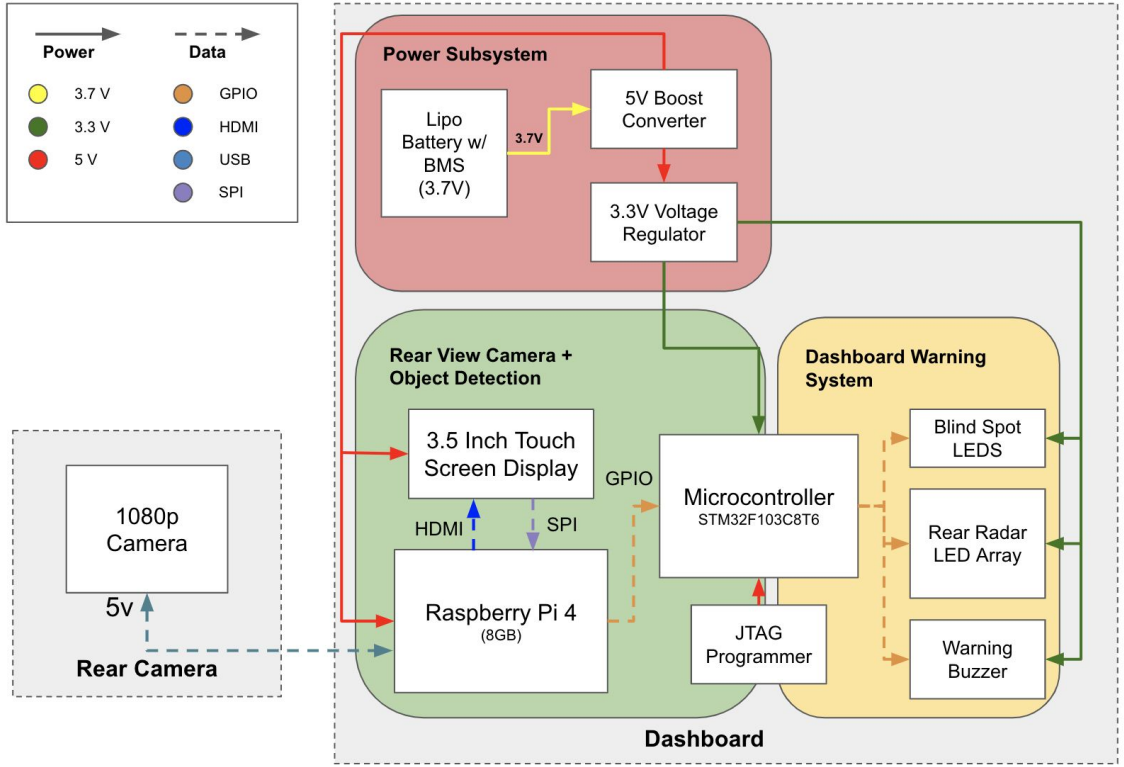
Design Overview



Design Overview

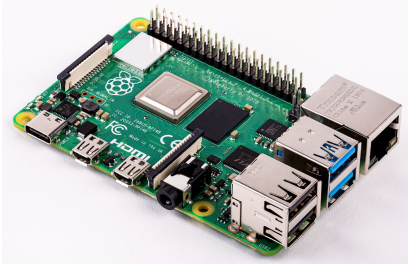


Block Diagram



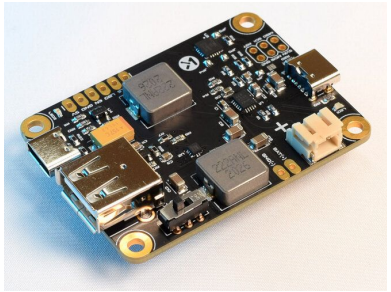
Hardware Overview

- Built around 2 major components
  - Raspberry Pi 4
  - STM32
- Live rear display
- Five different warning LED levels
  - Far, mid, and close distance
  - Right and left blind spots
- Power subsystem for over 3A peak
  - 3.7V Lipo Battery
  - 5V Boost Converter



Raspberry Pi 4

STM32F103

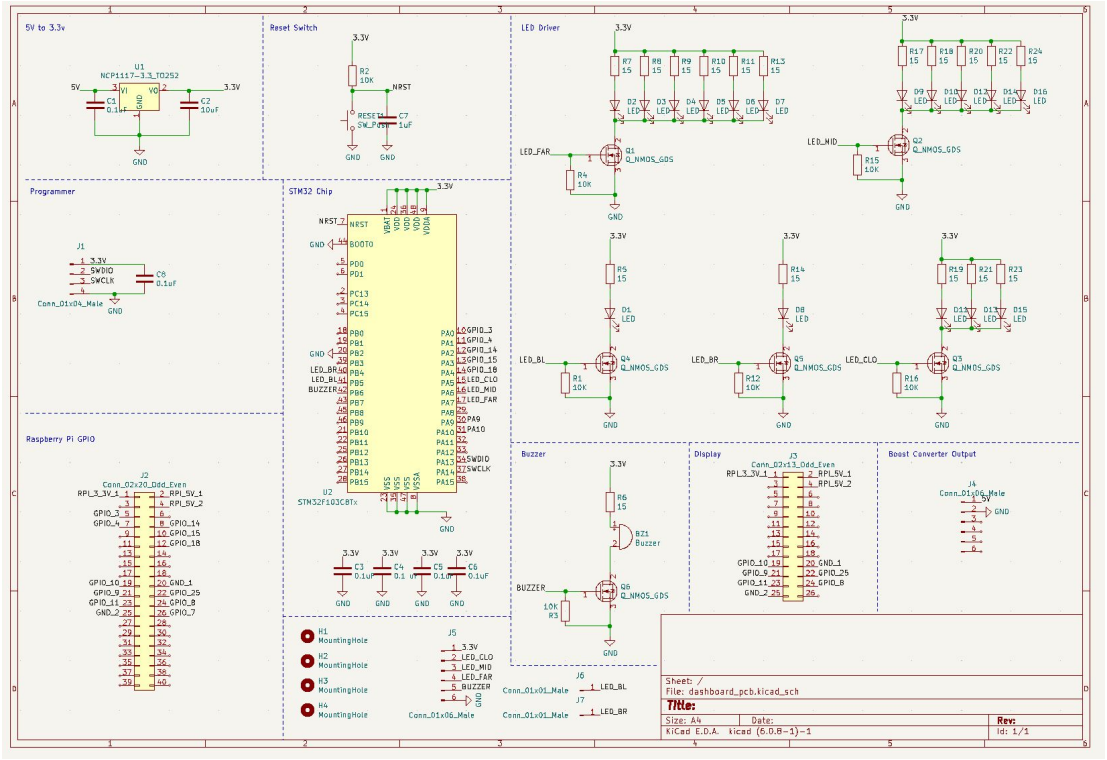


Amp Ripper 3000

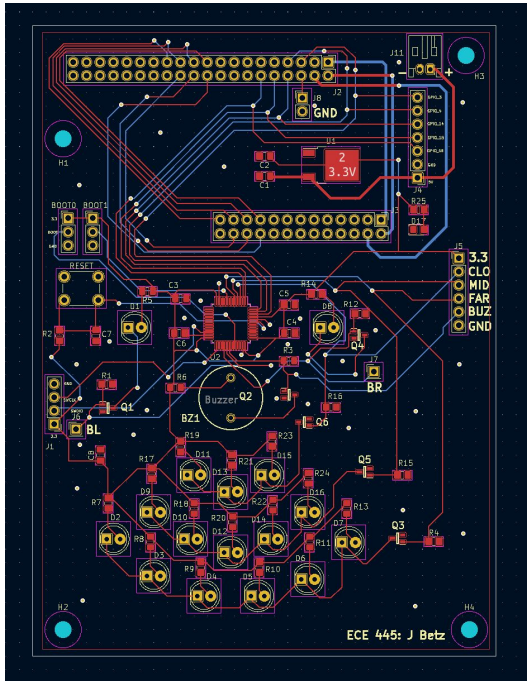
Circuit Schematic

Notable Features

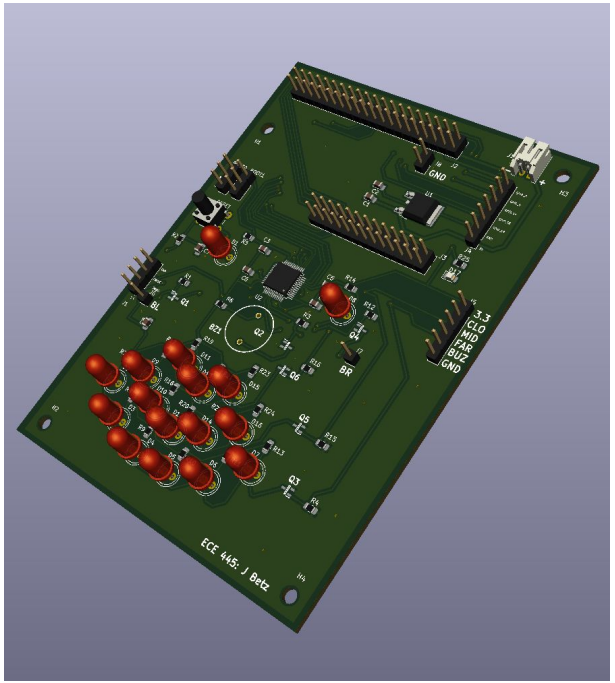
- STM32F103
- 3.3V LDO
- N-type MOSFETs
- JTag Programmer
- RPi GPIO
- Display



PCB Design



KiCad PCB Design

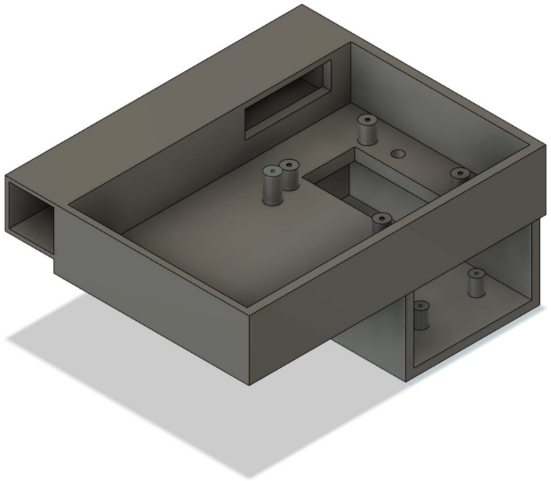


PCB 3D View

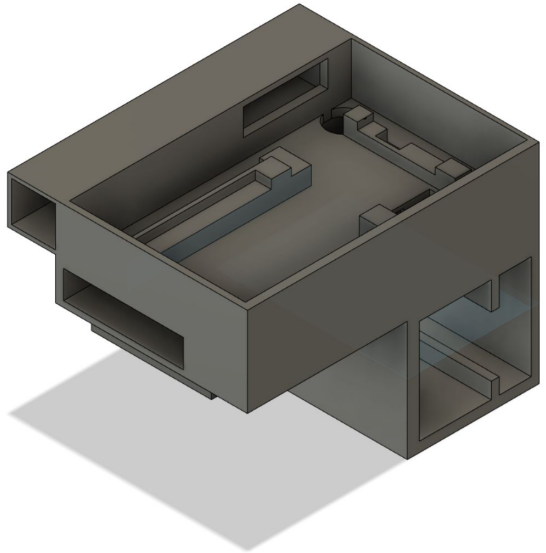
Enclosure CAD Design

Fusion 360 Design Notable Features:

- Separation between major parts
- Removable Lid
- Battery Slot
- USB Camera Cable Shroud

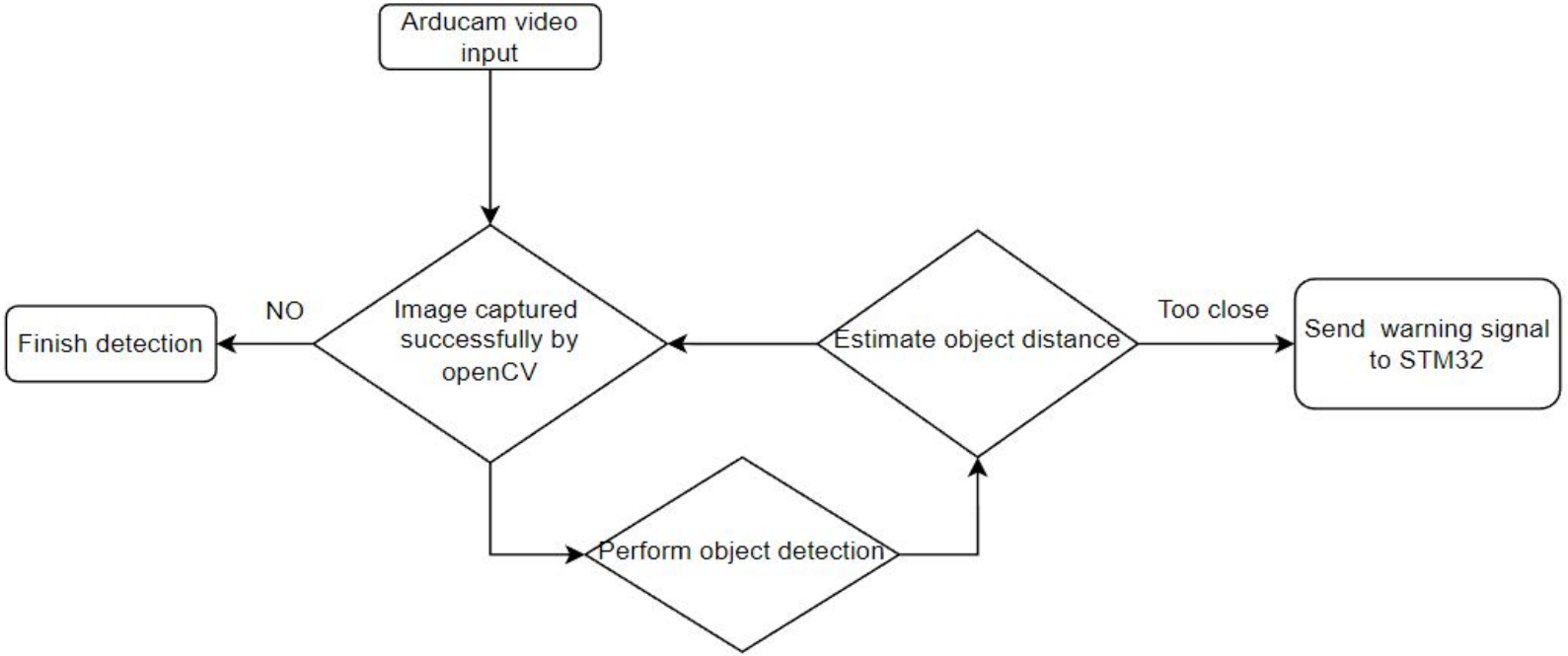


CAD Design V1



CAD Design V2

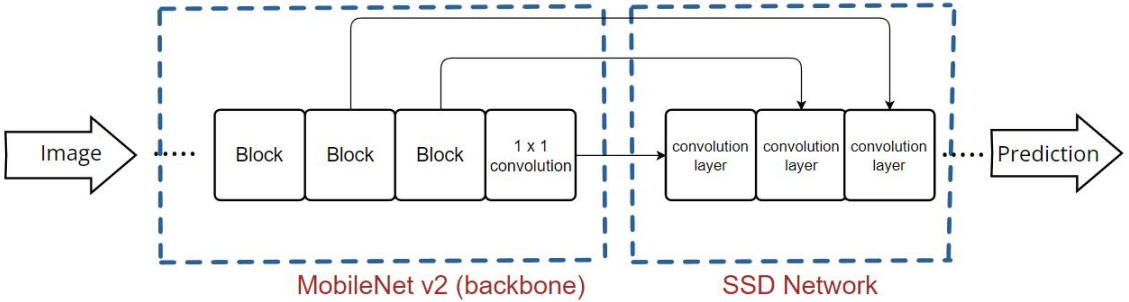
Software Design (RPi)



Software Design (RPi)

MobileNet V2 + SSD

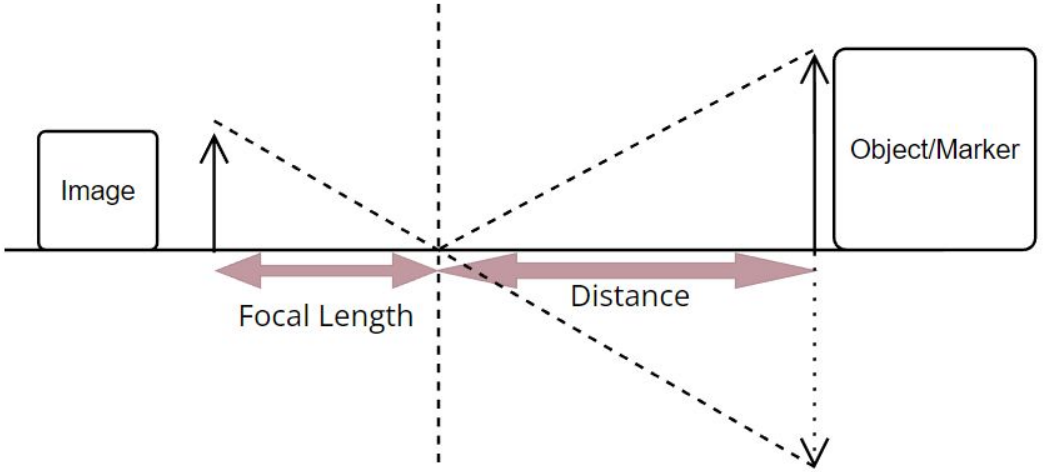
- Model selection for RPi(TensorFlow lite)
- Feature extraction in MobileNet V2
- Classification by SSD Network
- Additional training on BDD100k



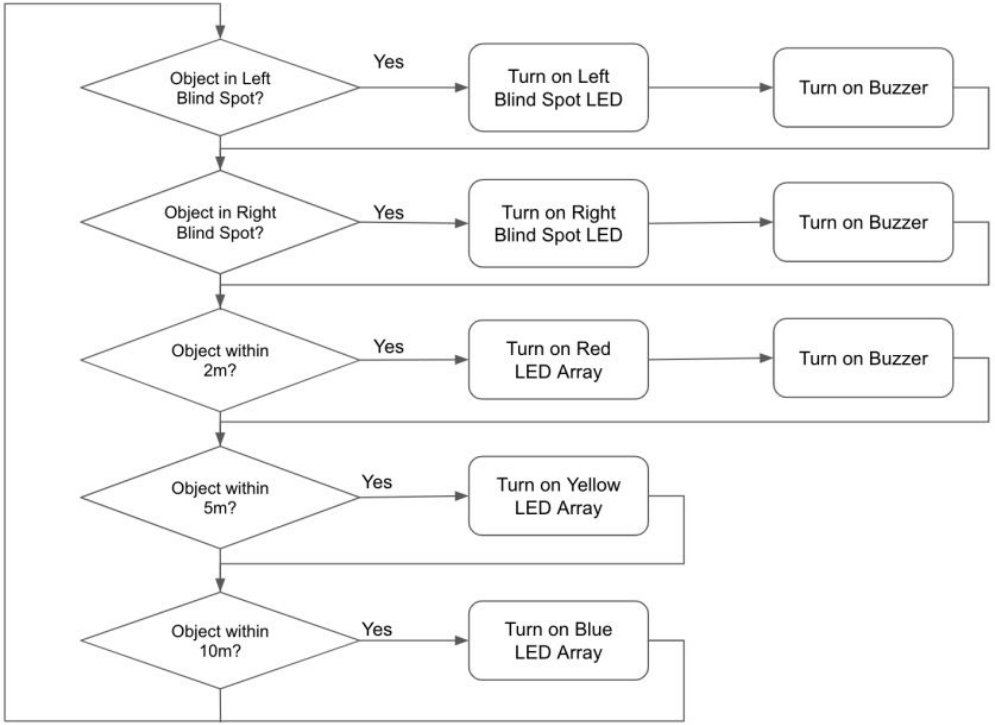
Software Design (RPi)

Distance Estimation

- Idea borrow from triangle similarity
- Focal length calculated using a marker
- OpenCV for pixel width finding



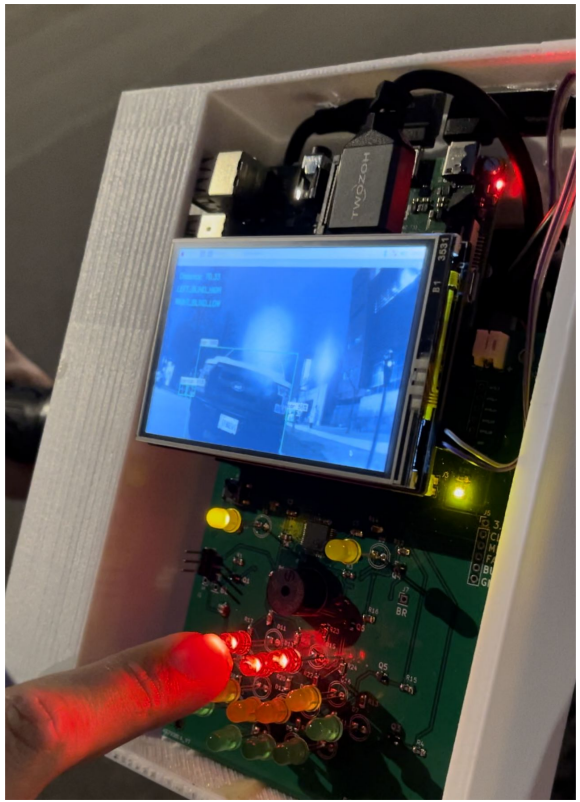
Software Design STM32



Software Design (STM32)

LED Array + Buzzer

- Frame counter for detection to reduce LED blinking due to false positive
- Persistent warning

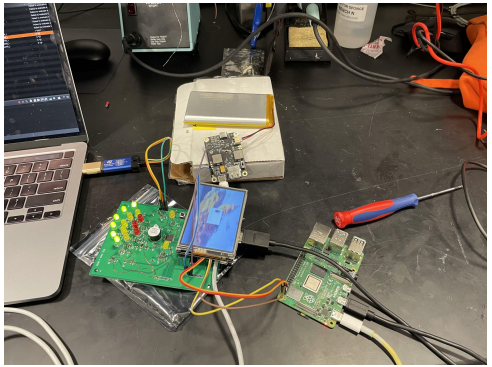


Results

Final Integrated Assembly

Test Verification

- All RV table tests were ran and verified
- Ran multiple high level tests
  - Travelling down bike lane, with car following
  - Running in low light conditions
  - Testing on multiple objects at once



Power Subsystem Verification

Object Detection Verification

Project Success and Challenges

Successes

- Very successful project!
  - High level requirements fulfilled
  - All subsystem requirements also fulfilled
- Project solves overall problem
- Project improves previous solutions

Challenges

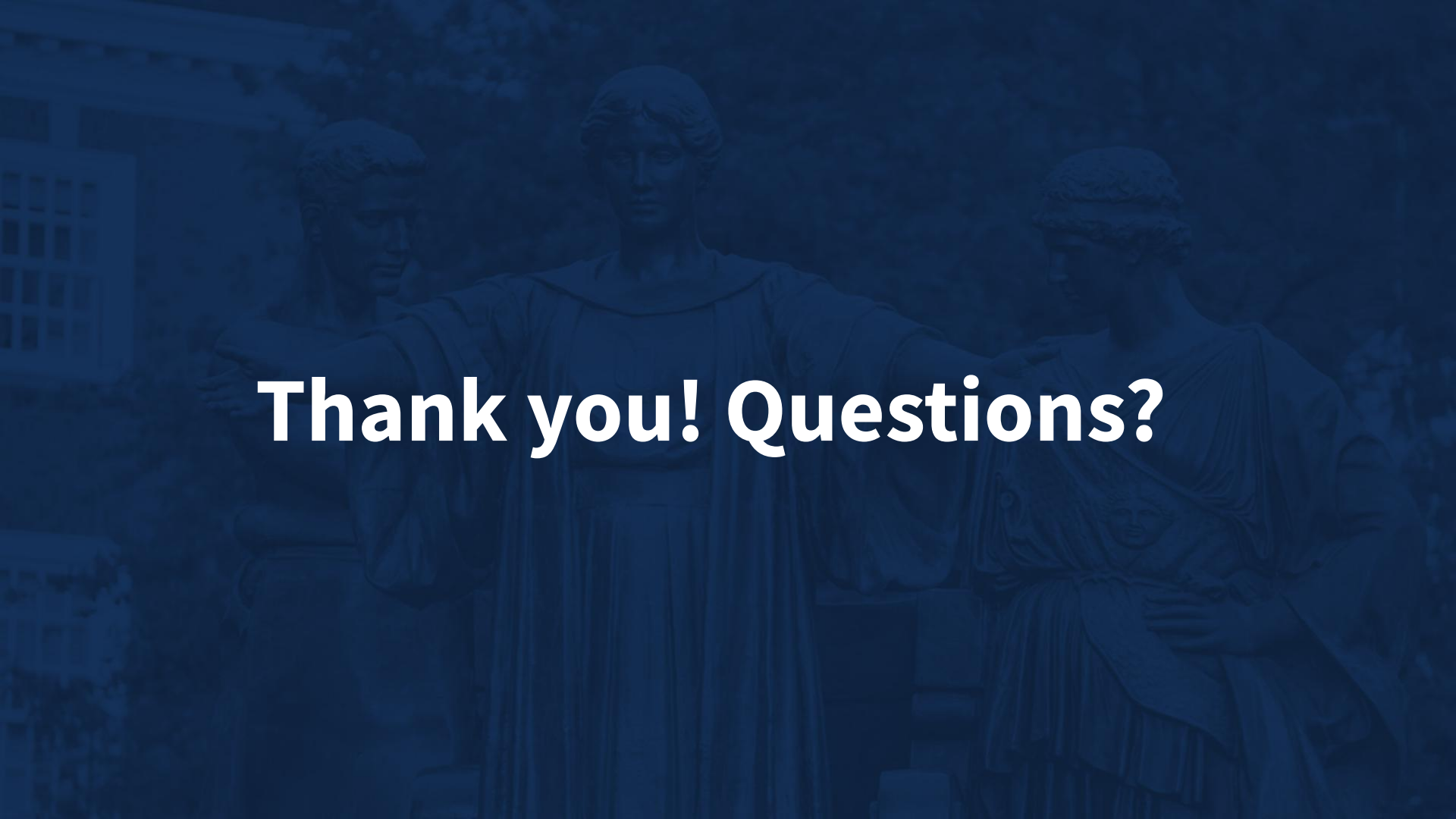
- Complicated Software
- Sensitivity tuning
  - Pro or Con?
- Bulky casing

Future Work

- Waterproof enclosure for rear-facing camera
- Test accuracy of other distance detection systems (LiDAR, Radar, Sonar)
- Clean up wiring system

Conclusions

- Learned about what to consider when developing a product
- Integrated knowledge learned in previous courses
- Successfully met our goals


Thank you! Questions?