Senior Design
Final Design Report

Driver 2.0

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ChaoYang Zhu
Chunjie Pan

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Project Description

Abstract

Billions of people drive on the road with no assistance from smart devices to aid them, resulting in a continuous increase in crashes over the decades. Our project aims at creating a simple device that uses computer vision and machine learning to detect distracted drivers and conditions on the road. This will decrease the probability of crashes, as well as increase the awareness of the driver.

Team Members

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Faculty Advisor

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Inadequacy of Current Solutions

There is no device that currently out there that detects objects, tired drivers, and road signs for drivers. There are currently only advanced cars that cost an additional hundreds of thousands of dollars that have sensors and cameras built in the vehicle. Not everyone can afford expensive vehicles, therefore a device that can detect and notify dangerous objects and distractions on the road will reduce the likelihood of a crash along with increasing the safety.

Problem Statement

There have been millions of distracted drivers and car crashes over the years. Car crashes are continuously increasing, and the issue is with drivers that are not aware or distracted. We need to find a solution that everyday drivers can utilize instead of buying a completely new vehicle.

Statistics

- Average of 6 million car accidents in the U.S. every year
- More than 1.5 million people in the US are injured every year in car accidents

The table below shows the crashes from 2008 - 2017. The increase in drivers and vehicle purchases illustrate the inadequate technology in vehicles.

Year	Fatal	Injury	Property damage only	Total crashes
2008	34,172	1,630,000	4,146,000	5,811,000
2009	30,862	1,517,000	3,957,000	5,505,000
2010	30,296	1,542,000	3,847,000	5,419,000
2011	29,757	1,530,000	3,778,000	5,338,000
2012	31,006	1,634,000	3,950,000	5,615,000
2013	30,057	1,591,000	4,066,000	5,687,000
2014	30,056	1,648,000	4,387,000	6,064,000
2015	32,539	1,715,000	4,548,000	6,296,000
2016	34,748	2,116,000	4,670,000	6,821,000
2017	34,247	1,889,000	4,530,000	6,452,000

Credit for Statistics

Background Skills and Interest

Background Skills: We have experience in full-stack web development, computer vision, and deep learning.

Interest: We are interested in adding to our skill sets and are looking forward to learning more about applications using Computer Vision.

Approach, Goals and Expectations

Primary Goals

- Create/Utilize devices such as Raspberry PI
- Utilize camera feed data to detect objects, drivers swaying, and road signs to enhance the drivers' safety
- Create an interface to help drivers in all conditions

User Stories and Design Diagrams

User Stories

- As a driver I want to be able to utilize the device to enable smart detection of dangerous road objects and conditions.
- As a passenger, I want to be able to help navigate and aid the driver using the device and ensuring that that the driver is aware.
- As a device owner, I will be able to utilize the advanced modeling that detects driver swaying and fatigue, as well as road sign detection.

Design Diagrams

Diagram 1:

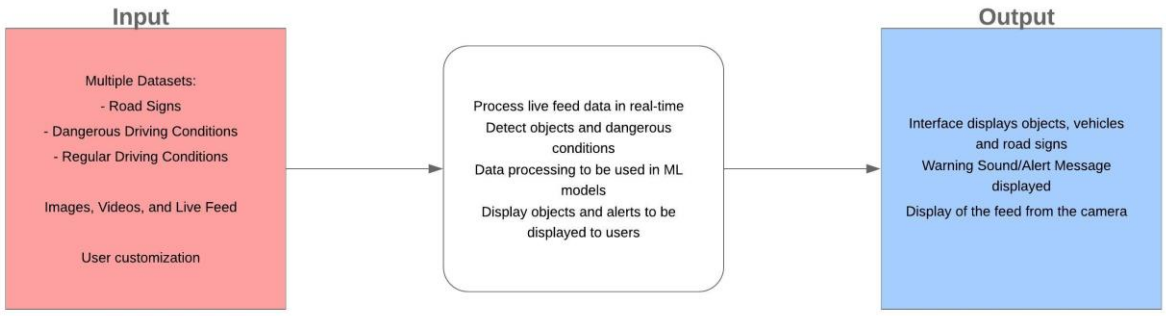


Diagram 2:

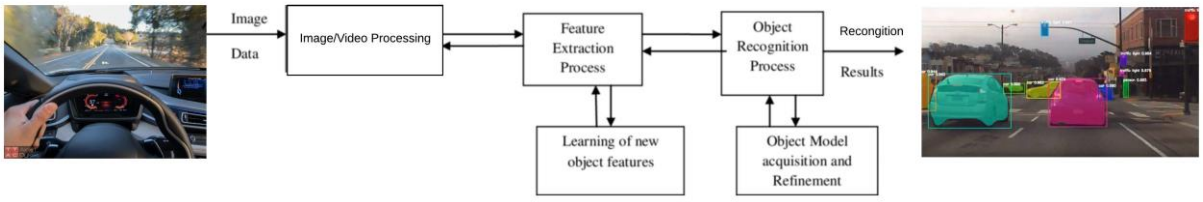
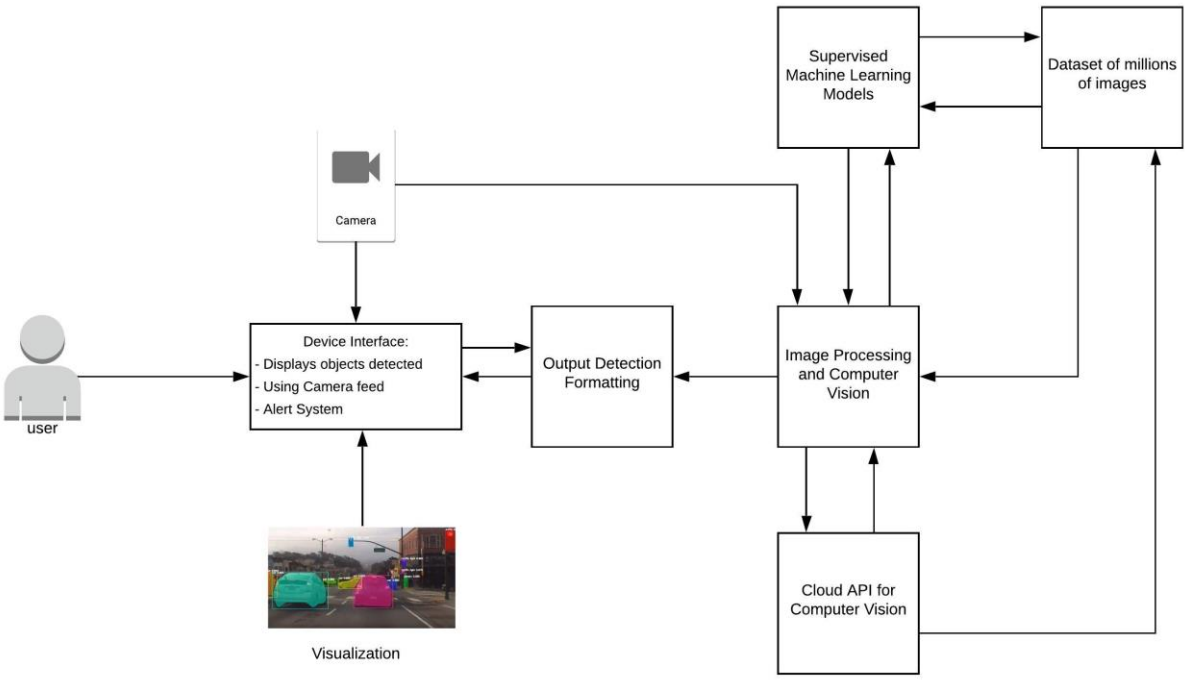


Diagram 3:



Design Description

Diagram 1:

- High-Level Design of the Input Layer, Computer Layer, and Output Layer.
- Able to illustrate the overall system design that will take place.
- Includes the amount of data, computation through ML models and output to the interface.

Diagram 2:

- A more concrete diagram illustrating from the user perspective.
- Illustrates the computer layer further.
- We will feed live feed road data into our image processing program that will be able to detect and use the ML models to output warnings to the user.

Diagram 3:

- An in-depth look at the internal system of the ML models and Computer Vision.
- The diagram will illustrate what the user should get back to the interface based on the computer layer.
- The diagram illustrates the different components of the machine learning model that will be used to first learn and then process the live feed data back to the user.

Test Plan and Results

1. Overall Test Plan Strategies

First, we will test the system components individually. We will use several different types of tests to ensure the high recognition rate and fast recognition speed. For example, we will use black box testing to see whether our project performs normal and output correct result or not. We will also perform functional tests to ensure that the user interface follows the technical specifications document. We will use abnormal and boundary tests to make sure the program is reliable. Will have performance tests to make sure the performance meet requirement.
Second, we will test the entire system in a real-life environment. This will further test the system reliability to make sure that it works well in the real world.

2. Test Case Description

OD1.1 **Object Detection Test 1**
OD1.2 This test will ensure that the object recognition rate can meet our need.
OD1.3 This test will run object detection model on several road videos under different environment (ex: sunny day, cloudy day) to see how many objects will be recognized.
OD1.4 Inputs: The input for this test will be the videos that were recorded on the road and include the objects that we want to detect like traffic sign.
OD1.5 Outputs: The model should return the names of recognized object every time when it occurs on the video.
OD1.6 Normal
OD1.7 Whitebox
OD1.8 Functional
OD1.9 Unit Test
OD1.10 Results: Most objects were recognized; the recognition rate was above 90%.

OD2.1 **Object Detection Test 2**
OD2.2 This test will ensure that the object detection speed can achieve 40 ms.
OD2.3 This test will run object detection model on several road videos that were recorded under different environment, to see the speed.
OD2.4 Inputs: The input for this test will be the videos that were recorded on the road and include the objects that we want to detect like traffic sign.
OD2.5 Outputs: The model should return the time spend when it finishes detecting on a frame in the video.
OD2.6 Normal
OD2.7 Whitebox
OD2.8 performance
OD2.9 Unit Test
OD2.10 Results: The object detection speed reached 36 ms which meet our specification.

FS1.1 **Full System Test 1**
FS1.2 This test will be used to see that the full system works together well
FS1.3 We will test the system on real time video. We will check the detection speed, mean Average Precision(mAP).
FS1.4 Inputs: real time video recorded by the camera on Jetson Nano device.
FS1.5 Outputs: the real time video should be displayed on user interface app and boxes around recognized object with prediction name. When detect dangers, the app will show alert messages.
FS1.6 Normal
FS1.7 Blackbox
FS1.8 Functional
FS1.9 Integration
FS1.10 Results: Video was successfully displayed on our app and boxes and names were shown at correct position and warnings were trigger in time. The speed and accurate rate achieved our expectations.

Results conclude that we were able to create machine learning model using a pre-trained network that can detect objects and dangerous conditions at a high accuracy and will show to the driver in few milliseconds. This program is demonstrated in our Driver 2.0 Demo and Testing video (link in Appendix). The program was run on a Jetson Nano standalone and plugged into a car using an adapter that can supply enough battery. Then the device is placed on the dashboard of the vehicle for the driver to clearly see the dangerous conditions and objects on the road. Furthermore, there was another program that we were building using a secondary camera that would utilize our computer vision program for face directional detection to ensure the driver is always aware while driving. We were able to implement this only partially as there were issues with the camera connection to the Jetson Nano. We found that both programs could work simultaneously while giving the driver and other passengers feedback in real time.

User Manual

Getting Started:

First, you should place the device out and place in on the center of your dashboard with the camera facing the windshield and the screen facing the drive / passengers. Once the device is situated and the tape is applied to make the device not move, we can power it on. The device should be plugged into the power port in the car (adapter is required). Once the device is connected to the power, the device's screen will light up and begin turning on. The device will ask the driver if they are ready to use, ensuring everything is properly setup (making sure the camera is facing the road).

The device will begin detecting objects as soon as it starts up and will give the user feedback instantly on the detected objects and conditions that may arise while driving.

The driver does not always need to watch the device, however, if the device detects a crash or distraction toward the driver, then the device will alert the driver knowing to "STOP" the vehicle. Once alerted the device will recognize when the driver has stopped and ensure that everyone is okay. The driver will continue to drive, and the alert will disappear if the driver is aware and okay to drive.

FAQ:

Q: What happens if the device does not power on?

A: Please ensure that the power is plugged in properly and the device is powered on. If not restart the device.

Q: What happens if the device is on, but does not display anything?

A: Make sure that the device is plugged in and connected. Ensure that the display is connected properly.

Q: The device is not recognizing objects in front of my car?

A: The objects being detected are those that can be detected based on the AI that is being used. We are always enhancing and using the newest models to train our AI.

PowerPoint Presentation

Driver 2.0

Team Members:

Vasu Bhog

ChaoYang Zhu

Chunjie Pan

Advisor: Wen-Ben Jone

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Goals Statements

Background

Billions of people drive on the road with no assistance from smart devices to aid them, resulting in a continuous increase in crashes over the decades. Our project aims at creating a simple device that uses computer vision and machine learning to detect distracted drivers and conditions on the road. This will decrease the probability of crashes, as well as increase the awareness of the driver.

Goal

Create a device that can detect and notify drivers about dangerous objects and distractions on the road in order to reduce the likelihood of a crash along with increasing safety.

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Intellectual Merits

Inadequacy of Current Solutions

There is no device that currently out there that detects objects, tired drivers, and road signs for drivers. There are currently only advanced cars that cost an additional hundreds of thousands of dollars that have sensors and cameras built in the vehicle. Not everyone can afford expensive vehicles, therefore a device that can detect and notify dangerous objects and distractions on the road will reduce the likelihood of a crash along with increasing the safety.

Our Device

Our project will use state of the art hardware and open-source software to detect many different objects using machine learning and computer vision. This will allow us to ensure that the driver is aware of his surroundings at all times through the use of our compact device. Our device is one of a kind on the market, as there is no device to directly help drivers of all ages be safer in any car they own.

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Broader Impacts

Our project focuses on the safety of the drivers around the world, no matter the vehicle. The global impact of our project is direct and can be exponential due to our project software and low costs. Our users age ranges from teenagers who are starting to drive to elderly individuals who may need additional help driving. As a result, our device will ensure that the driver is aware of their surroundings and of any dangerous conditions while driving. This will decrease the probability of crashes and injury, as well as increase the awareness of the driver.

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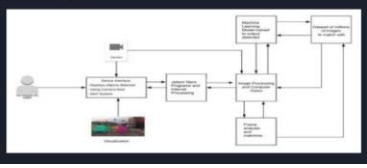
Design Specifications

System Overview

A device that can detect and notify drivers about dangerous objects and distractions on the road in order to reduce the likelihood of a crash along with increasing safety.

Design Diagram



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Technologies

- Software
  - YoloV3 - The latest variant of an object detection algorithm YOLO. A pre-trained model. We used preset weight and other configurations that YoloV3 has defined to train our prediction models.
  - OpenCV - A library of programming functions mainly aimed at real-time computer vision. We used for image processing, outline and send the detected object to the interface (monitor)
  - PyTorch - A open source machine learning library that can be used for computer vision and natural language processing. We used to train our prediction model with the preprocessed dataset.
- Hardware
  - Jetson Nano - A machine we run our application on. This is an NVIDIA Developer Kit that is designed to run multiple neural networks in parallel for applications like image classification, object detection, segmentation, and speech processing.
  - Cameras - We used a Road Camera and a Jetson Camera to record and live feed the video/images to our application.

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Milestones

1. Milestone 1 *Dec 30 2019 - Feb 11 2020:*
   Create a program that detects multiple road objects in a video/live feed.
2. Milestone 2 *Feb 12 2020 - Feb 22 2020:*
   Connect the program to a camera to read live feed data.
3. Milestone 3 *Feb 24 2020 - Mar 02 2020:*
   Setup the program with Jestson Nano.
4. Milestone 4 *Mar 03 2020 - Mar 19 2020:*
   Create an alert interface/program that triggers when object detected and ensure the user is aware.
5. MileStone 5 *Mar 20 2020 - April 13 2020:*
   Test our product and implement front facing camera.

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Results

We were able to create machine learning model using a pre-trained network that can detect objects and dangerous conditions at a high accuracy and will show to the driver in few milliseconds. This program is demonstrated in our Driver 2.0 Demo and Testing video (link in Appendix). The program was run on a Jetson Nano standalone and plugged into a car using an adapter that is able to supply enough battery. Then the device is placed on the dashboard of the vehicle for the driver to clearly see the dangerous conditions and objects on the road. Furthermore, there was another program that we were building using a secondary camera that would utilize our computer vision program for face directional detection to ensure the driver is always aware while driving. We were able to implement this only partially as there were issues with the camera connection to the Jetson Nano. We found that both programs could work simultaneously while giving the driver and other passengers feedback in real time.

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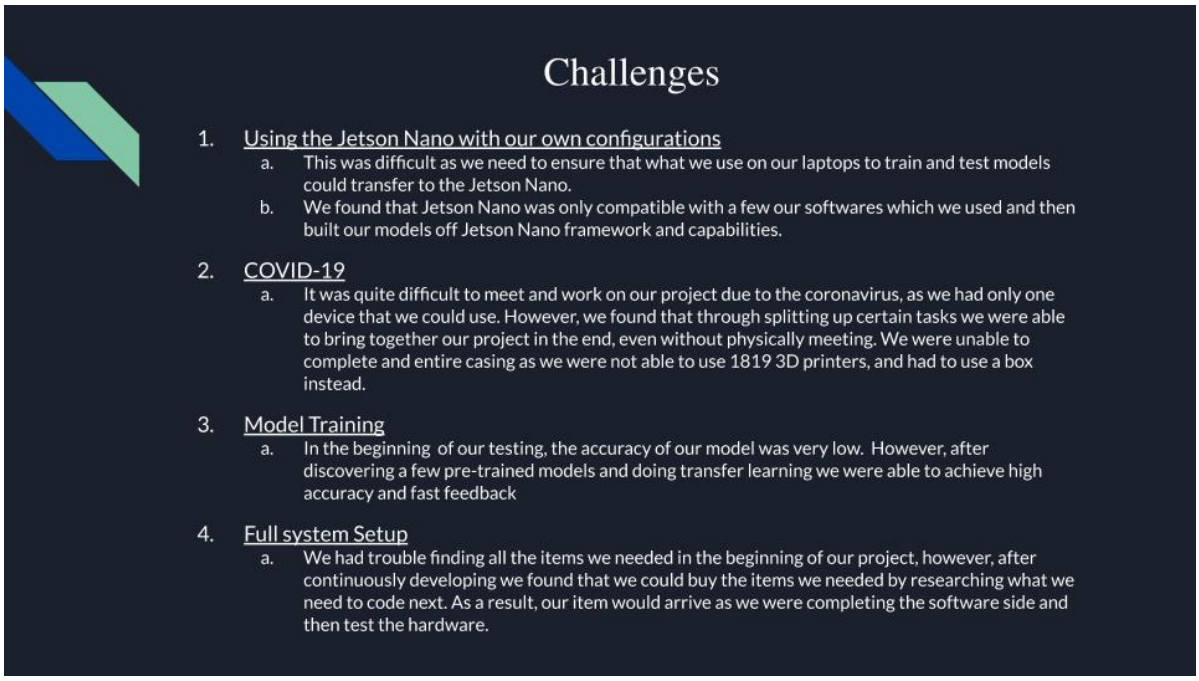


To see our Final PowerPoint in original format: Click Here

Expo Poster

DRIVER 2.0



ChaoYang Zhu Vasu Bhog Chunjie Pan

University of CINCINNATI

Project Advisor: Wen-Ben Jone

Purpose

Car crashes are continuously increasing due to distracted drivers and dangerous objects on the road. due to distracted drivers and dangerous objects. , and the issue is with drivers that are not aware or distracted. We need to find a solution that everyday drivers can utilize instead of buying a completely new vehicle.

Motor Vehicle Crashes By Type, 2009-2018

Year	Fatal	Injury	Total crashes
2009	30,862	1,517,000	5,505,000
2010	30,296	1,542,000	5,419,000
2011	29,757	1,530,000	5,338,000
2012	31,006	1,634,000	5,615,000
2013	30,057	1,591,000	5,687,000
2014	30,056	1,648,000	6,064,000
2015	32,539	1,715,000	6,296,000
2016	34,748	2,116,000	6,821,000
2017	34,560	1,889,000	6,453,000
2018	33,654	1,894,000	6,734,000

Source: U.S. Department of Transportation, National Highway Traffic Safety Administration

Solution

A device that can detect and notify drivers about dangerous objects and distractions on the road in order to reduce the likelihood of a crash along with increasing safety.

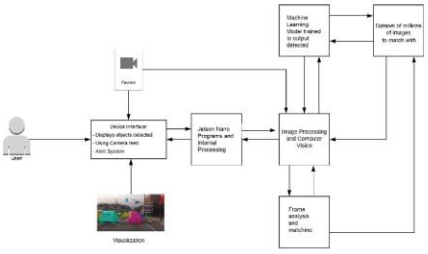
Project Overview

1. Create a device utilizing the Jetson Nano to process driving data.
2. Use camera feed data to detect objects, drivers swaying, and road signs using a deep learning model.
3. Create an interface to help drivers in all types of conditions to ensure the driver's safety.

Hardware / Software

NANO, OpenCV, python, TensorFlow, PyTorch

Design Diagram

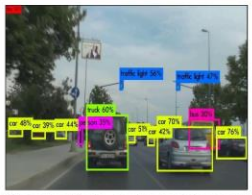


The driver will only be able to interact with the interface, while all the processing is handled behind the screen. The Jetson Nano will have the machine learning model on-board in order to get live feed data to continuously detect and alert the driver.

Setup

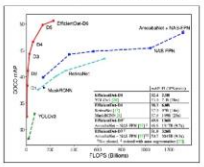
The device will be placed on the dashboard of the car to monitor the conditions on the roadway as well as the driver's awareness. It will contain two cameras, a 3D printed housing, the Jetson Nano, and small monitor.

Results



We were able to create machine learning model using a pre-trained network that can detect objects and dangerous conditions at a high accuracy and will show to the driver in few milliseconds illustrated in the picture above.

Face Directional Detection



Models we tested and re-trained

Another program will be using the secondary camera that our computer vision program will utilize for face directional detection to ensure the driver is always aware while driving.

Conclusion & Future Work

Our project focuses on the safety of the drivers around the world, no matter the vehicle. The global impact of our project is direct and can be exponential due to our project software and low costs. Our users age ranges from teenagers who are starting to drive to elderly individuals who may need additional help driving. As a result, our device will ensure that the driver is aware of their surroundings and of any dangerous conditions while driving.

Future Work:

- We plan to implement more stable housing for the device through 3D printing, as well as connect all the parts of the device in order to have a singular hand-held device.
- We would like to revise our machine learning models to work at a higher frame rate.
- We would like make the interface more user-friendly in order to allow the user to easily identify objects and dangerous conditions.

To see the Final Poster in original format: Click Here!

Self-Assessment

Vasu Bhog - Initial

Our project aims to answer the millions of crashes that still occur today due to distractions and dangerous objects while driving. As of today, there is research and companies that utilize cameras and sensors on vehicles to detect collisions and dangers. We will use computer vision to detect objects, road signs, and machine learning to analyze dangerous driving patterns. We will utilize our technical knowledge to develop an application and device that will be used to monitor driving conditions in any vehicle. We plan to use a small device such as a Raspberry PI and camera attachment to give us live camera feed data of the vehicle. Once we retrieve the data, we then will process it and illustrate to the user obstacles, road signs, and warnings that may occur.

Throughout my college career, I have learned a diverse set of technical and professional knowledge. I was able to learn specifically about computer vision and machine learning through courses I took abroad in France. I was able to get practical experience through a project that required the use of creating an application to detect objects using Java and OpenCV. I was able to understand the curriculum due to my previous technical knowledge and use of programming languages through Software Engineering courses. There have been many fundamental courses that allowed me to learn more about my interests today. I was able to develop many professional skills that allowed me to get the France opportunity as well.

My co-op and internship experiences intertwine with my degree in which I have a diverse set of technical and professional skills. I have worked on many different projects and roles ranging from data analyst to full-stack developer during my previous internships. I like to challenge myself and find projects that expand my technical knowledge and professional skills. I have been able to develop these skills through my co-op experiences at Microsoft, Fifth Third Bank and the research internship in France called UrbanLoop. I enjoyed learning from incredibly smart people and their perspectives on how to bring my knowledge to be used in an industry manner. I believe that all my internship experiences will benefit me greatly in successfully leading and developing our project.

I am extremely interested in this project as it deals with a revolutionary technology that can impact millions to billions of people worldwide. Computer vision and machine learning can solve many problems in today's fields of healthcare, transportation, and many others. I believe technology today should not be limited for only people who can afford it. The vehicle aid assistance that we plan to develop would be available to anyone to use in their conventional vehicles. It will allow drivers to rest assured that there are a detection and awareness in their smart device. I believe it is important for us to learn about these technologies along with the data that is available for us to utilize and create highly efficient models.

Our approach to solving this will be based on a learning structure and verification. We will begin with validating and processing images and videos of objects, road signs, and dangerous conditions on the roadway to aid the driver. Detection and validation will allow us to create reliable models for which we can use in our AI-enabled device. We will then utilize the raspberry PI and camera system to capture live feed. Once verification and system design are suitable for vehicles then we can test our product. I believe if we are able to satisfiable detect dangerous objects and distractions that could cause a crash, this would justify our project and success.

Vasu Bhog - Final

My individual contribution to this project was through the role of project manager as well as lead developer. I led the team in deciding what each team member must accomplish as well as how to develop our entire project. I built upon many skills I had already acquired as I found them to be quite useful on this project. I also was able to utilize my professional skillset to quickly learn the new technologies needed.

I was able to setup the Jetson Nano, acquire resources for my team to 3D print properly as well as getting the initial software that could be used on the Jetson nano. I purchased all required parts that would be needed for the project, as well as setup the use cases that would be needed for our project. I also found different Nvidia tools and courses that allowed for all team members to learn how to utilize it. I learned quite a lot about deep learning models as well as using smaller computer boards. We succeeded in training a model and utilize it to detect objects on the road including cars, trucks, people, and different objects. Obstacles were due to the jetson nano interface and utilization as we had many defects that we need to debug in order to get us to a prototype.

Our group accomplished many tasks that would allow us to demonstrate our core concept of detecting objects using real time data. I also believe that we built something that was quite novel and not created yet and can be utilized to help people around the world. Group work is quite difficult when creating a hardware project as we only had one device that we could test on. As a result, we must meet to work on it and if someone needed to test then they would need the hardware.

ChaoYang Zhu - Initial

There are millions of car accidents in the U.S. every year and cause millions of people injured every year. I believe, accidents occur mainly because of human behaves and the limitation of human’s ability to react and process all the information in a short amount of time. As technology rapidly grows, we invent the self-driving vehicle and other technology to help the driver. However, not everyone can afford to can a smart vehicle. For our project, we will be focusing on

computer vision and deep learning to create a project to help process information for the driver with an external camera and Raspberry Pi and show them on an interface. The goal is to break the limitation for the older vehicle to have a smart assisting drive system.

As mentioned in the first paragraph, the project involves computer vision and deep learning. For computer vision, we will be focusing on graphic processing. For this reason, all our team members are currently taking Computer Graphic I and self-studying with this knowledge, we want to use this project as a learning experience as well. For deep learning, every member has taken deep learning or machine learning previous, we use those experience to help develop the program and improve our skill in deep learning as well. For the interface for the system, I have taken User Interface I previously and created a web application as the final assignment for Python course. All that knowledge will help us solve the problem we might face and complete the project.

For my pass four co-op experiences, I have involved in diverse roles. Roles include application developer and research assistant. During co-op at Innomark Communications, I was an application developer in the IT department. My primary works were web app development for both front-end and back-end. The job involved using interface design and system (back-end) structure design. My last co-op was at Cincinnati Children's Hospital Medical Center as a biomedical developer, my goal at CCHMC was to create a program to analyze the collected data from the participant. The data was collected with Tobii Eye Tracker, which requires me to understand the row data's mean with the graphic shown to the participant. This will help me to understand the data/graphs captured with the camera and reformat them into the form that drive's need and desire.

As someone who does not like to drive, I always want to have as much assistance as possible from our technology. One of the common problems while driving is not seeing the road sign on the side or other objects such as the vehicle or small animals. Our first step will be road sign detection for images and videos processing, then we will try live feed for detecting road sign. After we complete the basic functionality, we will start to create a user interface for live feedback. This will complete the minimal requirement for our project. Then we can start adding more futures we want, such as the vehicle or small animal detection.

Our goal is to complete the minimal requirement for the project that can be in use for a live test on the vehicle. To accomplish this, we need to be able to detect the road sign while it is changing size (as we get closer to it) in the video. Our team will sit down in a meeting to complete this task. Since I have a lot of experience in interface design and web application development, I will be doing more for programming the interface for the user. I believe we will be able to complete the basic functionally for the project by mid next semester and start to implement more future for the rest of the semester. Base on the problem we might face while programming the futures, I believe we will be able to complete the prototype that can be in use for testing.

ChaoYang Zhu - Final

Throughout this senior design project, I worked on different parts based on the project needs. The whole process of complete the project can be summarized into a few stages, there are research, setup/planning, development/train, and testing. During the research, I helped with the search on which hardware we should use and what software or open source works best for our ideas. Then based on the setup/planning, we have to research more detail of each hardware and software, which I focused on learning software or open source such as YoloV3. After that, we start to design and build the training models based on a pre-trained model, meanwhile, I so designed and created a customized case for our project with a 3D printer that is available at 1819 Innovation Hub. Lastly, it is the testing stage, we tested the model with images, pre-recorded video, and live camera. Through the project, we worked most things together but split each stage into small tasks for each member to complete. During planning, all the skills that were identified during the initial assessment were used, furthermore, I found/used few more skills that we didn't identify during the development phase, such as modeling for 3D printing.

For the project, I was focused/helped a lot with debugging, such as hardware setup, preprocessing data, and training the prediction model. I also helped to solve some additional stuff for the project, such as design as a customized case. I believe that I brined a lot of values to the team and was able to come up with ideas/solutions for other members and the team when needed while being able to complete my own tasks. From the project, I have learned many things, such as the basic model for 3D printer, the ability to understand the process required for training a prediction model for both one and multiple classification models.

Our group was able to complete the basic requirement we previously set up for our project. Due to the COVID-19 outbreak, we were being affected with work efficacy, which causes us unable to complete the extra feature we designed for the project. Overall, we still were able to complete the initial goal of the project and was able to create an actual working product. Because of the COVID-19 outbreak, I learned the importance of communication and the effectiveness of working right next to each other.

However, we still were able to overcome the communication difficulty that was caused by the quarantine. Moreover, we were able to learn, experience and successfully overcome the difficulty of the distant group working. Since our members have been working together for a few years, the efforts for each member put into the project are the same. But Vasu definitely deserves the recognition for the main person who designs the "blueprint" of the project and communicates with all the faculties.

Chunjie Pan - Initial

The project aims to harness the power of computer vision and machine learning to detect dangerous and object on the road. The end project will utilize camera feed data, utilize Raspberry PI as platform and use Amazon Web Services to process image. Nowadays, the number of vehicles on road is increasing every day and there is a continuous increase in crashes over the years. However, there are barely any smart devices installed in vehicle to help driver recognized the dangerous on the road. For most people, they must buy a completely new vehicle to obtain smart assistant. The project will help people get smart assistant by installing a low-cost and small size device in their current vehicles.

As a Computer Science major, the curriculum at UC has played an important role in gaining the necessary expertise to develop the project. Data Structures (CS 2028) helped me understand concepts such as Object-Oriented Programming. Linear Algebra (MATH2076) helped me understand vector and matrix operations which are very important in machine learning and computer vision. Software Engineering (EECE 3093) introduced me to concepts such as agile methodology. Design & Analysis of Algorithms (CS 4071) and Machine Learning (CS 6037) improved my programming through concepts such as complexity and using neural networks in the machine learning.

I have gained a lot of software development experience through four co-op rotations. During my first co-op rotation, I worked in the UC College of Engineering and Applied Science as a research assistant. I gained the skill to design and implement a digital circuit simulator and displayed excellent teamwork skill and communication skill. For my second rotation, I worked at Siemens Innovation Center. I was a web application developer and created a web application from scratch with teammates. I have gained hands-on development experience of software. I also learned how to use the database and connect database to software efficiently. For my third rotation, I worked at the Institute of Automation, Chinese Academy of Sciences. I was an embedded software developer. I completed a PDF reader application alone and it was used in a printer system. I was also brought on as the development lead for the programmable motion control software project. I designed a set of programming language and interrupter functions. During this co-op, I gained embedded software developer experience and better understanding on the Linux system. During my last co-op, I worked at UC as a research assistant, I learned new technology that might be used in the project.

I have always been interested in computer vision, cloud computing and machine learning. I really like this project because it will not only provide a cost-effective drive assistant option for drivers but also decrease the probability if crashed and injury as well as increase the awareness of the driver. Of cause, I was also seeking a project that would also help improve my career options by giving me experience valuable to employers.

This project will be divided into three main parts: getting data from camera and sending the data to Amazon Web Service; using machine learning to recognize objects in each image; detecting dangerous from that information. As a team, we will work through all this task together. For my part, the focus will be on embedded development and machine learning. I will evaluate my contributions by measuring the accuracy and feedback received by teammate and advisors. The expected result of the project will be a small device with interface that can detect dangerous situations and objects on the road. I will know that I have done a good job if the device performance is well above baseline of our expectation.

Chunjie Pan – Final

I worked on all parts with my teammates include hardware design, object detection, and interface design. In the beginning, I took a 3D-printing class at 1819 hub and learned how to utilize their machine and software to print objects. Then we successfully printed a case to protect our case. Next, I learned different models like YOLO and EfficientNet, which are used in our project. After those leaning, I helped my team finishing object detection part. Last, in the end, I learned how to design an interface in Python and successfully designed a user interface that includes live video playing, camera, photo displaying, and alerting function.

Through this project, I learned how to do 3d printing, object detection, and user interface design. The most important thing I learned is how to build effective teamwork. The most difficult obstacle that I have met was image processing. Because I have not taken any classes that teach image processing, it cost me a lot of time to study from very basic.

My group basically accomplished most goals we had set at the beginning include setting up Jetson Nano, detecting objects on the road and show road and alert information to the driver. Group work can be very difficult when we are not able to meet frequently, especially, we only have one Jetson Nano device to work on. Sometimes, work was very inefficient due to less communication. However, we soon got used to working remotely and were able to cooperate well.

Each one in our group has their own role. I believe we all successfully played our roles and finished our tasks. My effort is as much as theirs. All my teammates deserve special recognition. They spent a lot of time day and night working on this project.

Summary of Hours and Justification

Billable Hours

Vasu Bhog

Date	Hours	Activity
8/28/2019	2	Met with other teammates to discuss different project ideas and then ended up on a Computer Vision project
8/30/2019	1.5	Assignment 1 Due Biography
9/04/2019	3	Met with teammates to discuss the finalize project idea and begin working on project abstract and description
9/05/2019	1.5	Met with Dr. Wen Ben to discuss our project and see his recommendations and suggestions
9/06/2019	2	Researched our project further in the aspects of hardware and software to understand if this project is feasible
9/08/2019	2	Assignment 2 Due Project Description with teammates
9/15/2019	1.5	Assignment 3 Due Self-Assessment
9/20/2019	3	I helped Pan research equipment for the project, like raspberry pi, camera, and intel accelerator
9/22/2019	4	I focused on creating the User Stories and Design Diagrams for our project that was for Assignment 4
10/09/2019	2	I helped assign certain tasks associated to our Task Lists Assignment 5
10/13/2019	4	Did more research into which camera would work best for our project and found that we could use a camera I already have
10/15/2019	2	Worked on Assignment 6 Milestones, Timelines, and Effort Matrix with the team
10/26/2019	8	I worked on researching OpenCV and looking at previous Java programs I created to relearn important image processing techniques
11/12/2019	4	Worked on Assignment 8 Presentation and recorded the presentation (editing, and recording) that would be presented in front of class
12/05/2019	4	Worked on updating our Github and creating a Github Wiki to illustrate our final report

12/10/2019	4	Worked on Assignment 9 Final Report
1/15/2020	3	Met with team to assign tasks to start the project
1/24/2020	4	Assignment #1 Due – Test Plans
2/1/2020	4	Assignment #2 Due – User Documentation
2/12/2020	4	Began Testing our model on Jetson Nano and enhancing or knowledge with Jetson Nano interface
2/21/2020	2	Assignment #3 Due – PPT Documentation
3/4/2020	8	Assignment #4 Due – Expo Poster Draft 1
3/11/2020	3	Debug the Jetson Nano when loading real time data onto the display
3/20/2020	2	Get Certification for 3D modelling and designed and constructed a base plate
4/3/2020	6	Assignment #5 Due – Poster Final Draft
4/9/2020	1	Preparing for Virtual Expo and finalizing information
4/10/2020	4	Complete training and debug the models
4/13/2020	8	Demo and Testing of our product (Constructing a box to hold, equipping vehicle with our device, testing and recording results)
4/14/2020	4	Create a video based of Demo and Testing footage
4/17/2020	4	Setup and Present our project to CEAS Judges, faculty, and students
4/20/2020	2	Assignment #6 Due – Final Self Assessments
4/24/2020	6	Assignment #7 Due – Final Reports
Total Hours	114	

Chunjie Pan

Date	Hours	Activity
8/28/2019	2	Met with other teammates to discuss different project ideas
8/30/2019	1.5	Assignment 1 Due Biography
9/04/2019	3	Met with teammates to discuss our project ideas
9/05/2019	1	Met with Dr. Wen Ben to discuss our project

9/06/2019	2	Researched on project topic (hardware and software) to find out the level of difficulty of our project. If it is way too hard, we will change our project
9/08/2019	2	Assignment 2 Due Project Description
9/15/2019	1.5	Assignment 3 Due Self-Assessment
9/20/2019	5	Researched equipment for the project, like raspberry pi, camera, and intel accelerator
9/22/2019	1.5	Assignment 4 Due User Stories and Design Diagrams
10/09/2019	2	Assignment 5 Due Task Lists
10/13/2019	3	Did more research into which camera would work best for our project
10/15/2019	2	Assignment 6 Due Milestone, Timeline, and Effort Matrix
10/26/2019	6	researched OpenCV
10/27/2019	7	Did more research into OpenCV and wrote a small OpenCV project
10/28/2019	3	Added more features into my small project
11/12/2019	2	Assignment 8 Due Presentation
12/10/2019	4	Assignment 9 Due final report
1/24/2020	4	Assignment #1 Due – Test Plans
2/1/2020	4	Assignment #2 Due – User Documentation
2/12/2020	4	Began designing user interface
2/21/2020	2	Assignment #3 Due – PPT Documentation
3/4/2020	8	Assignment #4 Due – Expo Poster Draft 1
3/11/2020	3	Debug our object detection model
3/18/2020	8	Take the 3D modelling class and get Certification for 3D modelling
4/3/2020	6	Assignment #5 Due – Poster Final Draft
4/9/2020	1	Preparing for Virtual Expo
4/10/2020	10	Complete the training of models as well as user interface.
4/20/2020	2	Assignment #6 Due – Final Self Assessments
4/24/2020	4	Assignment #7 Due – Final Reports
Total Hours	102.5	

ChaoYang Zhu

Date	Hours	Activity
8/28/2019	2	Met with teammates to discuss different project ideas and decided to go with Computer Vision project
8/30/2019	1.5	Assignment 1 Due Biography
9/04/2019	3	Met with teammates to collect every member's project ideas
9/05/2019	1	Met with Dr. Wen-Ben to present our idea and get feedback
9/06/2019	2.5	Researched on project topic (hardware and software) to find out the level of difficulty of our project. If it exceeds the difficulty we can handle, we will change our project
9/08/2019	2	Assignment 2 Due Project Description
9/15/2019	1.5	Assignment 3 Due Self-Assessment
9/20/2019	3	Helped Pan to research equipment for the project, like raspberry pi, camera, and intel accelerator
9/22/2019	2	Assignment 4 Due User Stories and Design Diagrams
10/09/2019	2	Assignment 5 Due Task Lists
10/13/2019	3.5	Helped on research the best camera that fit the project
10/15/2019	2	Assignment 6 Due Milestones, Timelines, and Effort Matrix
10/26/2019	8	Researched on OpenCV with team
11/12/2019	5	Assignment 8 Due Presentation and uploaded presentation
12/05/2019	5	Worked on updating our GitHub and creating a GitHub Wiki to illustrate our final report
12/10/2019	3	Assignment 9 Due Final Report
1/15/2020	3	Met with team to assign tasks to start the project
1/24/2020	2	Assignment #1 Due – Test Plans
2/1/2020	2	Assignment #2 Due – User Documentation
2/12/2020	4	Create a testing decision model
2/21/2020	2	Assignment #3 Due – PPT Documentation
3/4/2020	4	Assignment #4 Due – Expo Poster Draft 1
3/11/2020	5	Train and debug the models with collected data

3/15/2020	2	Filter the collected data that create noisy while training
3/20/2020	2	Design the 3D model for case with the Tinkercad
3/23/2020	2	Adjust the model based on the printed result from 3D printer
4/3/2020	3	Assignment #5 Due – Poster Final Draft
4/9/2020	1	Virtual Expo Info
4/10/2020	15	Complete training and debug the models
4/13/2020	2	Product road test and record demo and testing footage
4/20/2020	2	Assignment #6 Due – Final Self Assessments
4/24/2020	4	Assignment #7 Due – Final Reports
Total Hours	102	

Summary of Expenses

Item	Price
Jetson Camera (Driver Facing)	$24.75
Jetson Nano	$101.64
Jetson Nano Power Adapter	$16.04
7 Display	$32.96
Wi-Fi Adapter	$7.75
SD Card	$15.50
Jetson Nano Fan	$8.85
Road Camera	$29.95
Car Adapter	$23.50
Circuit Board Jumper Cap 2pin	$5.50
Custom Case (with 3D Printer)	$10.00
Total	$276.44

Appendix

GitHub Senior Design Wiki: https://github.com/VasuBhog/Senior-Project/wiki

Code Repo: https://github.com/VasuBhog/Driver2.0

Driver 2.0 Poster: https://bit.ly/3eOttsd

Driver 2.0 PowerPoint: https://bit.ly/3eSZU8Y

Driver 2.0 Demo Video: https://www.youtube.com/watch?v=MWGgYMlftgw

Overview of our Senior Design Project Video:
https://www.youtube.com/watch?v=5HsGWZ13QGY

OpenCV: https://www.learnopencv.com/

Previous OpenCV Projects: https://github.com/VasuBhog/Twizy-Project