



FoCoS

Team2 TRAFEC
ENSC 405W
PoC Prototype
Demonstration

The Team



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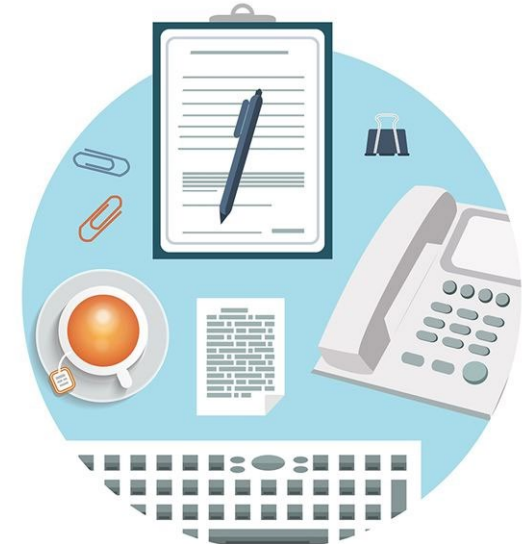
Introduction

- FoCoS is completely based on the idea of Forward Collision warning system
- Forward collision warning system as an aftermarket solution to the older cars
- FoCoS will provide an audio and visual alert to warn the driver about the risk of collision
- On-board sensor that detects the frontal object and the system that will determines the possibility of the crash



Background

- **Forward collision warning** systems: An active safety feature that warns drivers in the event of an imminent frontal collision
- Any FCW equipped vehicle is less prone to an accident and makes you and others feel safer on the roads.
- Some common situations:
 - Car in front of you has stopped at green light
 - Distraction from the car's infotainment system
 - The vehicle ahead suddenly slows down to turn without giving signal



Motivation

- The statistics from ICBC revealed that in 2013, 29% of the fatal accidents were caused by distracted driving[1]
- Existing after-market options are quite expensive
- Safety and security to the user
- Technology upgrade to an existing car








Business Case

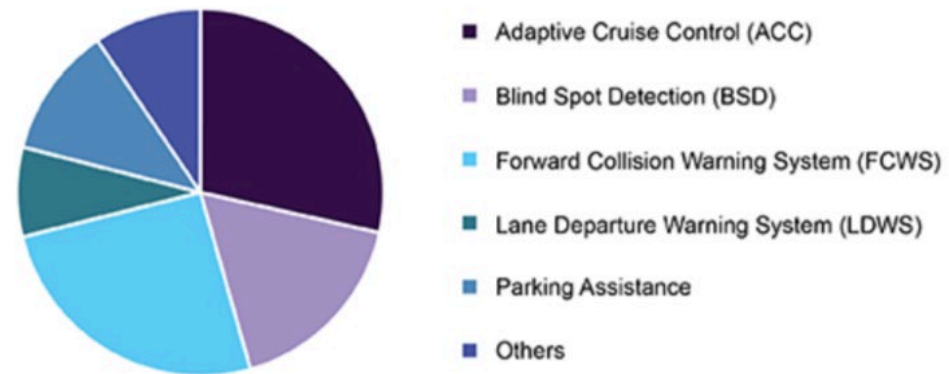
Competition



| | FoCoS  | Mobileye  | Safe Drive Systems  |
|----------------------|---|--|--|
| Product | FCW system with object detection | All-In-one camera system with FCW, lane departure warning and speed limit indicator | FCW with lane departure warning |
| Sensor | Radar + Camera | Camera only | Radar |
| Feedback | LED + Buzzer | In-Vehicle Display | In-Vehicle Display |
| Ease-of-Installation | Can be installed by User | Professional Installation required | Professional Installation required |
| Price | <\$500 (CAD) | \$1000 (USD) | \$1900 (USD) |

Market

- The target market for FoCoS will be older cars that are not equipped with new tech
- Market to exhibit a compound annual growth rate of 21.2% from 2018 to 2025
- Europe collision avoidance sensor market share, by application, 2017, given by image below



Funding

Funding is derived from three sources

- Wighton Engineering Development Fund
- IEEE Canadian Foundation
- ESSS Engineering Science Student Endowment Fund





Technical Case

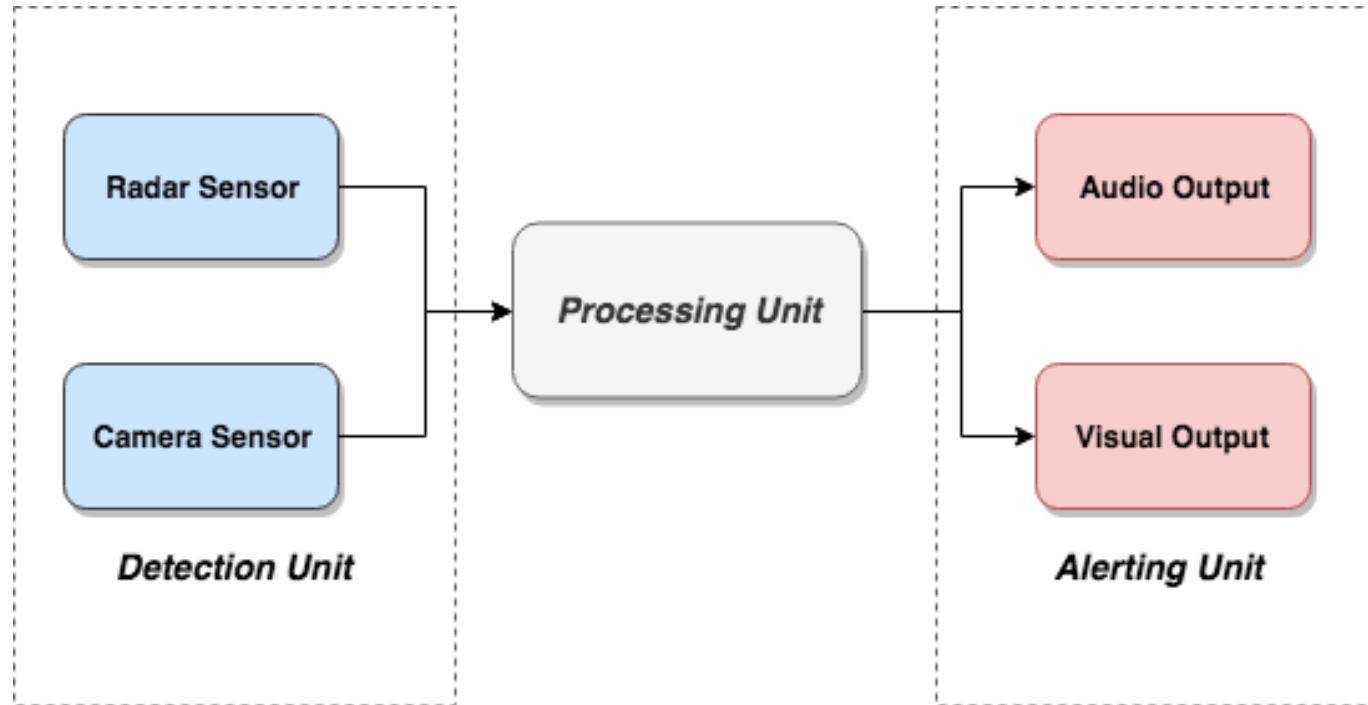
Overview

FoCoS is a small device consisting of three main units:

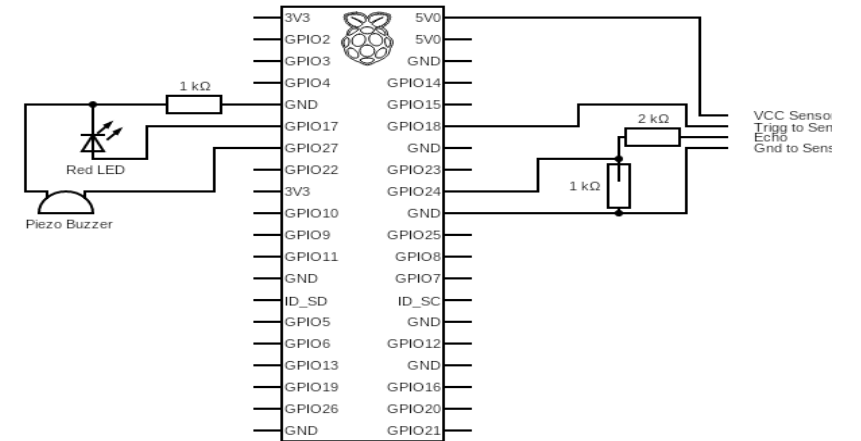
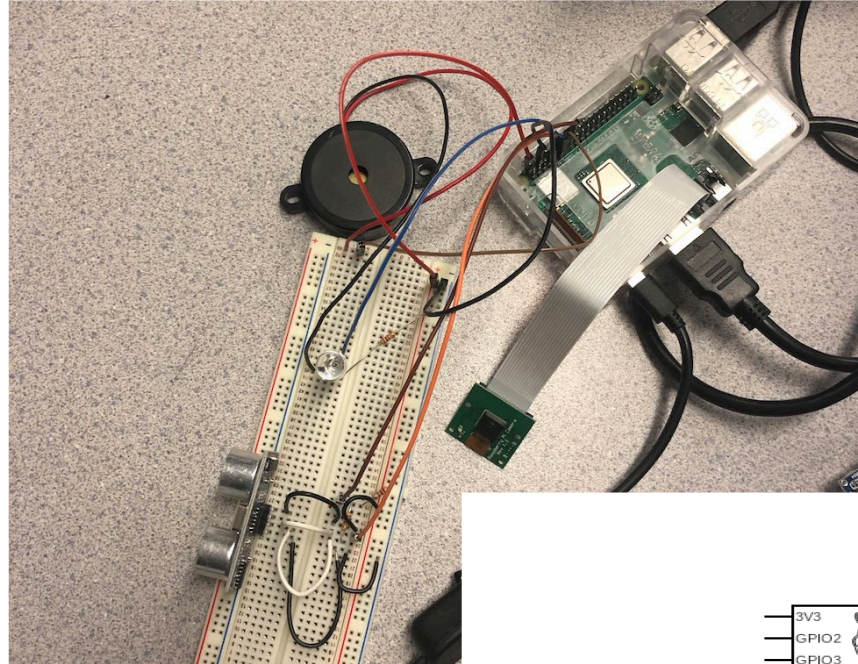
Detection Unit: Radar and Camera

Processing Unit: Microcontroller

Alerting Unit: LED and Buzzer

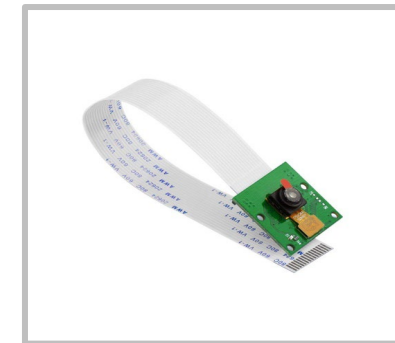
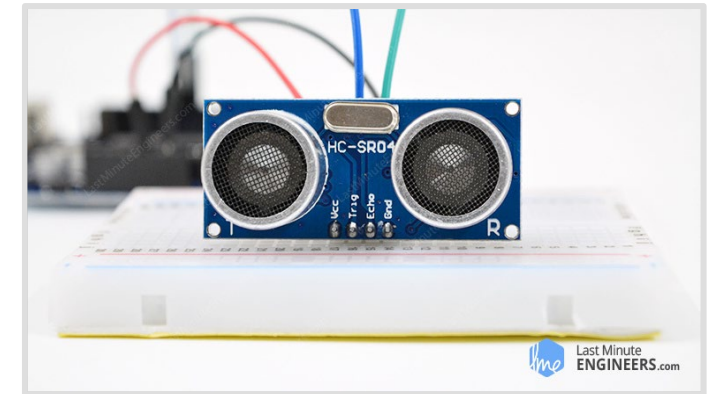


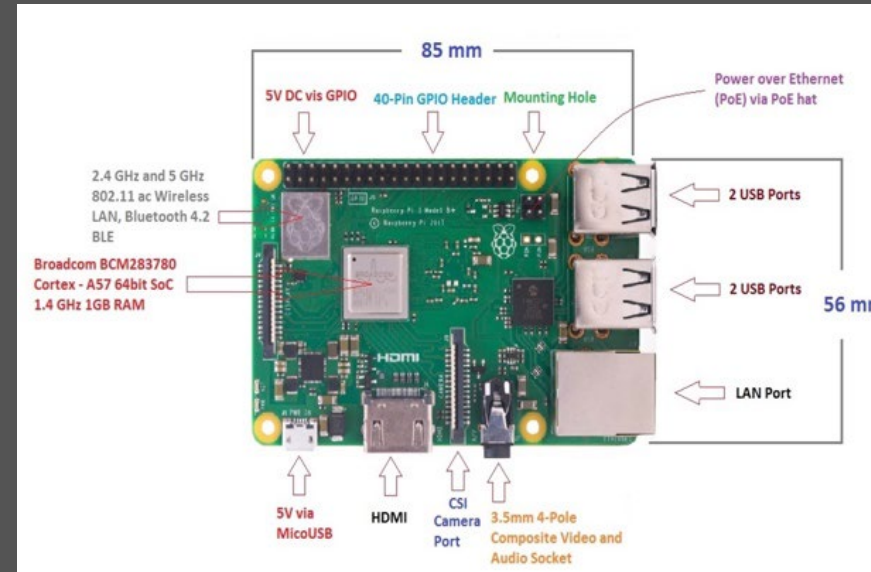
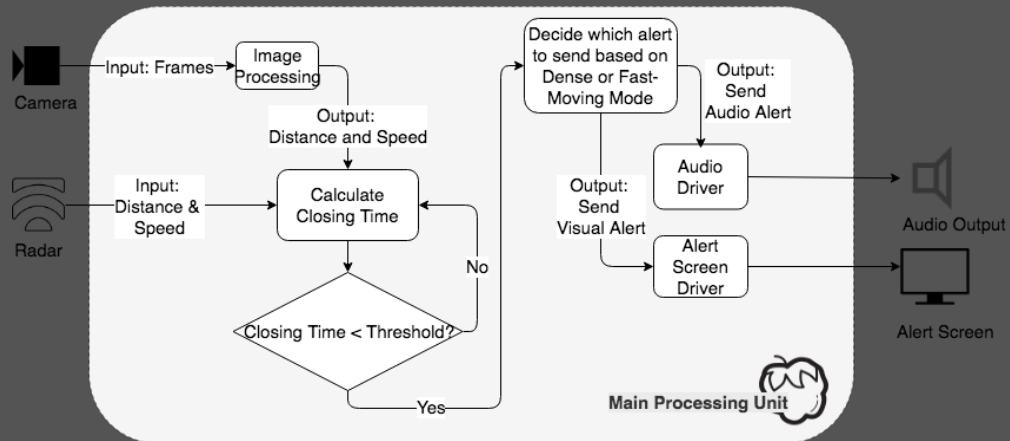
Circuit



Detection Unit

- Attached to front of subject vehicle
- Used to sense the car or pedestrian in front
- **Radar** (Primary Sensor)
 - Speed of travel and distance from other vehicles will be determined by monitoring changes in the Doppler Shift of the radio wave
- **Camera** (Secondary Sensor)
 - Will continuously monitor changes in distance of the Subject Vehicle from various objects on the road
 - Performing object detection using Tensorflow pre-trained "ssdlite_mobilenet_v2_coco_2018_05_09" model





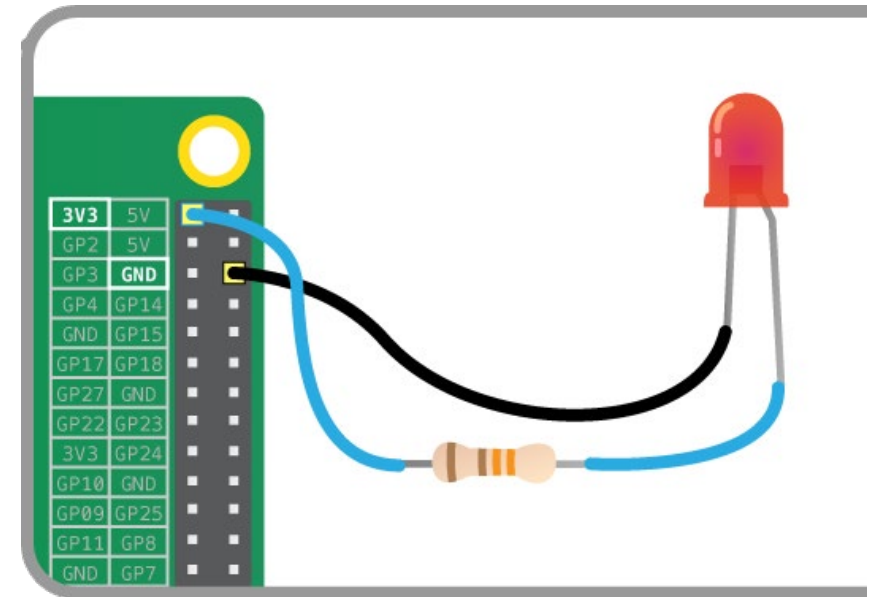
Processing Unit

- Using Raspberry Pi B+ as main processing unit
- Main Processing Tasks:
 - Accept data from Detection Unit
 - Calculate closing time
 - Get type of object detected
 - Signal Alerting Unit if object is a vehicle

Alerting Unit

- Warns driver of impending collision
- > LED Alerts given at Warning Stage
- > Buzzer Beeps at STOP Stage

If the driver presses the brake in the span of 3 seconds after the warning has been sent out, the car should stop without colliding with the object.



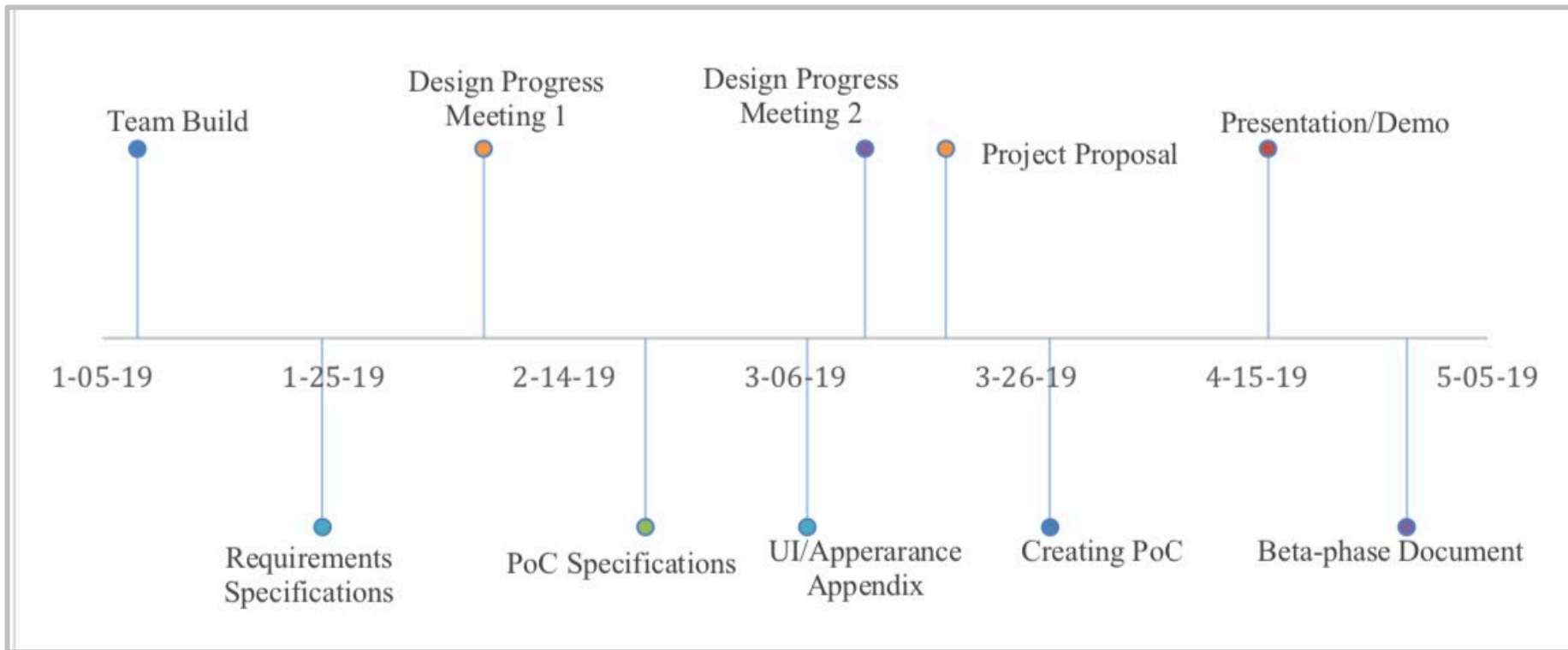
Materials & Costs

| Prototype Production Cost | | |
|--|---|-------------|
| Component | Description | Price (CAD) |
| Raspberry Pi 3 B+ package for research and final prototype | Microprocessor with SD card, HDMI cable | \$90 |
| Ultrasonic Sensor | Smaller radar with 2m range | \$10 |
| Mini External USB 2.0 speaker | Speaker for audio alert | \$20 |
| LED | Single red LED for visual alert | \$2 |
| Resistors, wires etc. | Various components needed for audio and other module connections | \$15 |
| Camera | Keystudio Camera Module 5MP REV 1.3 compatible with Raspberry Pi 3 Model B+ | \$15 |
| Other | Taxes, Shipping and Handling etc. | \$45 |
| Total: | | \$197 |

Major Changes in Scope & Design

Changes

- **Sensor:**
 - We are using ultrasonic sensor in PoC instead of Radar as originally planned
 - Short-Range Radar that we were planning on using on PoC did not give reliable reading
 - Still planning on using long-range Radar for Final Product
- **Camera:**
 - As per Dr. Rawicz's suggestion at 2nd Progress Review Meeting, we decided against using Camera to get object distance for PoC
 - Currently, camera used to confirm if obstacle detected by Sensor is a CAR
 - Will try to incorporate object distance calculation in Final Product



Schedule

Risk Analysis

Risks

- **Environmental conditions**
 - Sensor exposed to the outside environment
 - Dust and Moisture
 - Hot and cold temperatures
- **Installation**
 - Placement of the sensor and the camera
 - Precise readings and accurate data
 - Not blocked by any material

Risk Management

Management

- Sensor enclosed in the proper cover
- Installation guide with proper instructions



Adherence to Engineering Standards

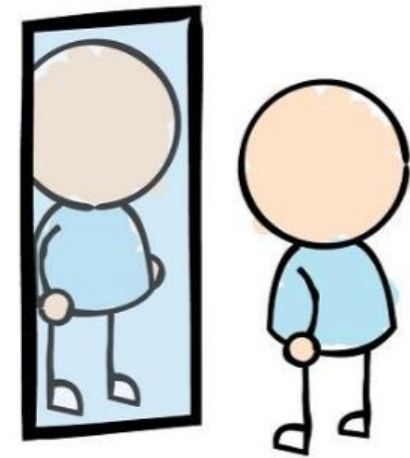
| Standard ID | Description |
|---------------------------------|--|
| CAN/CSA-C22.2 NO. 61508-1:17 | Functional safety of electrical/electronic/programmable electronic safety related systems - Part 1: General requirements [2] |
| CAN/CSA-C22.2 NO. 0-10 | General requirements - Canadian electrical code, part II [2] |
| CAN/CSA-C22.2 NO. 60065:16 | Audio, video and similar electronic apparatus - Safety requirements (Adopted IEC 60065:2014, eighth edition, 2014-06, with Canadian deviations) [2] |
| CAN/CSA-ISO/TR 14062-03 (R2013) | Environmental Management - Integrating Environmental Aspects into Product Design and Development (Adopted ISO/TR 14062:2002, first edition, 2002-11- 01) [3] |

Adherence to Engineering Standards (continued)

| Standard ID | Description |
|------------------------------|--|
| CAN/CSA-ISO 14040-06 (R2016) | Environmental Management - Life Cycle Assessment - Principles and Framework (Adopted ISO 14040:2006, second edition, 2006-07-01) [3] |
| CAN/CSA-ISO 14044-06 (R2016) | Environmental Management - Life Cycle Assessment - Requirements and Guidelines [3] |
| IEC 62471 | LED Lighting Products [4] |
| IEEE Std 1789 | IEEE Recommended Practices for Modulating Current in High- Brightness LEDs for Mitigating Health Risks to Viewers [5] |

Self-Reflection

- Communicate clearly
 - Meet more frequently
 - Team building activities
- Project improvements
 - Research more on electronics parts and components
 - Order parts timely
 - Give more time to testing

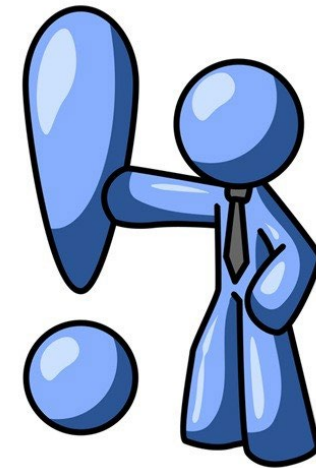


Plan for ENSC 440

- Work on Beta Phase Planning Appendix
- Design PCB
- 3D printing the casing
- Incorporate the long range sensor
- Implement the other mentioned features (dense traffic mode and fast traffic mode)
- Increase the frequency of the feedback

Conclusion

- FoCoS is a small and intelligent device designed to help user in navigating the roads more safely
- Add an extra layer of security in the car
- Also adds to the protection of the people around the car
- FoCoS will always be looking at the front of the car and without any distraction it's constantly working when the car is running
- FoCoS will bring a technology upgrade to an existing car



Questions

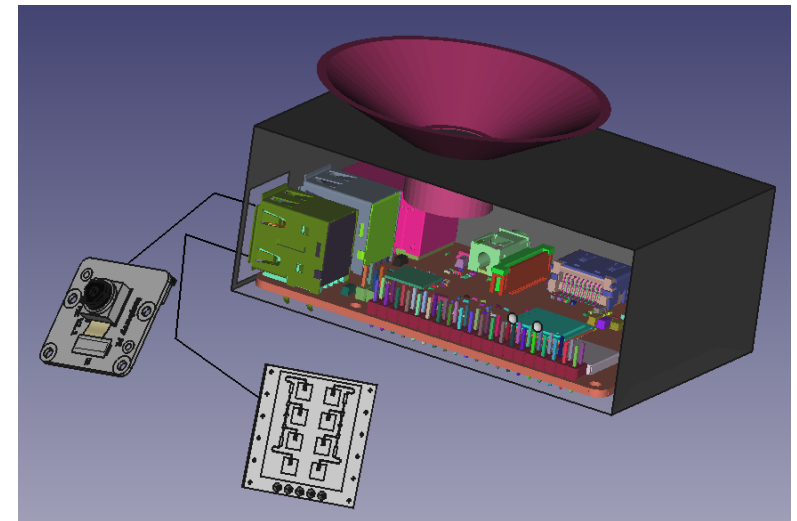




Demo

Appearance Modelled

- Psychology of the shape:
 - Board and sensor covered
 - Not a packed product
- Specifications
 - LED: Red
 - Speaker: 600 Hz
 - Sensor Range: 25m



Feedback Considered

- NXP board – Dr. Scratchley's feedback
 - NXP board doesn't have GPU, might be slower than Raspberry Pi
- Distance calculation using camera – Dr. Rawicz's feedback
 - Raspberry pi already takes a while for object detection.
 - Distance calculations through camera might be more slow
- FM transmitter – Ashley's feedback
 - Might not be user friendly in our case

Questions

Thank you for your patience



References & Acknowledgments

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