Driver Safety System

Final Project Design Document

Ahad Maqsood

924003505

Department of Computer Science and Engineering

Texas A&M University

CSCE 462

Dr Liu

April 30th 2020

Table of Contents

1. Problem Statement & Goal

Our society today has a dependency on advancing technology to improve our way of life as well as the lives of other individuals. We as a human race have made a lot of advancements in technology over the past century ranging from computers, cell phones to high-tech features in cars. However, the pace of advancement of technology has not caught up much in terms of vehicle safety as of yet. Despite having made advancements in vehicle dynamics, speed and fuel efficiency; not much has been done to improve driver safety over the past many years. While it is true that the cars are now equipped with new systems such as cruise control, navigation and many other features, there is however, no system that can actually prevent the vehicle from collision as of yet.

My project aims to provide enhanced vehicle safety features to the general population of drivers which will reduce vehicle-related accidents and save lives. According to the National Highway Traffic Safety Administration, there are more than 800,000 blind-spot-related accidents every year, about 300 of which result in fatalities. In addition, roughly 2 million rear-end collisions take place in the United States each year and result in about 1,700 deaths and 500,000 injuries.

To achieve the required level of safety, I have implemented a scale model driver assistance system that would include adaptive cruise control (ACC), front collision prevention (FCP), rear collision prevention (RCP), safe exit assist (SEA), and blind-spot assist (BSA). The adaptive cruise control feature will detect if a vehicle in front of the driver is traveling significantly slower and assist the driver by adjusting the vehicle speed to maintain a safe following distance. The front collision prevention feature will detect if the driver is accelerating at an unsafe speed towards a vehicle in front of it and bring the driver to a stop to prevent a rear-end collision with the front car. Similarly, the rear collision prevention feature will detect if a vehicle is accelerating at an unsafe rate towards the driver and alert the driver with audio and visual cues to prevent a rear-end collision. The blind spot assist feature will detect if a vehicle is in either of the driver's blind spots and steer the car away from the potential accident and prevent a side-impact collision. I have designed each feature to use ultrasonic sensors, each with an effectual angle of less than 15°, to detect the distance between the driver and the area of interest.

2. System Software and Hardware

The adaptive cruise control uses an ultrasonic sensor at the front of the driver's vehicle to measure the distance between the driver and a vehicle in front of them. The ACC engages when this distance measured is less than or equal to two times the driver's vehicle length. At this point, the ACC will take another measurement every 0.2 seconds and keep track of the current and previous measurements as well as their difference. If the current distance measurement decreases to three halves of the driver's vehicle length, the driver's speed will be decreased to the speed of the vehicle in front. If the current distance measurement increases, then the driver's vehicle will increase speed up to a max of the initial user set speed and will open the distance between vehicles. This cruise control speed setting will be maintained so the driver can maintain a safe driving distance until they decide to turn it off.

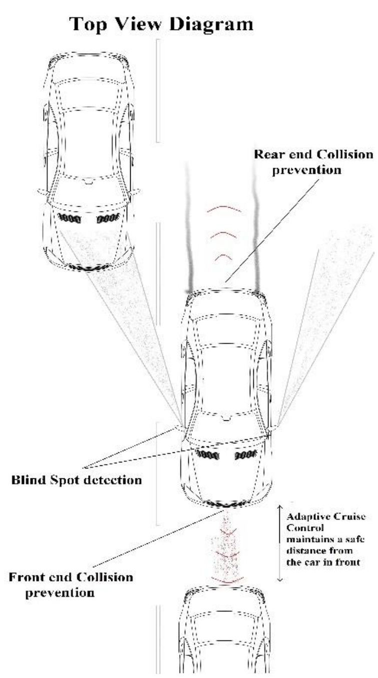

Fig. 1.0: Top View Design Diagram

The front collision prevention feature uses the same ultrasonic sensor at the front of the driver's vehicle to measure the distance between the driver and a vehicle in front of them, similarly to the ACC feature. The FCP will engage when the vehicle in front of it is still or relatively slow (speed ≈ 0) which is indicated by the difference of the measured distances being equal to the distance the driver traveled within range of 5 mph: $d/dt = dD \pm 5$. In this case, the driver's vehicle would be forced to brake to a complete stop when the measured distance is equal to about 2 cars length, which I have set it to the amount of 20 inches in this case. This will ensure the driver has enough time to come to a full stop and maintain a safe distance from the vehicle in front of them. The rear collision prevention feature works the same way as the front collision prevention feature. The key differences in implementation are as follows. The ultrasonic sensor at the rear of the vehicle is used to measure the distance between the driver and the vehicle behind them. The RCP will engage when the vehicle behind the driver is approaching too quickly. This is indicated when the speed of the vehicle behind the driver is greater than the speed of the driver and the distance between them is less than dR. In the case where the car is at a halt while the rear car is approaching fast, the car will accelerate in order to avoid the rear end collision. However, the system will not engage if there is already a car in front of it in order to prevent another frontal accident.

The blind-spot assist feature uses two ultrasonic sensors, one on the driver's side and the other on the vehicles on the right or left to the rear-view side mirrors, to detect if there is a vehicle in the driver's blind spot. The placement of these sensors will allow detection of a vehicle anywhere in the driver's blind spot because the length of the vehicle will always be large enough to detect at least part of it, despite the narrow effectual angle of the sensors. In case if the car in the next lane comes too close to it, the system will allow the car to steer it away from the potential accident. This is done by increasing the speed of left two DC Motors if the car is on the left side or increasing the speed of right two dc motors if the car on the right side gets dangerously too close to this vehicle.

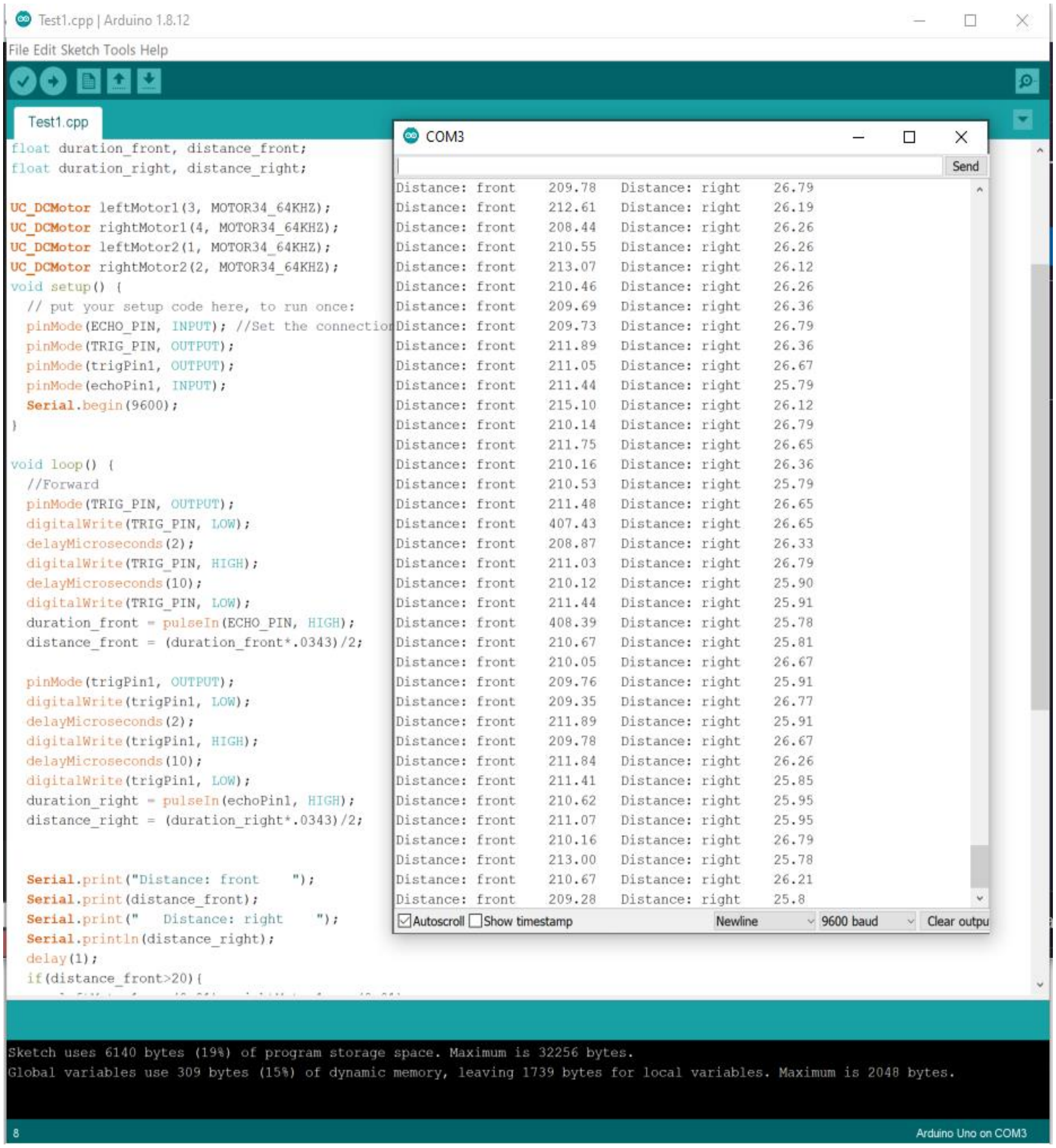

Figure 2.0: Data generated from Ultrasonic sensors. This is the distance measured by these Ultrasonic sensors. The data is gathered every 0.2 seconds

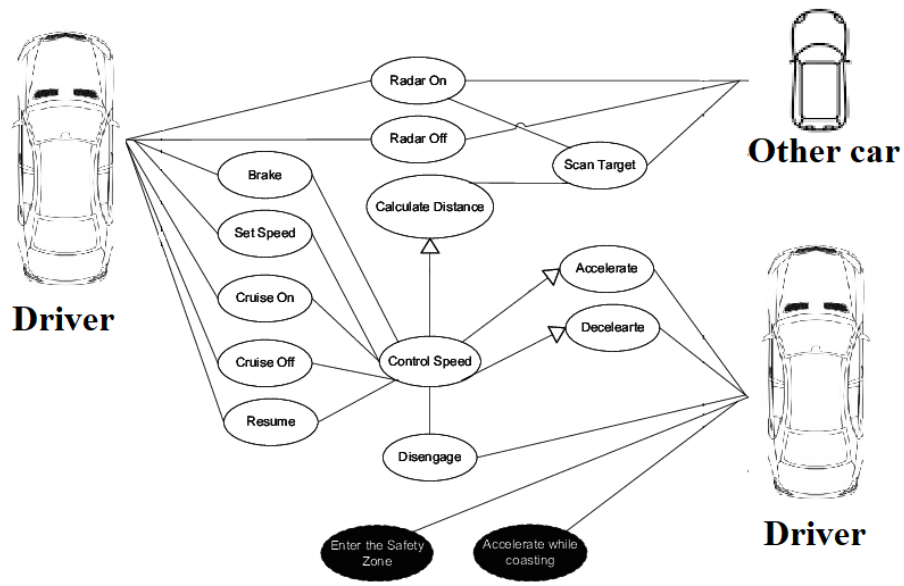

Figure 2.0: Design View Of the Safety system

This Vehicle consists of 4 DC motors; one for each wheel. This gives the vehicle more control over the situation in order to steer away from potential accident. Also in order to operate by itself, this will require the battery source. For this, two 3.7 volt batteries are attached to the Arduino chip for power supply. Further more it will require 4 ultrasonic sensors that are attached to the Arduino board.

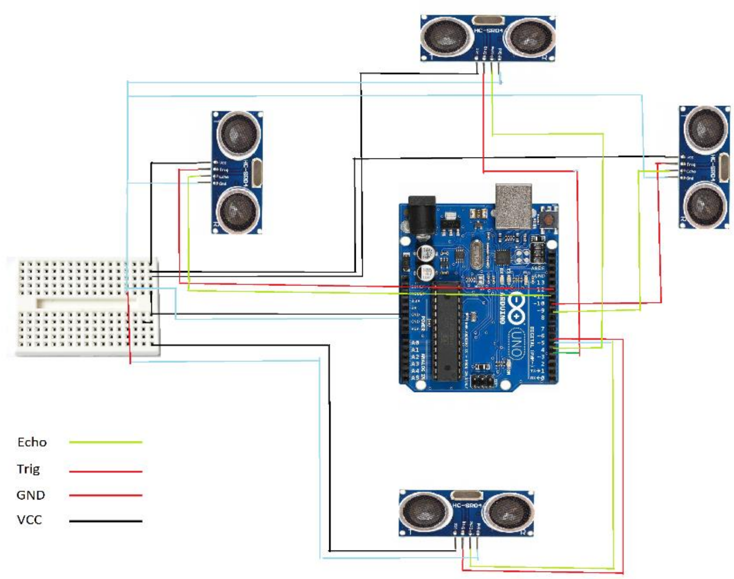

Figure 3.0 Schematics of 4 Ultrasonic Sensors attached to Arduino

3. Power Analysis

Since the car is mobile and needs to power DC Motors, it will need a high-powered battery to move it at a good speed. For this two 3.7V batteries are attached to the system in order to run it smoothly. The Ultrasonic sensors are attached to the 5V VCC on Arduino board and require the current of 15mA. Going by the calculation of current, the Arduino itself would require the Power = 7.4v * 46.5mA = 344.1 mW.

4. Bill of Materials

Product	Price	Shipping
Arduino Starter Kit	$38.99 + $3.22 tax = $42.21	Amazon: Free one-day delivery with Prime
4 Pcs Ultrasonic Sensors	$18.96 + $1.64 tax = $21.60	Amazon: Free two-day shipping with Prime
Robot Car Kit	$49.99 + $4.12 tax = $54.11	Amazon: Free three-day shipping with Prime
Total	$108.44 + $8.98 tax = $117.92	Amazon Prime: Free one to three-day shipping

5. Challenges

One of the main challenges I faced were due to Covid 19 pandemic. Being in the military, the pandemic made it hard for me to fully put implement the design according to the planned schedule. On top of that, two of my Teammates dropped out of the course due to safety concerns. This left me being the only one left to take charge of the whole project. These all circumstances combined put extreme pressure on me but I was able to cope to the challenges and proceeded to finish the product as intended.

6. Timeline

Week	**Tasks**
Week 1 March 30th	Parts Ordered
Week 2 April 2nd	Parts Received
Week 3 April 06-10th	Begin Soldering DC Motors/Dry Test motors with Arduino
Week 4 April 13-17th	Arduino/Motors attached to Chassis, Wheels attached to DC Motors
Week 5 April 20-24th	Car Ready, Final coding changes/Testing
Week 6 April 27-30th	Final Documentations

7. Future Steps

This product has a lot of potential if utilized properly. After this semester, I intend to keep this car and turn it into a full autonomous vehicle that can avoid obstacles. The car will be able to navigate on its own through the maze. I had initially planned on implementing some extra additional features but was unable to do so due to unforeseen circumstances. I am positive that if given enough time, this will turn into something with a lot more potential.

8. Demo Video and other references

https://drive.google.com/open?id=17mDgg5h1cHIW1wvVl5oGFqeEx-MVBp7n

https://drive.google.com/drive/u/1/folders/1mocHN4biuTr1Mih2kHDzPSgJbzgeFSsV