Secure, Anti-Theft, Flexible, Engineered Taillight — SAFE T

App-Controlled Taillight with Turn Signals for Bicyclists with Theft-detection

Initial Project and Group Identification

Divide and Conquer, Version 2.0

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EEL 4914 Senior Design I
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Project Narrative Description

The goal of this project is to develop an accessible, low-cost solution to the problems bicyclists face. During nights, cyclists cannot effectively indicate their intended actions since the visibility is so low. Hand signals may not be as effective as they are during the day. Moreover, it cannot be guaranteed that drivers or pedestrians know exactly what the signals mean. Additionally, it is not a surprising fact that bicycles are stolen every day, especially when left in public areas.

As technology gets more and more economical, an affordable solution can be made to solve or at least mitigate these issues. Various considerations have been made to design an effective product that customers would want while keeping costs to a minimum. While the exact specifications are not yet decided, requirements are constrained enough to limit the number of choices available without major trade-offs.

The final product would be a unit that would consist of a tail light with turn signals powered by a battery. Bicyclists see plenty of action so the build needs to be sturdy and more importantly, it should withstand a reasonable amount of water exposure. The battery would be, in turn, powered by either a solar solution or using a USB connection, whatever is preferred by the user. The security and safety elements would primarily consist of an alarm system and an emergency button on the wireless controller. The alarm will be armed using the emergency button. The alarm will be loud enough to alert nearby pedestrians and also to dissuade the theft. They are also inexpensive pieces of technology which makes them an easy choice. Furthermore, would use wheel sensors to track the speed and the total distance traveled, which can be useful for tracking cycling behaviors.

All of these components would be controlled by a controller which would receive inputs from physical buttons, mainly the turn signals, and would also be made to be highly configurable using an optional mobile application that would connect to the main unit using Bluetooth technology. For example, a battery-saving option would be a highly desirable configuration to prevent wasting energy and to prevent charge wait times. An automatic system that does this would be even more desirable. A major benefit that we see using a mobile application is the extensibility of without making any changes to the internal design. The distance tracking, for instance, can be used along with the health application that typically comes with major phone operating systems to keep track of the calories burned by the user. But that is beyond the scope of this project; however, it demonstrates the extensibility that mobile integration brings to .

One of the challenges we anticipate is controlling the effective charging and discharging of the battery that is part of the final product. We intend to fine tune the system to charge and discharge at an optimal rate using data obtained from various tests. However, one of our stretch goals is to use the mobile application to collect telemetry data to tailor to ’s usage. Another stretch goal is to have the emergency button work along with a smartphone to utilize the SOS features supported by them in cases of emergency.

We discussed using NFC tags to create a lock and key system that could be a much more reliable way to arm the alarm system, without having to make estimates or using thresholds. However, the idea was put aside due to our lack of experience working with RFIDs and therefore, the difficulty involved in estimating the complexity of this addition.

List of Requirements

Table 1: Hardware Requirements

1.0	Lighting needs to be at least 75 lumens
1.1	At least 100dB alarm
1.2	IPx6 waterproof
1.3	Operational for 5-10 hours under continuous blinking.
1.4	2000 mAh rechargeable battery
1.5	Fully recharged within 2 hours
1.6	Backup battery shall use AA batteries
1.7	LEDs for lighting
1.8	Bluetooth 5.0 compatible
1.9	Maximum weight of 2 pounds
1.10	16-bit architecture or greater (possibly ARM or a low energy RISC chip)

Table 2: Software Requirements

2.1	Support iOS and Android platforms
2.2	Bluetooth 5.0 LE compatible
2.3	Maximum size is 1GB
2.4	Maximum RAM usage of 512MB
2.5	Support iOS devices iPhone 8 or above
2.6	Android API 28 or above must be supported

Project Block Diagram

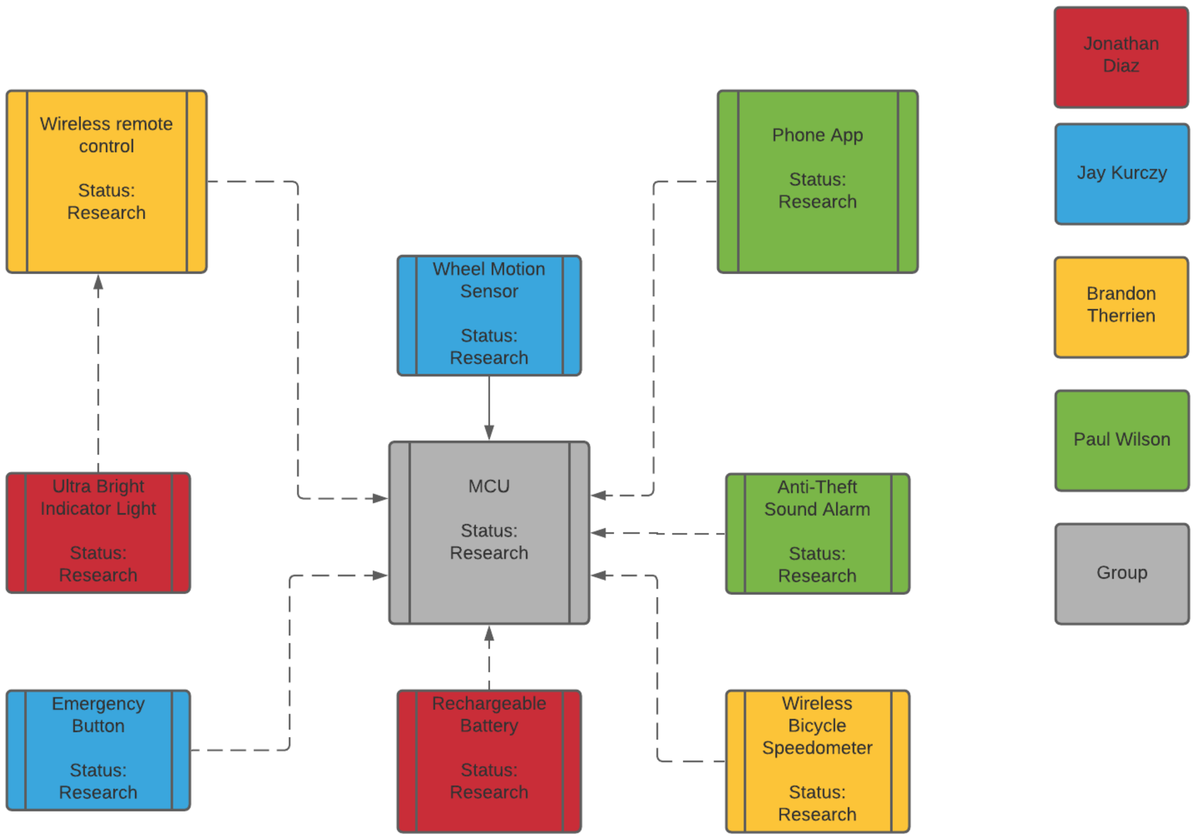

Figure 1: Project Block Diagram

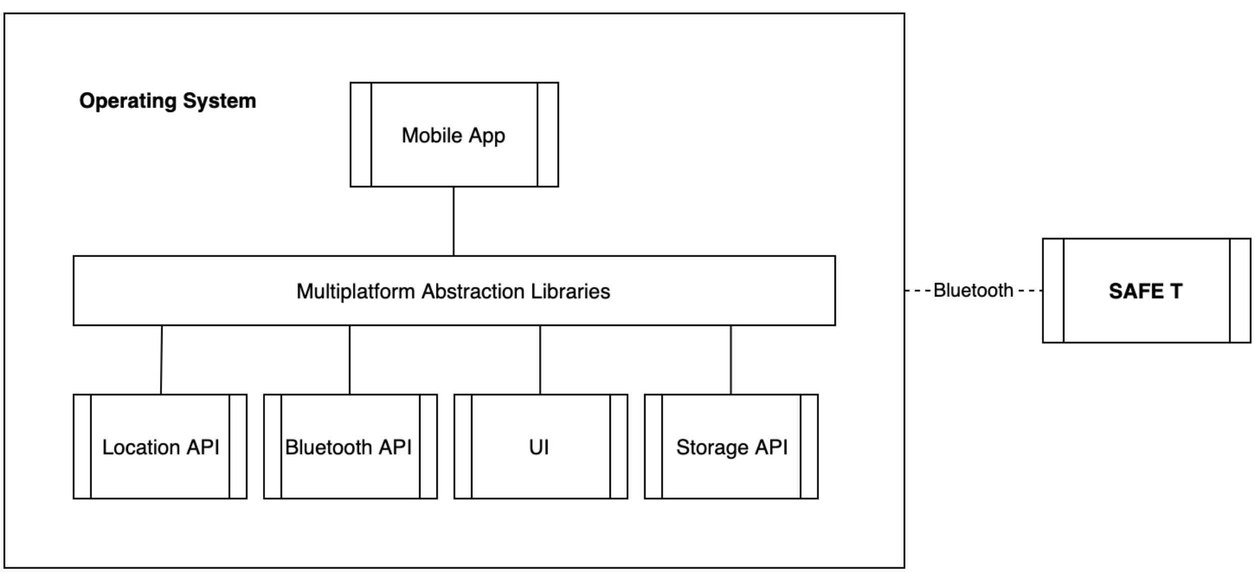

Figure 2: OS-level Software Block Diagram

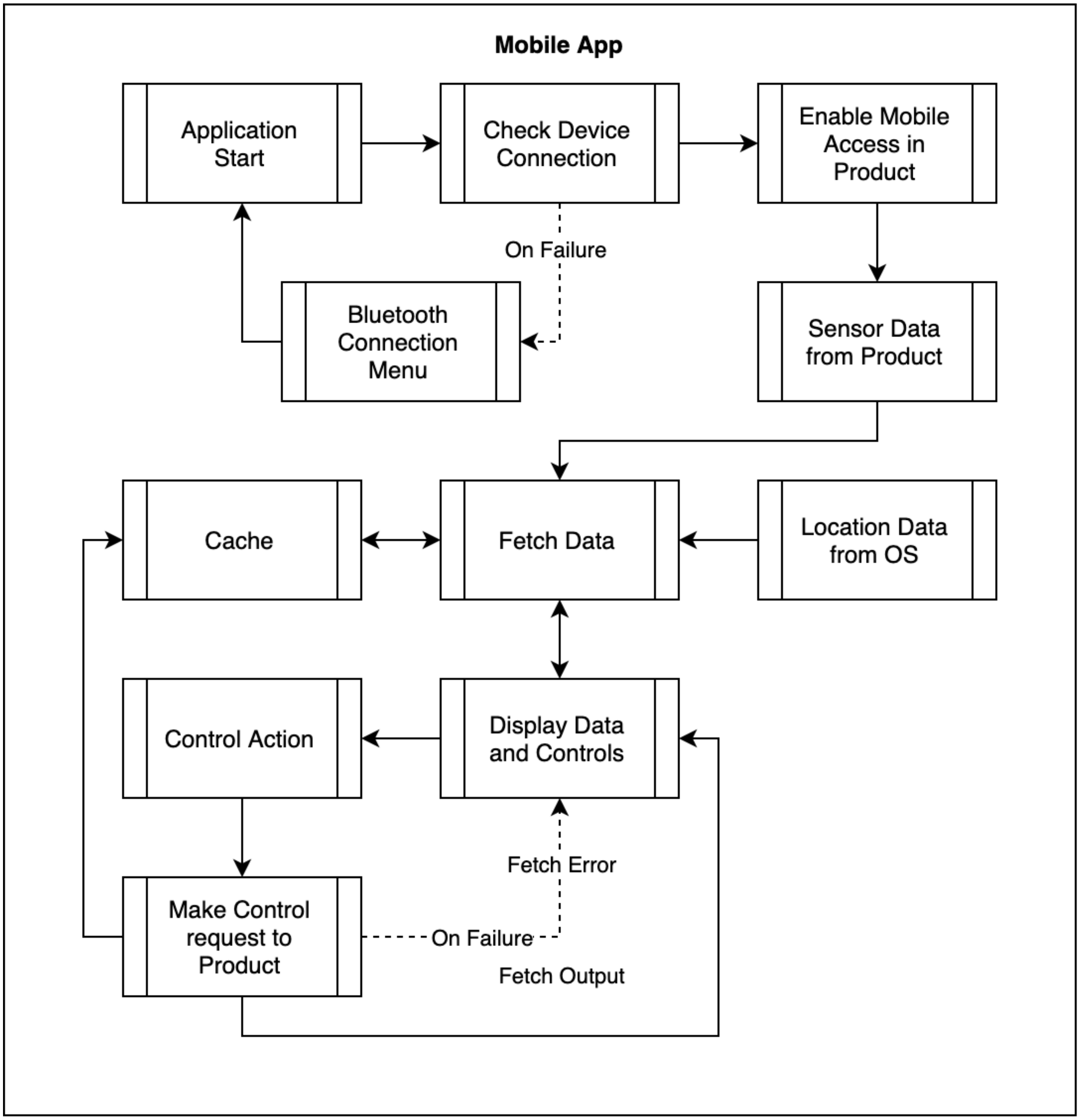

Figure 3: Application-level Software Block Diagram

Note: In figures 2 and 3, the block design approaches are currently being researched and the members administering these blocks are yet to be determined.

Estimated Project Budget

Table 3: Budget

Item	Cost
MCU + case	$30 - $50
Anti-Theft Alarm	$20 - $40
Bike	$0
Smartphone	$0
Turn Signal Indicators	$20 - $30
Wheel motion sensor/ Bike speed sensor	$20 - $50
Buttons + Wires	< $30
Bluetooth module (If not built into MCU)	< $20
Batteries (AA & Li-ion)	$50
TBD/Other	$100
Total	$370

Note: The bicycle and smartphone are the most expensive parts needed, however the project assumes the consumer/user already has these two items.

Finances

Table 4: Finances

Person	Split
Brandon Therrien	25%
Jay Kurczy	25%
Jonathan Diaz	25%
Paul Wilson	25%

Expenses will be split four ways, 25% per person.

House of Quality

Category	Weight	Customer Requirements (Explicit and Implicit) / Engineering Requirements	Lighting	Alarm	Waterproof	Battery life	Rechargable Battery	Backup AA batteries	Bluetooth compatible	Weight	Architecture	Cost	Dimensions		iOS Support	Android Support	RAM usage	Maximum Size
		Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		Direction of Improvement	◇	◇	◇	▲	▲	◇	◇	▼	◇	▼	▼		◇	◇	▼	▼
Battery	6	Fully Charge within 2 hours	●	●		●	●		▽		▽	○						
	8	Continuous Usage (Long battery life)	●	▽	○	●	●	▽	▽		▽	▽					▽	
Access	7	Accessibility							●	▽		●	▽		●	●	○	○
	6	Easily Affixable	●	○	▽		●	▽		●		▽	●					
	6	Portability	●	▽	▽		●	○		●			●					
Features		Bright Lighting	●			○						▽						
		Anti-theft		●	▽			○	▽						▽	▽		
		Solid Build Quality	▽	▽	▽		▽	▽	▽	○			○					
		Target	>= 75 lumens	>= 100dB	IPx6	5-10 hours	2000 mAh	1-4	5.0 LE	<= 2lbs	>= 16-bit	<$400	<= 12"x12"x12"		>= iPhone 8	>= API 28	<= 512MB	<= 1GB

Relationships	
Strong	●
Moderate	○
Weak	▽

Direction of Improvement	
Maximize	▲
Target	◇
Minimize	▼

Initial Project Milestone

	Task No.	Task	Date Begin	Date End	Date Due	Prereq. Task(s)	Status
	1	Finalize Group and Project idea	21-Aug-21	1-Sep-21			Completed
	2	Research and Planning	16-Sep-21	30-Oct-21		1	Completed
	3	Work on "Divide and Conquer 1.0" Document	1-Sep-21	16-Sep-21	17-Sep-21	1	Completed
	4	Meet with Senior Design Professor	20-Sep-21	20-Sep-21		3	Completed
	5	Work on "Divide and Conquer 2.0" Document	20-Sep-21	30-Sep-21	1-Oct-21	2,3	In Progress
	6	Work on Final Project Documentation	1-Oct-21	4-Nov-21	5-Nov-21	5	In Progress
	7	Gather Initially Needed Parts	1-Oct-21	30-Nov-21		3	Upcoming
Senior Design 1 (Fall 2021)	8	Initial Building and Additional Research (as needed)	1-Oct-21	5-Dec-21		3	Upcoming
	9	Layout Physical Specs	5-Dec-21	20-Jan-22		7,8	Upcoming
	10	Build Physical Components (light, alarm, etc.)	20-Jan-22	15-Feb-22		7,8	Upcoming
	11	Build Initial Software Components (app)	20-Jan-22	15-Feb-22		6	Upcoming
	12	Integrate Physical Components with Software	15-Feb-22	15-Mar-22		10,11	Upcoming
	13	Final Testing and Troubleshooting	15-Mar-22	20-Mar-22		12	Upcoming
	14	Finalize Project	20-Mar-22	25-Mar-22		13	Upcoming
	15	Writing Final Report	15-Feb-22	25-Mar-22	2-Apr-22	14	Upcoming
Senior Design 2 (Spring 2022)	16	Writing Website Report	15-Feb-22	25-Mar-22	2-Apr-22	14	Upcoming