Initial Project Document

Situation-Aware Stop Signal

Senior Design 1

Group 3

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Group 3
EEL 4914
09/27/2018

Project Narrative

At the crossroads of one small neighborhood in Orlando lies a small memorial at the corner of a four-way stop. It stands in remembrance of someone's loved one – a neighbor – who lost their life in a fatal accident in that very same place. Every year, in our community and in others, there are a multitude of accidents that occur at small, residential intersections. These are often the result of drivers running stop signs due to visual distraction, the influence of alcohol, and other forms of carelessness. Stop signs have long been important tools for controlling traffic at small intersections, but they are becoming less effective in an age when both traffic and distractions are more present than ever on the road.

Our goal is to design a system that has the potential to change our community – that is, to improve driver safety and *save lives*. We propose a replacement to the conventional "stop sign." We propose a **Situation-Aware Stop Signal**.

The Situation-Aware Stop Signal, influenced by technology used in existing traffic lights and autonomous cars, is designed to be modular and implementable at small intersections currently guarded by stop signs. Using object-detecting technology like RADAR and LIDAR, the Situation-Aware Stop Signal is capable of detecting approaching vehicles and intelligently alerting drivers. Situational awareness made possible by its strategic placement allows the Situation-Aware Stop Signal to anticipate safety-critical events before they occur.

This ability is conducive to a two-part mission for the project:

1. To help drivers stop safely before the intersection
2. To protect drivers from others who may *not* be stopping safely at the intersection

To help a driver stop safely before the intersection, a traffic signal is displayed to alert the driver that he or she is nearing the intersection and needs to stop. To protect a driver from others who may *not* be stopping safely at the intersection, the driver is given a visual alert if cross traffic is detected as coming from either perpendicular direction. This is particularly useful for intersections that are populated with trees and other objects that may obstruct the driver's vision when preparing to cross the roadway.

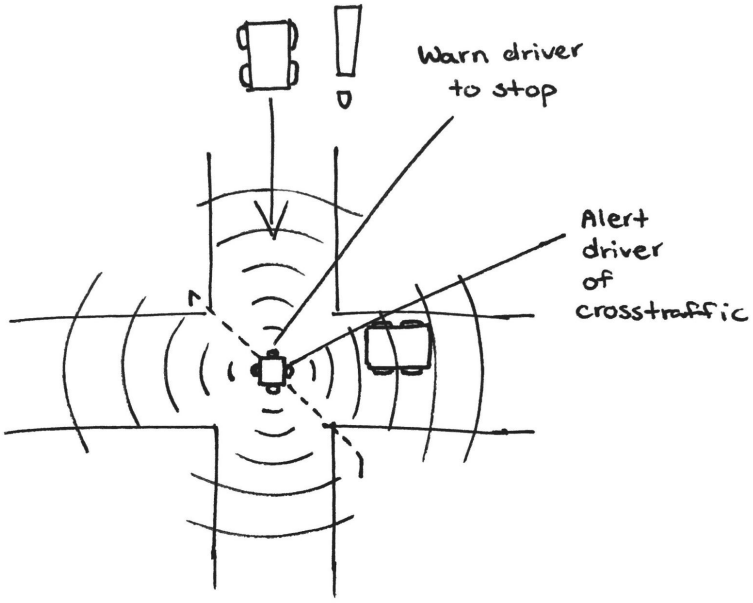

Figure 1: Sketch of idea

In order to achieve this ambitious mission, it is necessary for the product to be accurate as well as self-sustaining. To make itself a candidate for real-world application, the Situation-Aware Stop Signal is designed to use solar power as its primary source of energy. By emphasizing sustainability and low-cost components, we intend to make a device that is appealing to companies and governments as an affordable solution for both private and public roadways.

Currently, the market targeted by this product is dominated by the very low-cost stop sign. Although it brings with it a low price, the stop sign is a primitive product that has changed very little in the last 100 years. With the advances of today's technology, we believe that we can design an affordable alternative with the features needed to ensure a safer community.

Ultimately, it is a safer tomorrow that we hope this inspires. In an age when technology has made its way into some of the most trivial parts of our lives, infinite remain the opportunities to use it in everyday, untouched places with tremendous impacts – especially in those where it has not been widely utilized because of factors like cost and scale. In a day like today, where we go and how we safely get there may be ever-changing as technology becomes more affordable and more compact. This is the platform for the Situation-Aware Stop Signal.

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Requirements Specifications

Product Features

High Priority Functionality:

- The device shall be modular so that it can be placed in whatever orientation is preferable to the user installing the signal
- The device shall signal drivers to stop or yield as needed
- The system shall warn drivers and pedestrians when there is cross traffic present
- The system shall control traffic at intersections to increase traffic flow rates

Low Priority Functionality:

- The system shall have manual control for authorized personnel to control traffic
- The device shall take photos of vehicles that do not stop at the sign
- The device shall display the vehicle's speed
- The system shall display a warning if the vehicles speed is deemed dangerous

Power Supply & Consumption

- System should be supplied by two sources for sustainability
    - Solar panel located on/near the device
    - Internal battery
    - Backup battery
- Internal battery should be charged by the solar panel during the day
- Internal battery should last 12 hours or overnight
- When idle the system should go into low-power mode

Operable Conditions

- Weather resistant so that the system can last in normal outside conditions (IP52)
- Should remain operable between 20℉ and 200℉ (subject to change)

Safety Features

- Lights will warn vehicles but not be distracting enough to cause drivers to cause drivers to take their attention away from the road
- Signals will adhere to Florida road laws and suggestions
- Signals will be visible during the day and night
- In case of software failure or low battery (< 5%) the system should function as a simple stop signal

Accuracy & Tolerances

- Vehicles should be in view of our system between 1m and 50m
- All readings from sensors should be within +/- 5% from their actual value
- Completely false readings outside of that range should occur less than 5% of the time
- Internal battery should always remain in operable condition >2% battery level
- The system should respond to stimulus within 75ms

Constraints

Our project has a few constraints imposed on it, the most important being the laws dictated by the US Department of Transportation which deal with how road signs may be displayed and used in accordance to local and state road laws. Other constraints imposed on our system include budget and processing power. This is reinforced by our need to have high quality sensors as people's lives are at risk and the system needs to be accurate, yet cheap to stay appealing.

The last constraint on our system is size: the product needs to be large enough so that we can mount a solar panel that can produce the correct amount of power to the battery for adequate charging and long term use. Yet, the product can’t be so large that it is difficult to move around or that it fails when windy conditions are introduced.

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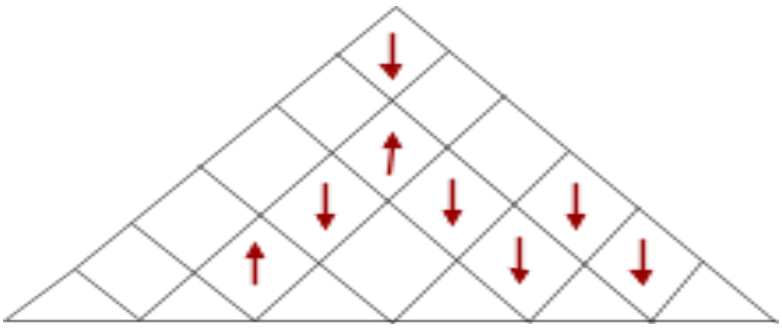
House Of Quality

House of Quality Legend	
Strong Positive Correlation	↑↑
Weak Positive Correlation	↑
Weak Negative Correlation	↓
Strong Positive Correlation	↓↓
Positive Impact	+
Negative Impact	-

Table 2: House of Quality Legend



	Engineering Requirements	Obey Traffic Laws	Low Power Intake	Self Sustained Solar Power	Accurate Sensors	Low Cost	Modular Structure
Marketing Requirement		+	+	+	+	+	+
Regulate Traffic	+	↑↑			↑		
Self Sustained	+		↑	↑↑	↓	↓	
Accuracy	+	↑	↓		↑↑	↓	↓
Low Cost	+		↑	↓	↓	↑↑	↓
Easy Installation	+				↓	↓	↑↑
Efficient	+		↑	↑	↓	↓	
Engineering Requirement Targets		Follows MUTCD standards of DOT Traffic Law (ie presentation placement)	Needs < 20 Watts	Able to store 0.3 Wh per minute	90% Accurate within 25 feet	< $215	Installation ~15 minutes

Table 1: House of Quality

Block Diagrams

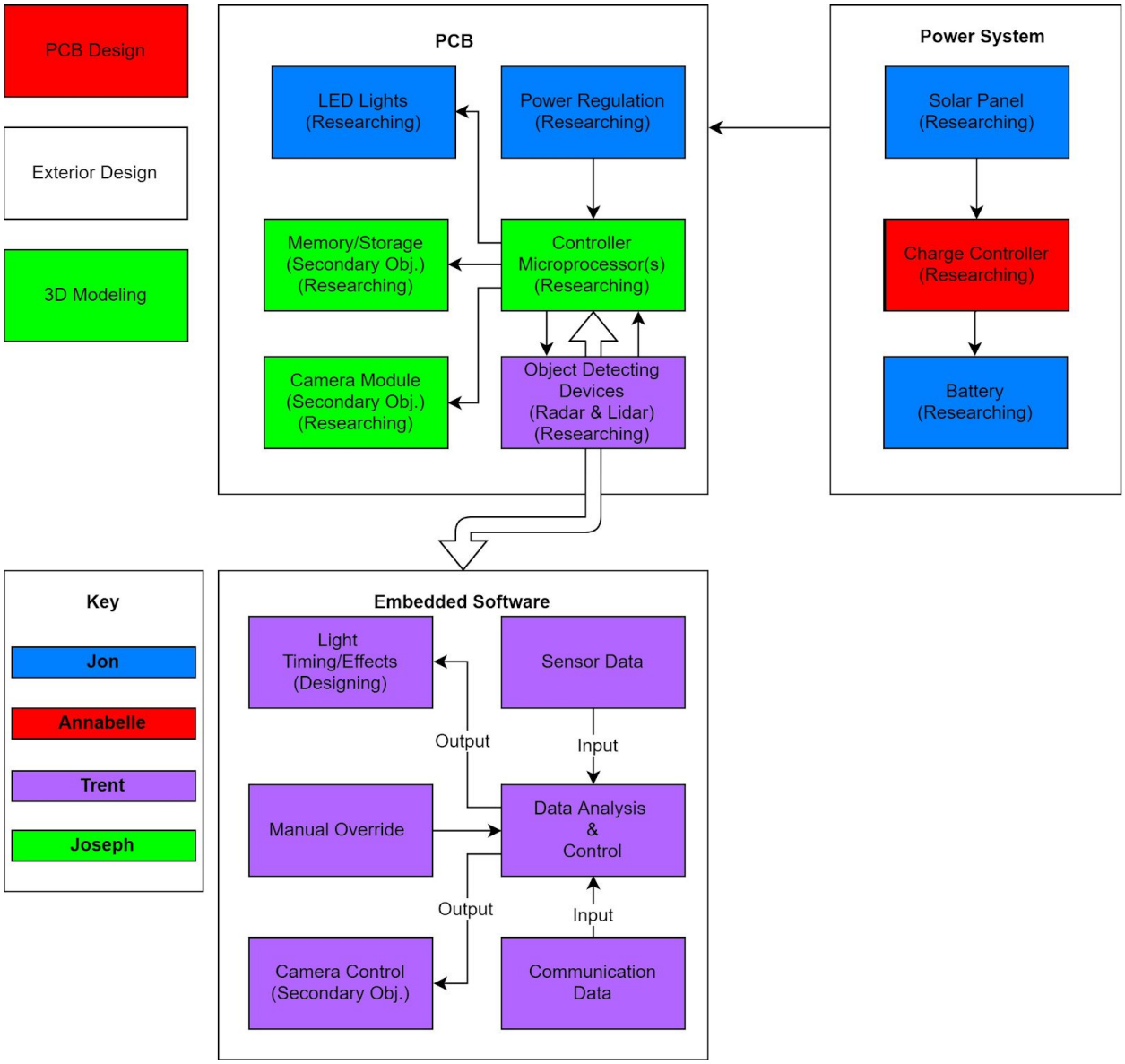


Figure 2: Full Project Block Diagram

Estimated Budget & Financing

We are self-funded, and the current budget is around $1000 (estimate). This project is not incredibly expensive but depending on the technology in the sensors and other components it could be more expensive than we currently anticipate. Also, due to the nature of our design, we need to build more than one functional device so that we may test the wireless communication and cross-traffic warning system.

Estimated Costs			
Part	Quantity	Unit Price	Total Cost
Solar Panel	2	$50	$100
Battery	1	$40	$40
LEDs	1	$40	$40
Microcontroller	1	$10	$10
PCB	1	$20	$20
Radar	2	$33	$66
Lidar	2	$100	$200
Miscellaneous	1	$200	$200
Cost per unit	1		$676

Table 3: Estimated Budget/Cost for Project

Senior Design 1 Milestones			
Objective	Duration	Start Date	End Date
Senior Design Project Idea	1 Week	August 20, 2018	August 24, 2018
Brainstorm Ideas	2 Weeks	August 25, 2018	September 7, 2018
Divide and Conquer	1 Week	September 8, 2018	September 14, 2018
60 Page Draft	7 Weeks	September 15, 2018	November 2, 2018
100 Page Draft	2 Weeks	November 3, 2018	November 16, 2018
Rough Draft	1 Week	November 17,2018	November 25, 2018
Final Draft	1 Week	November 26, 2018	December 3, 2018
Order components	4 Weeks	December 4, 2018	January 6, 2019

Table 4: Senior Design 1 Milestones

Senior Design 2 Milestones			
Objective	Duration	Start Date	End Date
Build Prototype	3 Weeks	January 7, 2019	January 25, 2019
Test Prototype & Redesign	3 Weeks	January 26, 2019	February 15, 2019
Finalize Prototype	2 Weeks	February 16, 2019	March 1, 2019
Peer Presentation	TBD	TBD	TBD
Final Report	TBD	TBD	TBD
Final Presentation	TBD	TBD	TBD

Table 5: Senior Design 2 Milestones