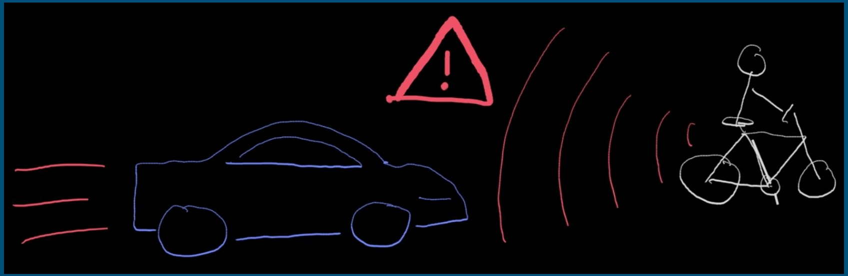
Bikewards View

Albany Bloor, Emily Clayton, Jason Xu
Team B3

The Bicycler



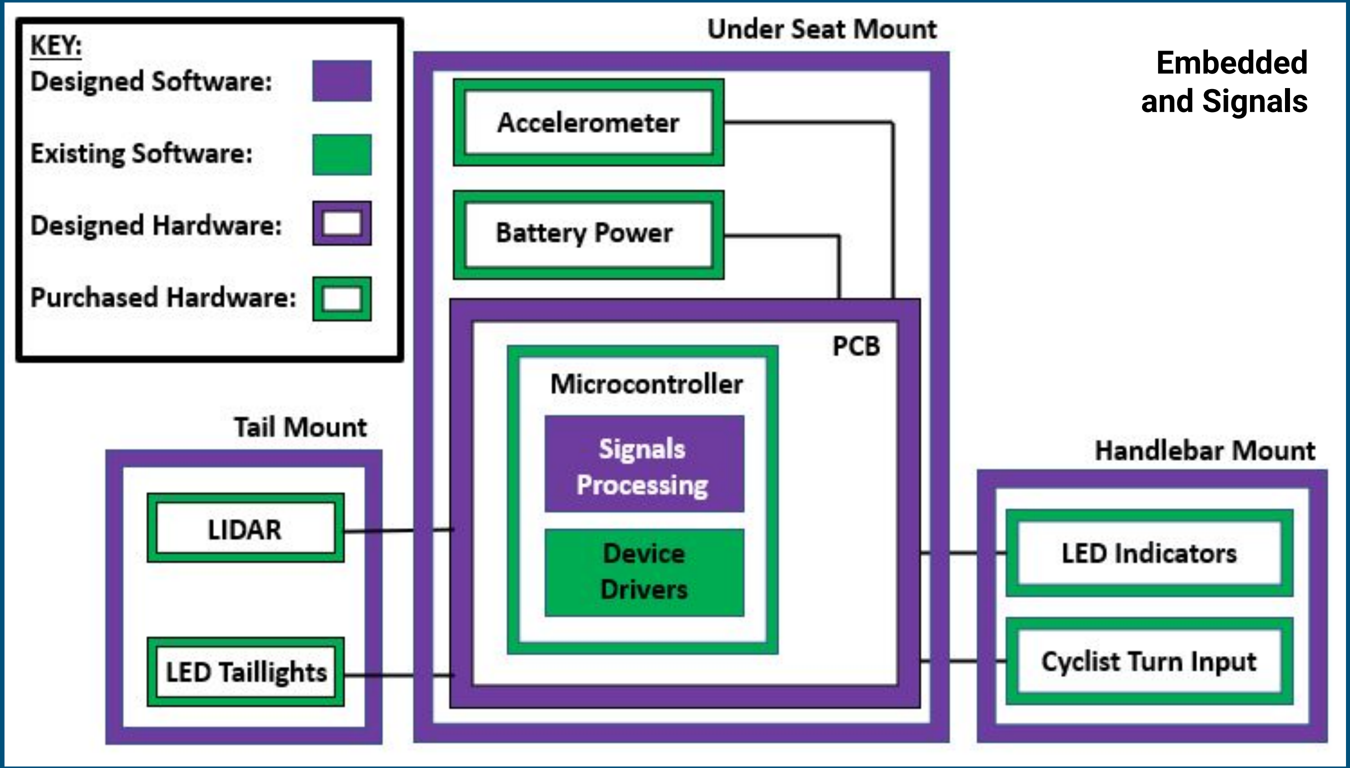
Today’s bicycler often shares the road cars, but their conveyances lack many of the safety features being offered to today’s drivers despite they’re greater vulnerability.

There are two important steps in keeping anyone on the road safe today, informing them of dangers and making sure others on the take notice of them. BikewardsView looks to facilitate both of these. Filling in crucial information about their blindspots for the bicycler and alerting other users of the road when they strey to close.

BikewardsView adds further security than any mirror ever could, filtering out stationary vehicles in the information relayed to the driver and crucially not only warning them, but the other party.

Bikewards View

Bikewards view will use a microcontroller to host custom signals processing software that will connect to a purchased sensor and warning lights through a custom hardware on a PCB



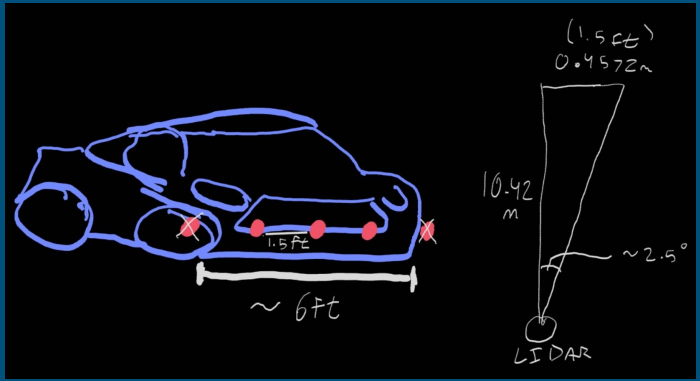
Sensor Requirements

10.42m range minimum - assuming a differential speed of 30kph (20kph biker and 50kph approaching car) want 1s to allow the bicylcer to react including and a further 250ms is allowed for processing/latency on our end.

$$10.42m = 30kph * \frac{1mps}{3.6kph} * 1.25s$$

Field of View - 90 degrees at minimum to cover range not seen by 270 degrees visible to human with static body and minor head motions.

Minimum Angular Resolution - 2.5 degrees



BIKEWARDS VIEW

Choosing LIDAR

Initially we were looking into an array of ultrasonic sensors, and though ranging requirements and FOV might have been satisfied, we would not have had the angular resolution we required.

Solution - A rotating LIDAR, the RPLIDAR Slamtec A1M8 is our current selection.

- Rotation Speed: 2 to 10 Hz
- Collects up to 8000 points per second
- For 8Hz this is a point every 0.36 degrees = 360 degrees/(8000 points per sec * 0.125 sec)
- 8Hz corresponds to 125ms period, allowing total refresh of data w/in our processing period with compute time to spare.

BIKEWARDS VIEW

Latency & Battery Longevity

Latency

- Update the driver as quickly as bicycler can process info (250 ms)
- New info must be processed before next set up data delivered

Battery

- BikewardsView needs to last for a commuters entire day and be easily rechargeable.
- 1 hr active use (30 min commute both ways), 8 hrs on standby minimum
- LIDAR 100mA draw, 200mAh min
- To be chosen based on requirements of other components.

BIKEWARDS VIEW

Microcontroller Selection

STM32F4 Has a plethora of I/O ports with support for all common serial protocols that will allow us to read from the LIDAR sensor and drive multiple LED arrays

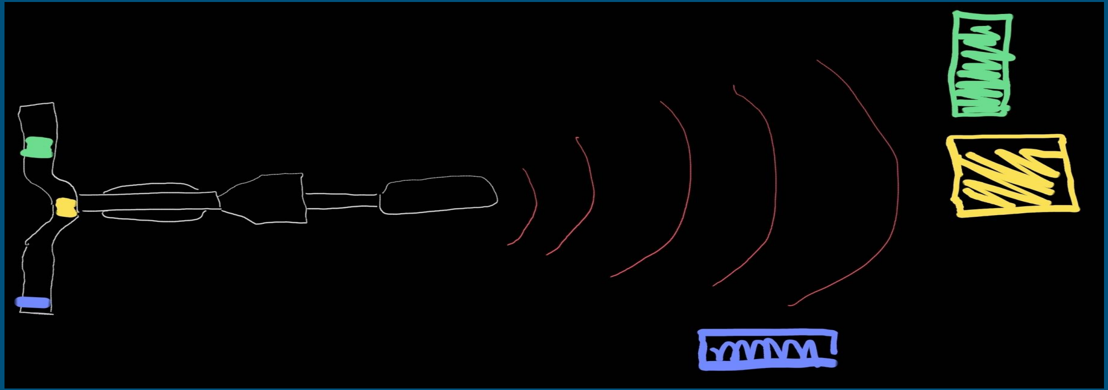
Experience within the team for the STM32F4 family, having used them for 18-349

Considered downgrading to more efficient processors, but power consumption benefit negligible

Bikewards View

LED Array and Signals

LED Handlebar strip gives direction of obstacle to biker (around 30 lumen max)



Tail Lights: American standards: 80-300 candela. Following standards will help ensure safety and correct communication. Translates to 90 lumen with the smaller surface area

Accuracy & Lidar Testing

Never fail policy for cars within the 10.42m range moving towards the bicycler with a differential speed of 30 kph +- 10kph

Allow a false positive rate of 5% in general, 10% for stationary vehicles

Perform initial tests of lidar detection without object speed filtering at varying ranges and object sizes.

Preform testing with either bike or obstacles stationary and code to filter out objects with increasing distance from bicycler.

Bikewards View

Testing

Log and time data processing, use tools to find load on system, measure power consumption in both active and sleep mode

Correctness testing for algorithm and interface

Test LED effectiveness for biker and drivers by observation under different conditions

Final real world testing with Jason biking around Oakland

Key Challenges & Risk Mitigation

We foresee a key challenge in the light sensitivity of our LIDAR in bright conditions a risk we plan to mitigate by testing the LIDAR early and in a variety of lighting conditions and possibly adding some sort of light filter or shading.

We also foresee possible issues with the lidar encountering travel vibrations, might try to implement a rudimentary suspension system to fix if necessary.

Testing of separate components before integration should help stave off problems in later stages of the project.

Built time into schedule for delays and integration problems, as well as a full week for corrections after demo

Bikewards View

Schedule/Tasks