ELEC 4319 - Senior Design Project II

Smart Scooter

Spring 2020

Team Members

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II. Abstract

Electric scooter transportation has become more popular in urban areas of the U.S. With the rise in popularity of scooter usage, the number of safety concerns increases as well. According to a new Rutgers University study, the number of incidents climbed from 2,325 in 2008 to 6,957 in 2018. A staggering 66% of those treated were not wearing helmets. Through surveying the major stakeholders Lyft, the Auraria Campus Police Department, and students, the top concerns decided collectively by our group are: obstacle detection, helmet requirement, and speed restriction.

This project focuses on using current technology to increase the safety of scooter transportation in urban areas. Increasing scooter transportation safety includes making it safer for the rider and for the pedestrians around the rider. To make it safer for the rider, we want to require the rider to wear a helmet. The helmet will assist the rider in identifying obstacles. It will have a LED on the left and right side to the helmet. The LED will light up if an obstacle is detected. This feature will help the rider make better decisions when operating the scooter.

III. Design Process

a. Methodology

i. Affinity Analysis

Economic

- Cheaper than other transportation
- Profitable
- Easy maintenance
- Doesn't break easily
- Sustainable

Leisure

- Fun to use
- Fast
- Seating

Personal needs

- Include cup holder
- Charger for phone
- Basket
- Helmet
- Loud bell
- Phone holder

Environment

- Reduces traffic
- Less CO2 emission
- Saves gas

Safety

- Auto braking
- Safe for environment
- Sensor limits speed
- Safe for pedestrians
- Tires for all seasons
- Sensor to call peramedics

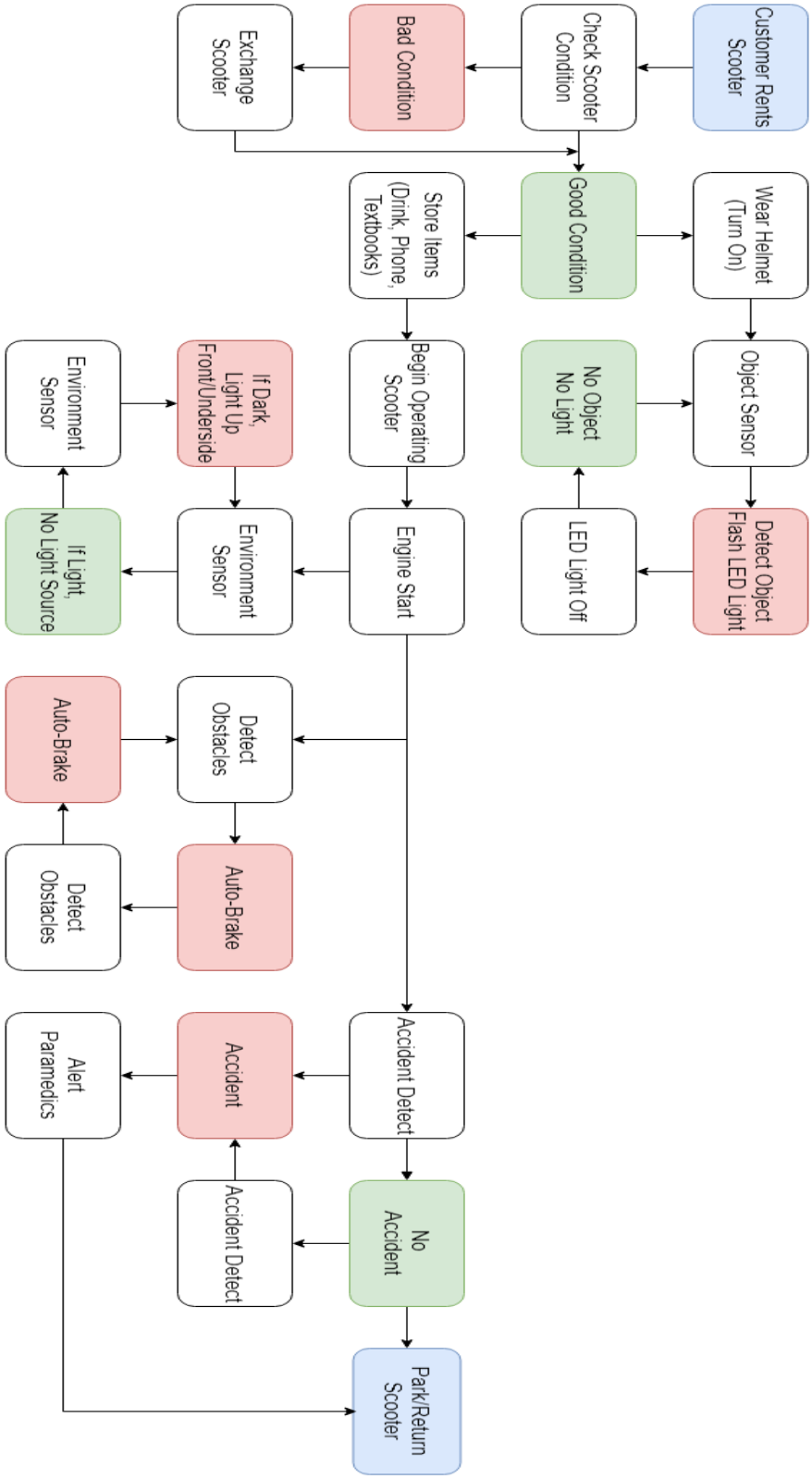
Flexibility

- Easy access
- Easy to ride
- Include lights for night driving

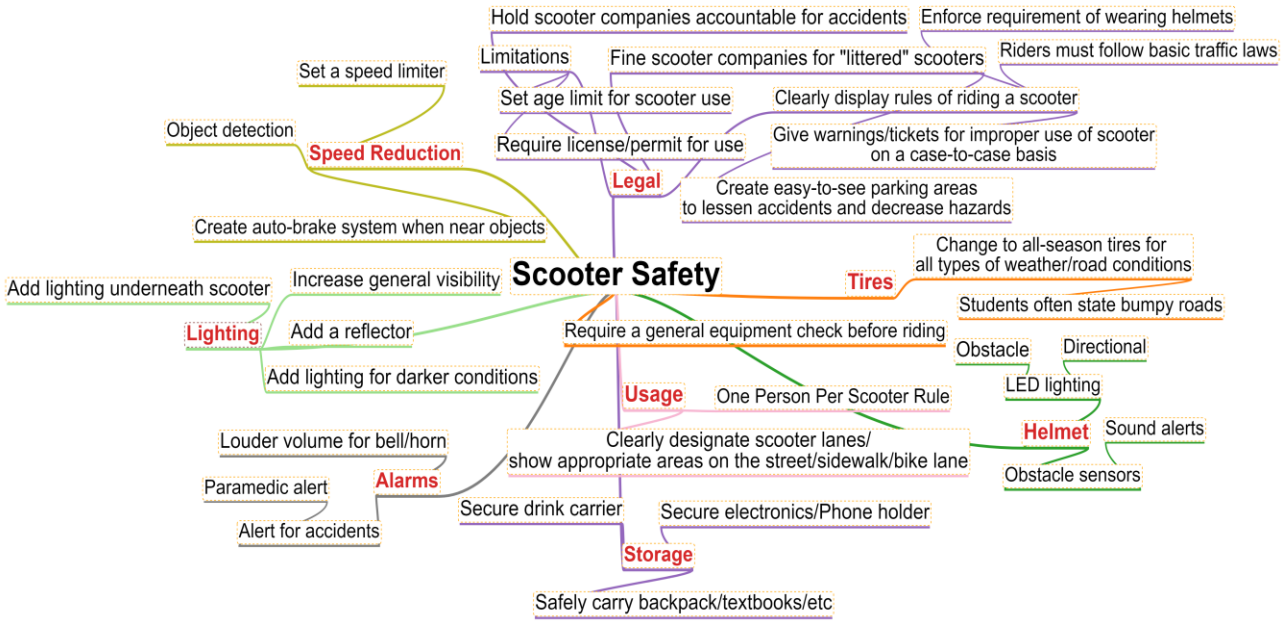
Top 10 Customer Needs

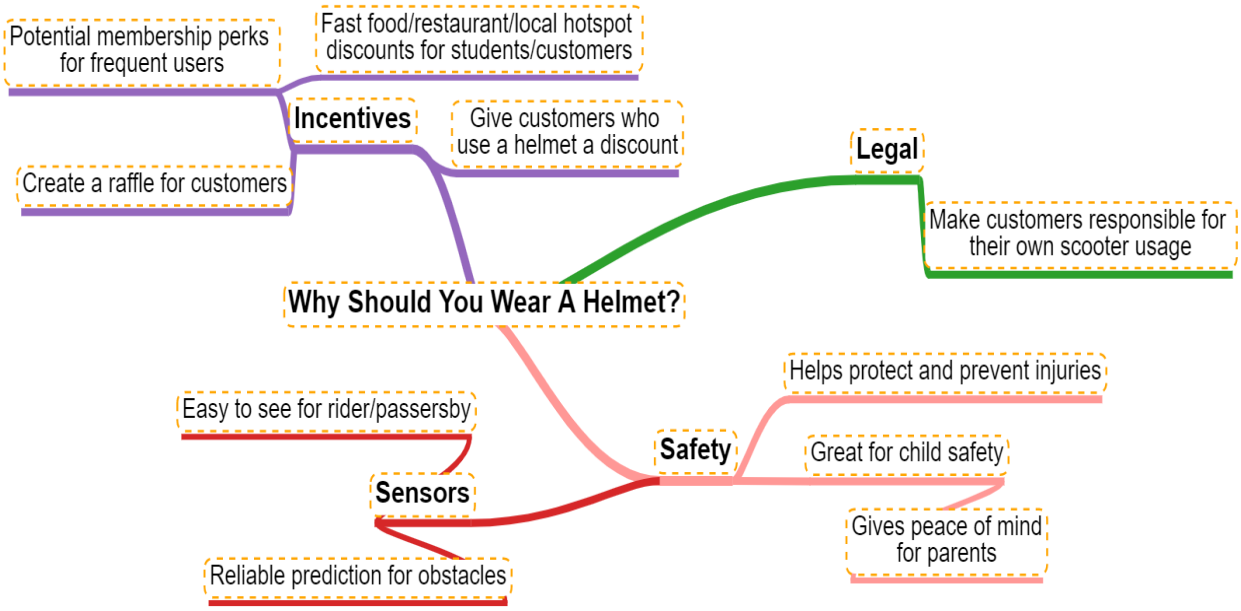
- Helmet
- Speed reduction
- Lights for night driving
- Warning Sensor for paramedics in case of accident
- Basket for personal items
- All-Season tires
- Portable charger for phones
- Louder Bell Horn
- Coffee/Drink Holder
- Lighting underneath the scooter

ii. Journey Map

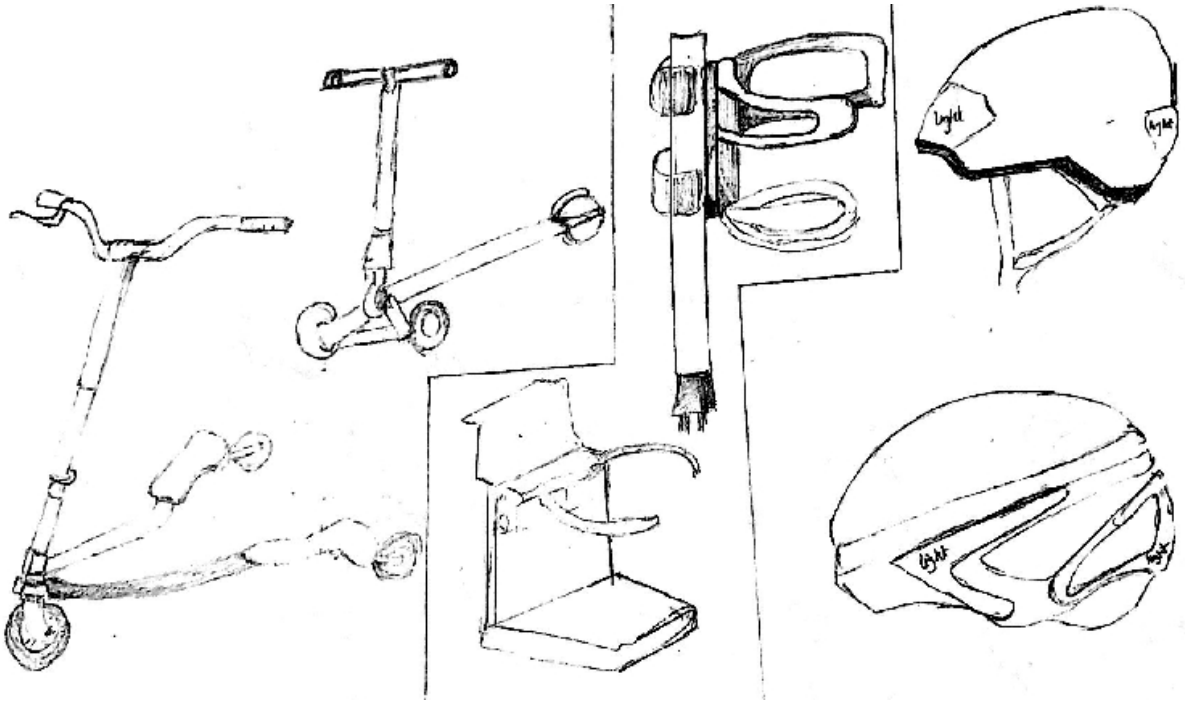


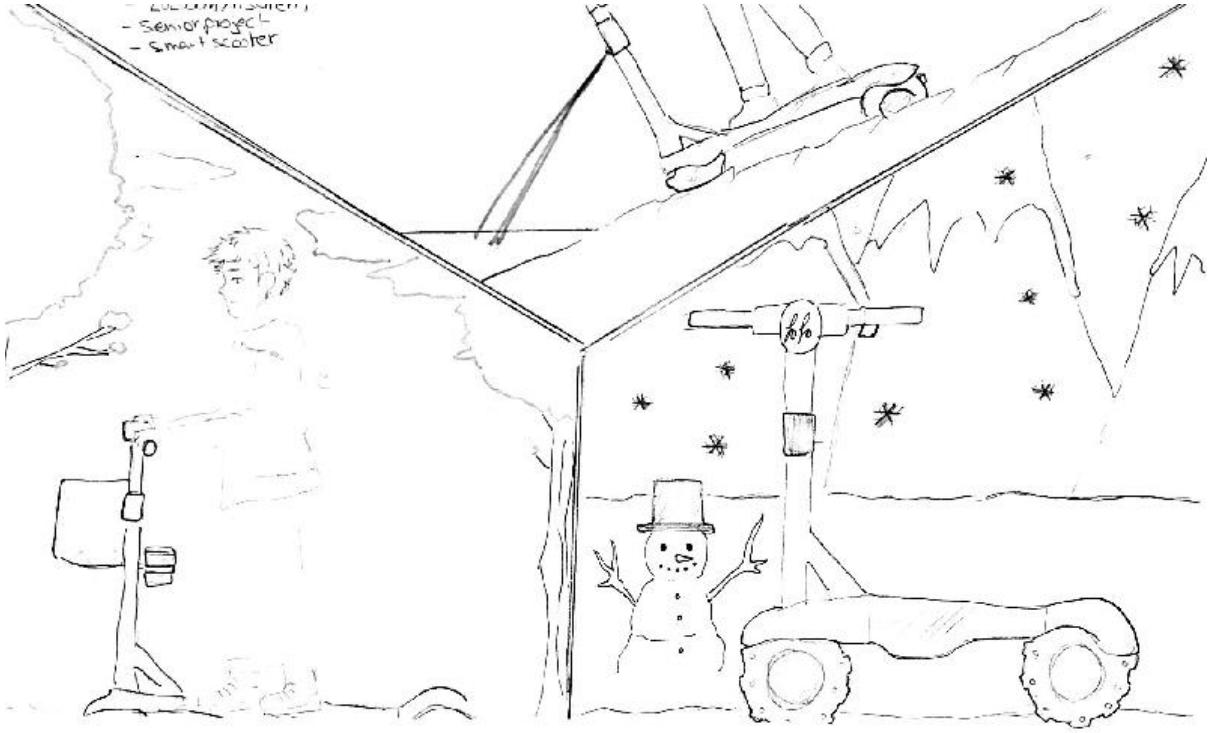
iii. Mind Maps





iv. 6-3-5 Output





b. Constraints

- Affordability (stay within the Senior Design budget)
- Semester time constraint

c. Specifications

i. Design requirements

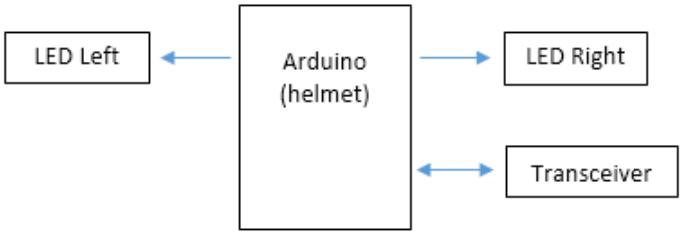
- Create a helmet to detect obstacles. LEDs on the helmet will indicate if an obstacle is present.
- Detecting obstacles within a range of 50cm.
- Wireless connection between the helmet and scooter able to transmitting/receiving data within 5 meters.

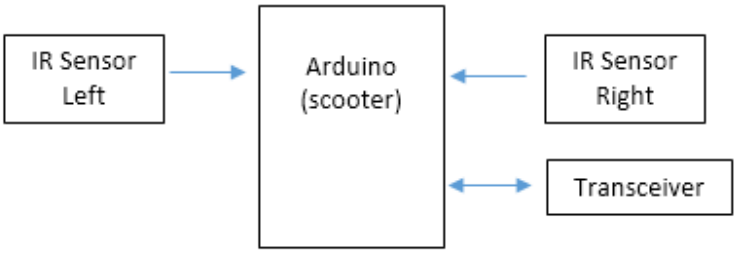
ii. Parts list

Part	Quantity	Unit price	Total price
Arduino Uno Starter Kit	1	30	30
Arduino Uno	2	15	30
IR Sensor	2	13	26
Transceiver (NRF24L01)	2	2	4

IV. Engineering Documents

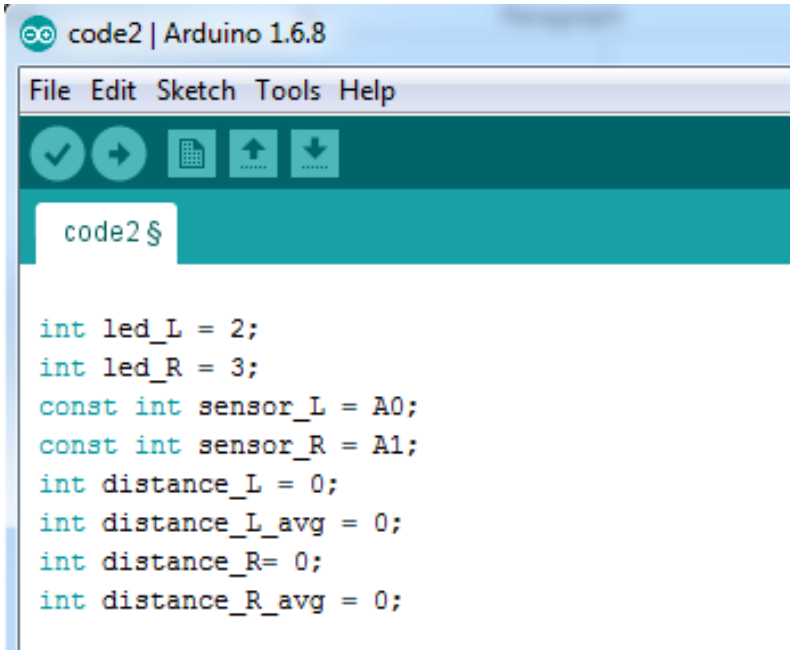
a. System Block Diagrams



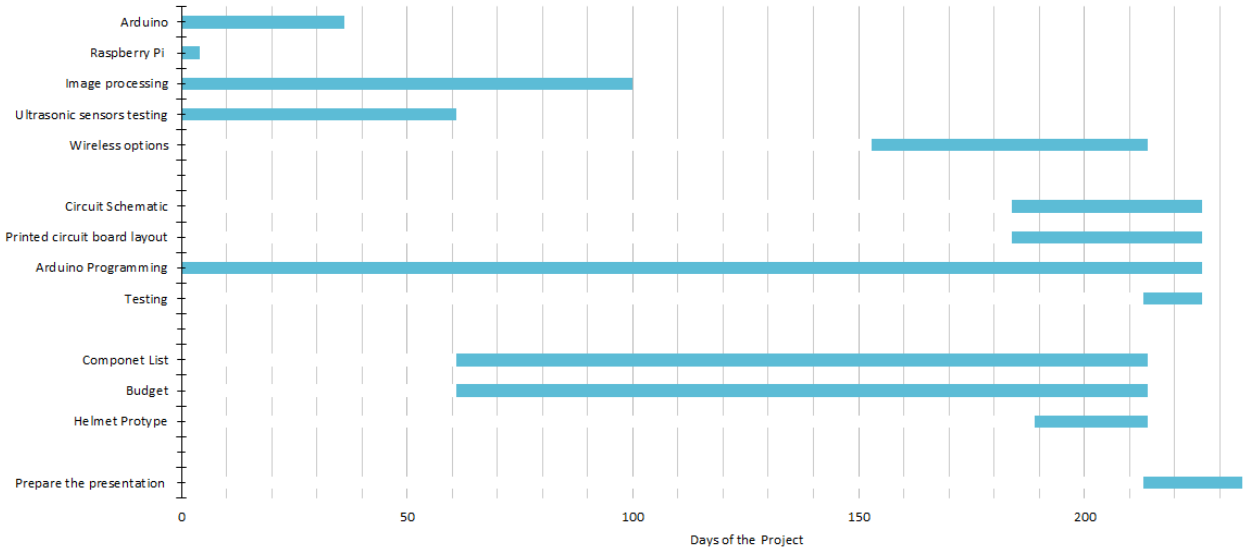


a. System Software

Screen shot of Arduino software

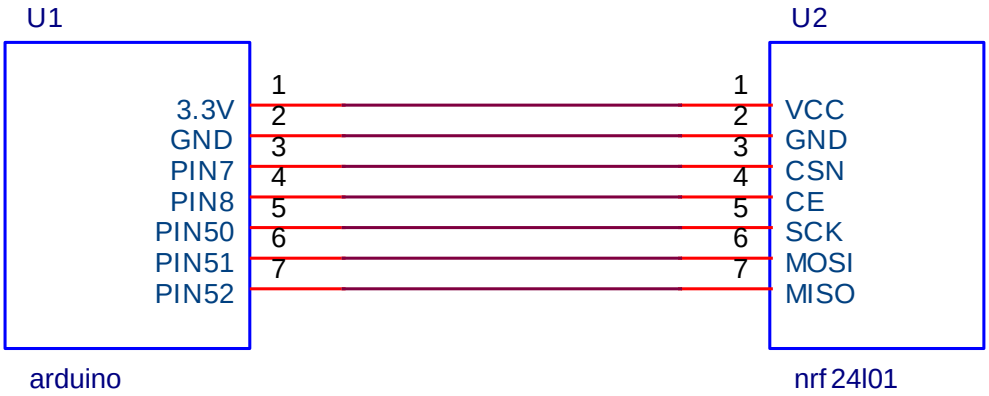


b. Gantt Chart



V. Computer Design Tools

Sample schematic for connecting the NRF24L01 to the Arduino using ORCAD's PSPICE.



VI. Patent and Standards Research

a. Research related to design

Object detection has become a common function nowadays through many devices, such as security cameras for example, so the idea for adding sensors to a helmet wouldn't be unheard of. Many things use sensors to detect movement for many purposes, but the main focus of this project is for security and safety that detection would bring. The idea for adding obstacle sensing capabilities to a helmet adds more uniqueness to its overall function. There are countless other patents for sensors and helmets with various purposes, including some that match the functions included in this project. Many existing patents involve the use of sensors and lights to notify the user of incoming objects both inanimate and living.

b. As low as 9,000 and up to 430,000+ similar patents searched through https://www.google.com/?tbm=pts with keywords "infrared sensor object detection helmet speed reduction"

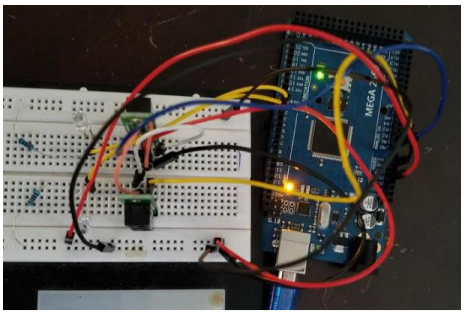
Patent Number	Title	Description
US8884229B2	Passive infrared range finding proximity detector	detect infrared radiation emitted by objects within a detection area
CA2123296C	Passive type moving object detection system	detection regions for monitoring a human intruder and a row of detection regions for detecting a non-human intruder
WO2017018825A1	Infrared object detecting module and side view mirror	emits infrared rays and uses reflected light from the emitted infrared rays to determine whether an object is present
EP2732440A2	Method and system for people counting using passive infrared detectors	detecting an object transiting an interrogation zone of an electronic article surveillance ("EAS") system and determining whether the object is a person entering or exiting the facility
US7259658B2	Passive infrared sensor and obstacle detection system used in the same	detects the presence of an intruder in a security area by receiving the infrared light that the intruder emits
US8194920B2	Method and system for detecting objects using far infrared images	a far IR sensor operable to sense thermal radiation of objects and surroundings in a field of view

US9457709B2	Bicycle helmet with an adaptive light notification system that varies brightness Abstract	adaptive light notification system and method for activating turn signals using sensors

VII. Proof of Concept

a. Obstacle detection

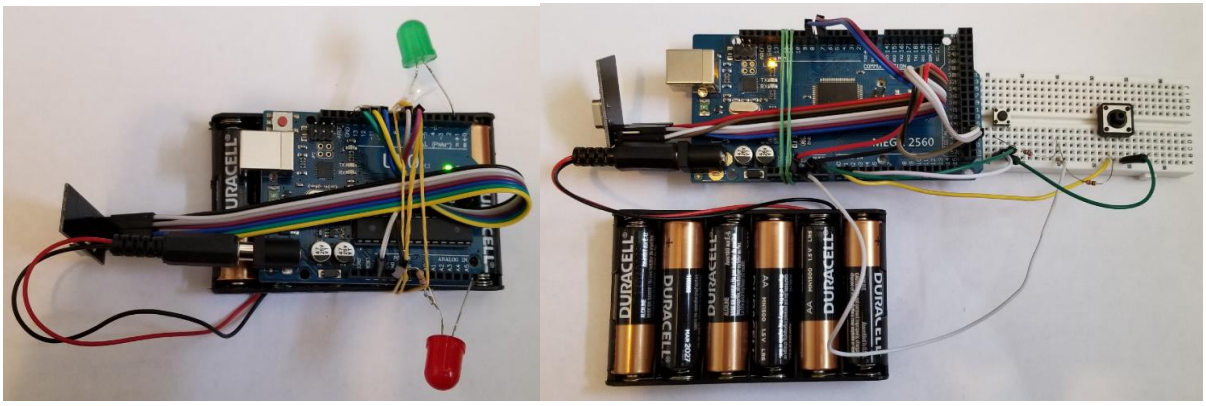
To detect obstacles, we will be using two infrared sensors connected to the Arduino. The infrared sensors will tell the Arduino if an obstacle is present and the Arduino will light a LED accordingly to report to the user. The sensor's accuracy is dependent on the obstacles distance away from the sensor. We want to accurately detect obstacles that are within 50 cm of the scooter. A prototype was created to test the accuracy of the sensor, see Figure 1. We had a person walk pass the sensor 20 times at a distance of 50 cm from the sensor. We recorded how many times the sensor detected an obstacle. This was done again at a distance of 100 and 150 cm. The results are provided in Table 1. The results indicate that the sensor detected every obstacle provided when it was within 50 cm of the sensor. This test proves that our obstacle detection system is functional.



Range	Number of Detections	Error
50 cm	20/20	0%
100 cm	18/20	10%
150 cm	10/20	50%

b. Wireless communication

Since the infrared sensors are mounted on the scooter and the LEDs are mounted on the helmet, we need a way for the scooter and helmet to wirelessly communicate. A low cost transceiver (NRF24L01) was chosen for this and a prototype was created to test its accuracy. The prototype consists of a transmitter and receiver, see Figure 2. A push button is connected to the transmitter and a LED is connected to the receiver. The system is set up so that the LED will light up when the button is pressed down. We first placed the transmitter and receiver 5 meters apart and repeatedly pressed the button 50 times. We recorded how many times the LED lite up. This was done again at a distance of 6 and 7 meters. The results are provided in Table 2. The results indicate that the wireless communication was 100% accurate when the transmitter and receiver was within 5 meters. This test proves that our wireless communication system is functional.



Distance	Correct data transmission / total transmission	error
5 meters and less	50/50	0%
6 meters	41/50	82%
7 meters	32/50	64%

VIII. Marketing Brochure

Ride safely without the worry of bumping into anything!

The Smart Scooter helmet will detect things from afar and warn you before you go crashing into something! Ride with the confidence and safety of a helmet today!

Smart Scooter

Senior Design Project 2020

Don't risk injury!

- With the Smart Scooter helmet, you and others will know about any incoming traffic.
- Bright LED lighting built into the helmet will let everyone know what's to come!

The Smart Scooter helmet has a long-lasting battery and fucntions simultaneously with the scooter system.

Product Capabilities

- Bright LED lights on both sides of the helmet
- Infrared sensing technology to detect objects from afar

How the helmet works

1. User will put on the helmet.
2. User will ride a scooter and eventually have incoming traffic.
3. The Smart Scooter helmet will detect an obstacle or object way ahead of the User.
4. The lights on the helmet will turn on depending on the direction fo the obstacle.
5. User will be aware of the incoming obstacle or object and will maneuver the scooter accordingly.

This helmet helps protect you from harm and prevents bad accidents!

"Since these new helmets were introduced, there have been significantly less major accidents between riders and drivers."

-Auraria Campus Police Department

"The Smart Scooter helmet is a step in the right direction for everyone. Accidents happen, but with this helmet, things are not as bad as before."

"With the implementation of safety helmet usage, there has been a huge drop in number of scooter-related accidents. Everyone should be using these helmets and be staying safe."

THE DENVER POST

IX. Project Design and Implementations Task and Responsibilities

TASK NAME	START DATE	END DATE	START ON DAY*	DURATION* (WORK DAYS)	TEAM MEMBER	PERCENT COMPLETE
Research						
Arduino	8/20	9/24	0	36	Nasser	100%
Raspberry Pi	8/20	8/23	0	4	Lulwah	100%
Image processing	8/20	10/25	0	100	Saud	100%
Ultrasonic sensors testing	8/20	11/27	0	61	Nasser	100%
Wireless options	1/20	3/20	153	61	Duyen	100%
Design						
Circuit Schematic	2/20	4/1	184	42	Nasser	100%
Arduino Programming	8/20	4/1	0	226	Lulwah/Saud	100%
Testing	3/20	4/1	213	13	Duyen	100%
Electrical Part						
Componet List	10/20	3/20	61	153	Lulwah	100%
Budget	10/20	3/20	61	153	Duyen	100%
Helmet Protype	2/25	3/20	189	25	Saud	100%
Patent and Presentaion						
Prepare the presentation	3/20	4/10	213	22	Duyen	100%