Senior Project Problem Statement Report

Project Title: Autonomous Vehicles

2/12/2020

Team #4: V2V Communication

Adam Jensen
Daniel Komac
Wesley Ngyuen

Dr. Thomas Douglas

Elevator Pitch

Establishing a network of smart cars to allow for autonomous and nonautonomous systems to communicate real time information and react to different situations.

Executive Summary

In our project we aim to create a system that will allow vehicles to communicate their location and surroundings to other cars in order to minimize motor vehicle accidents and make cars more eco-friendly and efficient. Currently smart cars rely solely on the sensors and cameras attached to the car in order to gather information about their surroundings. This limits the amount of data that the car can collect, as well as creates the possibility of misreading and error. We will try to correct this problem by creating a system that allows vehicles to communicate with each other; instead of relying on five sensors, they have the combined knowledge of every car in the area. When applied to vehicles that do not have sensors, non-autonomous vehicles, these vehicles will be equipped with a device that will communicate their location to the vehicles around them and warn the driver in case of emergency.

In order for the vehicles to communicate, we will use Wi-Fi to connect the vehicles to a central computer, and Bluetooth to connect the vehicles to each other. This will be achieved by using transceivers connected to Arduinos that will connect to the main computer; Bluetooth modules would connect the cars to each other. In order for the vehicles to observe their environment, multiple ultrasonic sensors and cameras will be used on each vehicle. This will allow our vehicles to accurately react to stimuli in their environment and gather enough data for the main computer to give out correct instructions.

Our proposed project will allow for the theoretical savings of hundreds of billions of dollars that are spent yearly on accidents related to misconduct in cars. Statistics show that over 90% of accidents are driver related. This could easily be prevented if we remove drivers as a factor due to automation providing a system in which forms of traffic and measures of security can be managed more efficiently.

Abstract:

The following report presents a topic which we believe would improve society by optimizing current algorithms or by implementing a new piece of technology to allow obsolete devices and mechanisms to be up-to-date or compatible with current and future models. We believe this can be achieved with applications of local and server communication.

So far we have found a few tools to help implement and further research into these topics, such as Arduino Minis, to help support our idea of P2P(V2V) communication and to send messages back to our server either using our computers or a Raspberry Pi. Potentially using languages such as Python to help facilitate communication and other forms of network communication protocols for our AVs.

This idea was brought to light because of a high amount of death within the last decade, amount of emission, and cost of healthcare. If we are able to implement some of our features efficiently to have a system in which AV and Non-AV can communicate with one another, then we can reduce these numbers greatly. That is our ultimate goal: to provide a safe environment for vehicles to be able to operate optimally and have a safe environment for living beings to coexist with these machines

Key Word Index- Automation; Networking, Communication; Smart Car

Introduction:

This report will explore the societal problems of current vehicle transportation and why V2V communication must be implemented in order to create more eco-friendly and safe transportation. The improvements we propose are within our skill set and will provide a challenge we are willing to take. By the end of this project we plan to have a working model, scaled for convenience, able to communicate with another system while also relaying important information back to our main servers to ensure the data we are getting is valid for our test conclusions.

The fundamental idea is a system of AV's whose position, speed, and movement are controlled through a cloud and internal computer while receiving and transmitting information. This information will be crucial to how our system works and how it is able to assist other AV and non-AV's in making appropriate decisions in time sensitive scenarios. Our systems will be able to prevent vehicle to vehicle collisions and pedestrian accidents, while improving traffic and maximizing fuel efficiency.

The use of various microprocessors and FPGAs is mandatory to obtain a functioning system that is durable and reliable for field testing. We plan on making small scale versions to test the networking systems and their efficiency in reacting to different stimuli to ensure that our concept is applicable. We then plan to scale our designs up to possibly apply them to vehicles.

Main Body:

Although cars are an essential part of our lives, due to climate change, human and mechanical error, and traffic congestion, the way that we use our vehicles needs to change. We need to find a way that will make vehicles safer, more efficient, and eco-friendly. A new technology that may revolutionize vehicles and fix these problems is the development of a fully autonomous vehicle that utilizes vehicle to vehicle communication in order to avoid accidents, improve traffic flow, and provide optimum fuel consumption. Currently, autonomous cars are being developed by car companies such as General Motors, Toyota, Volvo, Volkswagen and BMW as well as Internet auto companies such as Google, Uber and Tesla, but they are currently 5 times as likely to crash as a conventional car (Ali). This is because they do not currently fully utilize Vehicle to Vehicle communication (V2V).

According to the DMV, within the US in the year 2016, there were 7,277,000 reported motor accidents (DMV). Human error was found to be a definite or probable cause in 90-93% of motor accidents, according to the Tri - Level Study of the Causes of Traffic Accidents published in 1979(Rowley). In 2016, of the 35,092 motor accident fatalities, 29% were caused by alcohol-impaired drivers, 27% by over-speeding drivers, and 10% by distracted drivers (Ali). Therefore, if human error was removed, it is possible that 6,767,610 motor accidents could have been avoided. If possible, then this would have saved nearly 300,000 lives in a decade, and in one year would have saved 190 billion dollars in healthcare savings (Rowley).

Another major problem associated with motor vehicles is carbon emissions, part of which is caused by traffic congestion. Traffic congestion could be solved from the use of V2V autonomous cars through the use of clusters, platoons and multi-platoons. Clusters, platoons and multi-platoons all work by creating a hieratical network structure. A cluster is formed from groups of cars based on their geographic location and their speed. A platoon is a cluster that is made up of a string of cars that move together at the same speed with the same distance between them. Each platoon is led by an autonomous vehicle with the rest following at a set distance like a train. It has been found through simulations that this would improve traffic efficiency by 30%. A multi-platoon is made from many different platoons and would organize itself based on the most efficient algorithms for speed and safety. Simulations have found that this would achieve high traffic capacity values with little congestion (Wang).

A single passenger car will release an estimated 4.6 metric tons of carbon dioxide per year. This amounts to nearly 20% of all US carbon emissions. A way to reduce this would be to create a shared autonomous vehicle (SAV), which Uber has been trying to do. A SAV is an autonomous taxi that would provide point to point travel for passengers. Passengers would schedule a time for pickup and drop off, and would “share” the vehicle with others. It has been found that one SAV could replace between 3 to 11 personal vehicles on the road, and that between 14% and 39% of travelers would choose to use SAVs. This would also reduce the space needed for parking lots allowing for more businesses and living spaces (Levin). Another way that we could curb carbon emissions with the use of autonomous vehicles is through real time energy management. Autonomous vehicles could accurately predict ideal velocity to improve fuel efficiency. This is known as Equivalent Consumption Minimization Strategy (ECMS) and was found to improve fuel efficiency by 5% (Zhang).

Autonomous vehicles (AV) are an inevitable future due to the vast benefits that they will have on our society. However in order to get there, V2V communication will need to be implemented. Conventional cars are still five times safer to drive than AV. This is because even in the best vehicles there are, sensors can be unreliable with identifying situations and have a certain range of vision. It is due to these problems that Tesla's AV were involved in five fatalities and one fatality in Uber. V2V would also need to be implemented in order for AV's to efficiently alleviate congestion.

Autonomous vehicles relying solely on sensors affects both the safety and the maneuverability of the vehicle. Sensors can be unreliable because they lack the knowledge of their surroundings and are narrow in scope. In May of 2016 a Tesla killed its driver by driving into a truck. This was because the sensor was blocked from sight due to a white towed car corner. They may also make incorrect decisions such as when an Uber AV in 2018 killed a pedestrian due to misreading their location and assuming they were further away than they were. The risk increases when placed in complex intersections with high pedestrian and traffic flow, as well as with bad weather including snow or ice. Problems also arise when there are irregularities such as faulty traffic lights, missing signs, or faded street paint. The only current solution being utilized for these problems is the addition of more sensors to cover more space and to try and analyze as much as possible. This increases the price of AV's, as some sensors can be priced at $75,000.

By relying solely on sensors AV's become much more expensive and haven't become safer than a conventional car. This could be entirely changed with Vehicle to Vehicle communication. With V2V communication, AV's would have a shared input of their surroundings, so speed signs, locations, road conditions, as well as accidents would all be shared. This would increase reliability, as even if a sensor makes a mistake, when checked with other vehicles the right decision may be made. This also increases the area that the AV has knowledge of so in the case of an emergency, it would have more time to react and slow. In the case that a vehicle runs a red light, the sensors of the car may only have a vision of 6.6 meters, resulting in a collision. However, by communicating with other vehicles, that vision is increased and would allow the AV time to stop to avoid someone running the red light. V2V also increases how well the vehicle maneuvers. It was found that when using V2V communication, basic tasks such as merging or making turns were found to happen up to 50% faster (Ali). V2V also allows for cars to find the most efficient way to navigate traffic, forming clusters, platoons and multi-platoons while also finding the most fuel-efficient speeds to drive at.

The way that this V2V communication would be implemented would be through the use of both cloud and local communication. Both these types of communication are needed in the event that the AV loses cloud connection such as in rural areas or in tunnels. The cloud connection that is currently being researched for AVs is 5G LTE, but for the sake of our project we would use wifi to connect to a central computer that would communicate location and environment information with each of the vehicles. This will be done using Arduino Nanos on each of the vehicles that would communicate using NRF24L01 transceivers. The computer would relay environment conditions and optimal driving instructions to the Arduino, which would then interpret the data and drive accordingly. While receiving instructions, the Arduino would also take input from sensors and cameras within the vehicle that would measure the vehicles location, the location of vehicles around it, road signs, road lines, and other conditions.

This information would then be sent through the transceiver to the main computer who would make adjustments and send info back to the vehicles. Our local connection would use bluetooth in order to communicate information from vehicle to vehicle. The information sent would be the cars location and the recorded sensor data. This way if there was an abrupt stop due to an accident, vehicles would have time to react instantaneously and not rely on the cloud. In the event that connection with the cloud was disconnected, this communication would be how cars navigated and observed surroundings.

In order to increase the effectiveness of V2V communication, nearly all cars would need to be accounted for, including older models that are not autonomous. In order to do this, we would need to create a system that would allow the cloud and local communication between AV and non AV's. This would be done by installing an Arduino on NAV's with the same transceiver that would transmit the vehicles location at all time to surrounding vehicles and the cloud. This way, cars would know of the presence of all vehicles on the road, regardless of if they were self driving or not. This would notify other vehicles in the area of these cars' locations, as well as accidents involving them. The Arduino in NAV's would also connect with the cars speaker system and would notify the driver with alerts in the presence of an accident or other situations that the driver may need to react to. This would be through a wired connection that would power the speakers on if off and would override any current noise. Hopefully, this device will become the new "seatbelt" for vehicles of the future.

Autonomous cars are the future, but in order for them to take over the world like the original cars did, they will need to implement a V2V communication system.

Project Proposal:

Our design will use cameras or Ultrasonic Transducers to convey road side information. There are a plethora of sensors available upwards of around $20 and should be able to provide us with vision and sensory feed. This sensory feed can be filtered into an Arduino or Raspberry Pi which can be as cheap as $10 ~ $40. These parts will allow for the vehicle to be able to interpret inputs and output data at real time. Using a python passed protocol system to relay information between devices. MQTT is also another form of protocol that we may look into for an open-source tool to help us get each device transmitting and receiving data accurately. Other supplies are motors, a battery and potential remotes which combined may be around $10. Most of this can be performed from our homes and may need to access the soldering station in the lab or use on campus computers but two members in the group have soldering irons. Our approach isn't the fabrication of the Automated Vehicles but the communication done between each vehicle.

As stated in our report we've seen other companies(Tesla, and Uber) develop these products but without having them be fully autonomous and able to handle a variety of scenarios without some form of human attentiveness. We are trying to achieve a level above these companies to feel like we've achieved the appropriate goal without feeling like we're tackling too much on this project. We plan to optimize the machine learning format and potentially risk assessment algorithms that are used to help alleviate the amount of casualties and accidents that are currently caused by AVs. There isn't any current AVs that are able to reach higher than a level 3 in terms of automated vehicle movement. We are planning on upping the level of

understanding through thorough testing and manipulation of factors in our code along with potential alterations to the sensors to view surrounding environments in a different format.

In order to test our system, we will need to create three different autonomous vehicles that will need to connect to each other and the main computer while taking in data from various sensors and cameras. Each autonomous vehicle will use two motors, a H bridge, and a power source in order to drive. Finally, a separate RC car will be procured to represent our non-autonomous vehicle device. Each RC/AV car will have similar technology on it so totally at about 4 cars would result in around $400 total of team cost.

Features and Metrics:

I. Software/Hardware Implemented per AV
   A. Three Sensors
   B. One FPGA
   C. Four Motors with H Bridge
   D. MQTT Protocols
   E. Server Broadcasted Information
   F. Server Receiving Protocol

II. Work Distribution
   A. Work will be distributed evenly to ensure that each member has an equal opportunity to prove their worth in the group and help alleviate any stresses from each team mate. Adam will handle most electrical components of the assignment since this is directly related to his field in Electrical Engineering while Wesley and Daniel will work mostly on the coding portion and server creation since their majors are Computer Engineering.
   B. We suspect that this project will take us little time to achieve a base form of the system, ie. communication between vehicles, but to achieve a level 3+ in automation will require a great amount of our time to ensure it functions properly. We estimate that assembling the AV will take anywhere between 4-10 hours, individually or for all 4. Configuring the FPGA should take 4-6 hours. The main bulk of our assignment will be data processing and assuring our results are accurate and what we want to be processing which make take us 60+ hours, this will be the bulk of the project since we need to understand and improve on a system that is faulty.

III. Understanding Completion
   A. Our metrics will only be able to be determined finished if they can return accurate data in real time. Our sensors will need to be able to relay information in real time to our computer and then between each other device. This is how we'll be able to measure the completion of the integration of the sensors
   B. FPGA will need to broadcast data and receive data while being able to comprehend what technique to use to avoid a "dangerous" scenario. Having a series of outputs define whether it's behaving in the appropriate manner, ie. directional movement away from "danger", will be proof enough to demonstrate that our AVs FPGA is working accordingly.
   C. MQTT Protocols or other various Networking protocols can be used to obtain information from other devices. As long as these devices are relaying information correctly then that is proof of concept.

IV. Team Member Contributions:
   A. Daniel Komac
      1. Provides Python and database language background
      2. Worked in VHDL and Verilog hardware programming languages
      3. Extensive understanding of C,C++,Java, DOS, and other coding languages
      4. Operating system knowledge from previous design of a processor and kernel design

B. Adam Jensen
    1. Provides knowledge of machine vision
    2. Coding experience in C,C+, Verilog, VHDL and Python
    3. Taking classes on the creation ADC and DAC controllers
    4. Provides knowledge of improving signal gain

C. Wesley Nyguen
    1. Provides database knowledge utilizing Python and MySQL
    2. Considerable experience with C, C++, Java, HTML, VHDL, Verilog, and other languages
    3. Hardware troubleshooting skills acquired from hobbies, and refined through school experience

    4. Ample writing knowledge that can be utilized to improve reports.

Conclusion:

In this report we've conveyed the idea of a fully fledged autonomous system that will be able to incorporate non-autonomous vehicles into it. This system will be able to prevent a large number of accidents in a year which also reduces several other negative qualities associated with a crash by a large factor. It's clear that a large portion of these accidents are caused by human error and removing the human factor from transportation would allow for a safer overall system of transportation.

By using knowledge that we've accrued through the semesters and new knowledge that we plan to obtain through diligent research, we will fabricate a system that allows vehicles to communicate with one another while also communicating to vehicles outside the system. The use of FPGAs or Microprocessors will be used to achieve the overall end result.In tandem, sensors and local networking protocols will be used to achieve a seamless communication network between cars and servers to ensure accurate and vital information is provided with due diligence. The network will allow existing smart cars to be able to openly share relevant traffic information while changing to the current environment without any delays. Similarly, with this system we will be able to incorporate a sort of add-on system that can be attached to non-autonomous vehicles that will allow the car to also relay information in real time while also receiving information and outputting it to the driver. The output may be through audio updates or some form application. This is the breadth of our project, the system that will allow for more relevant information to be conveyed and prevent accidents or deter more from occurring during accidents.

Our final result will be a fully automated car that can understand the information being relayed to it from other vehicles. The transmitted data will be relevant for bettering the transit of other vehicles within the system along as its own transit. V2V communication is the end goal allowing for a full system that allows for safe autonomous driving while taking into consideration many outside factors.

References:

Ali, Anum, et al. "Vehicle-to-Vehicle Communication for Autonomous Vehicles: Safety and Maneuver Planning." *2018 IEEE 88th Vehicular Technology Conference (VTC-Fall)*, 2018, doi:10.1109/vtcfall.2018.8690946.

Darbha, Swaroop, et al. "Benefits of V2V Communication for Autonomous and Connected Vehicles." *IEEE Transactions on Intelligent Transportation Systems*, vol. 20, no. 5, 2019, pp. 1954–1963., doi:10.1109/tits.2018.2859765.

Levin, Michael W. "Congestion-Aware System Optimal Route Choice for Shared Autonomous Vehicles." *Transportation Research Part C: Emerging Technologies*, vol. 82, 2017, pp. 229–247., doi:10.1016/j.trc.2017.06.020.

Rowley, John, et al. "Examining the Driverless Future: An Analysis of Human-Caused Vehicle Accidents and Development of an Autonomous Vehicle Communication Testbed." *2018 Systems and Information Engineering Design Symposium (SIEDS)*, 2018, doi:10.1109/sieds.2018.8374759.

Wang, Jiadai, et al. "Networking and Communications in Autonomous Driving: A Survey." *IEEE Communications Surveys & Tutorials*, vol. 21, no. 2, 2019, pp. 1243–1274., doi:10.1109/comst.2018.2888904.

Wang, Nannan, et al. "Cooperative Autonomous Driving for Traffic Congestion Avoidance through Vehicle-to-Vehicle Communications." *2017 IEEE Vehicular Networking Conference (VNC)*, 2017, doi:10.1109/vnc.2017.8275620.

Zhang, Fengqi, et al. "Real-Time Energy Management Strategy Based on Velocity Forecasts Using V2V and V2I Communications." *IEEE Transactions on Intelligent Transportation Systems*, vol. 18, no. 2, 2017, pp. 416–430., doi:10.1109/tits.2016.2580318.

Glossary:

V2V: Vehicle to Vehicle

AV: Autonomous Vehicle

FPGA: Field Programmable Gate Array

Appendices:

Budget: Roughly estimated to be about $400 total
Motors and small components total around $20
Majors sensors and FPGAs total around $40+
Code is open source or custom
We will have four vehicles all custom built to our specification

Resumes:

ajadamjensen@gmail.com
(707) 815-6881

Adam P. Jensen

OBJECTIVE

Working professionally as an electrician, I learned how to communicate with my supervisors and workers from other trades, find alternate solutions to complex issues, and learn new skills while applying existing ones to current projects. Now as an electrical engineer, I wish to apply the skills and work ethic that I gained from skilled manual labor to expand my knowledge of engineering and show my dedication to this industry.

EDUCATION

Bachelor of Science, Electrical/Electronic Engineering Expected:
December - 2020 California State University, Sacramento
G.P.A. 3.3

Related Courses:

- Intro to Logic Design
- Intro to Microprocessors
- Intro to Feedback Systems
- Intro to Machine Vision
- Electronics 1
- Electronics 2
- Applied Electromagnetics
- Power System Analysis 1
- Signals and Systems
- Modern Comm. Systems
- Network Analysis
- Product Design Project I

Last Updated 01/27/2019

RELEVANT SKILLS AND KNOWLEDGE

Languages: Matlab, C, C++, Python, Verilog
Tools/Packages: PSPICE, Advance Design Systems, AutoCad, Multisim, VirtualBench
Equipment: Oscilloscope, Multimeter, Function Generator, Power Supplies
Hardware: Raspberry Pi, Propeller Microcontroller, Nucleo, Microchip Pickit 3, Analog Discovery

EMPLOYMENT

Apprentice Electrician Wulff Electric 5/1/17 - 8/21/18
Promoted from being a general laborer up to the position of an apprentice electrician. Worked on residential, commercial and industrial sites, which required learning the different responsibilities and common issues associated with each site type. Projects included establishing the electrical room of a multi-floor apartment complex, installing the breaker panels for each floor of the complex, and setting up pathways to motors of industrial machines and connecting them with the control and power sources.

Apprentice Electrician Churchill Manor
8/22/18 – Current
Electrical work on commercial properties which included the installation of a wired high-resolution surveillance system and the conversion of mercury vapor light fixtures to LED.

PROFESSIONAL ACTIVITIES AND ACCOMPLISHMENTS

- Worked on several multi-million-dollar projects in which I contributed to the development of the project from the ground up. This included the expansion of several factories, the construction of a 5-story apartment/parking retirement complex, and the wiring of a smart house.
- While working 50+ hours a week I still attended community college and received a 4.0 in the semesters I was enrolled.
- Sacramento State's Deans Honor List: Fall 2019
- Worked in a group to create a self-driving RC car that would detect obstacles and follow a line

Wesley Nguyen

3825 Tivoli Court, Stockton, CA 95212
(209) 774-6180
wnguyen370@gmail.com

OBJECTIVE: To hone and refine my knowledge and understanding of computer hardware and software.

EDUATION: ***CSU Sacramento***
Bachelor of Science, Computer Engineering Fall 2020

COURSEWORK:

Program Concept and Methodology	Computer Hardware Design	
Introduction to Logic Design	Data Structure and Algorithm Analysis	
Introduction to Computer Architecture	Operating System Principles	
Introduction System Programming in UNIX	Electronics I	
Introduction to Circuit Analysis	Network Analysis	
Computer Networks and Internets	Signals and Systems	
Advance Computer Organization	Database Management Systems	
Advanced Logic Design	Operating System Pragmatic	(*In Progress*)
Computer Interfacing	Cmos and Vlsi	(*In Progress*)
Discrete Structures	Probability and Random Signal	(*Fall 2020*)

KNOWLEDGE & SKILLS:

Programming Languages:
C C++ Java HTML MySQL Python Verilog VHDL

Software:
Microsoft Word Microsoft Excel Microsoft PowerPoint

Others:
Hardware Assembly/Disassembly Software Troubleshooting

PROJECT EXPERIENCE:

Automated Greenhouse System
- Utilized Arduinos to create an I2C network of abstracted sensors and relays, controlled from a master I2C device.
- Project was done to recognize a proof of concept to abstract sensor and relays, as we acknowledged the fact that utilizing multiple Arduinos was highly inefficient.
- Worked in a team of four, learned how to effectively communicate with one another and set goals.

OS Pragmatics ***In Progress***
- Utilize primarily C, ASM, and SPEDE to design and implement a multitasking operating system.
- Working in a team of three, learned how to effectively manage a repository, deal with scheduling conflicts, and how to compromise.

VOLUNTEER EXPERIENCE:

Religious Service Consultant **Mary Help of Christians Center** **Aug. 2017 - Present**
- Provide training to altar servers for religious services.
- Assist with technology troubleshooting.
- Stepped down from Assistant position for more time flexibility to focus on my education.

Religious Service Assistant **Mary Help of Christians Center** **June 2008 - Aug. 2017**
- Head Aide to presiding priest.
- Delegated tasks to other aides and oversee general training.

- Interact with the community and help with various tasks (technology troubleshooting, custodial duties, childcare).

Don Bosco Youth Group (Youth Leader) **Mary Help of Christians Center** **Aug. 2011 - May 2016**

- Guardian for students between the ages of 6-15 years old during weekly catechism classes.
- Involved in the student's learning and recreational activities.
- Assist adults with various tasks, such as cleaning, lunch duty, and purchasing school supplies.

Daniel A. Komac

Email: komacdan@hotmail.com
Phone Number: (916)591-9930
Address: 5909 Small Hill Ct., Citrus Heights, CA 95621

Objective

A Computer Engineering internship position involving circuit/logic design, software development, hardware development, networking, and computer architecture.

Education

Bachelors of Science, Computer Engineering
California State University, Sacramento, CA, Expected: Fall 2020
GPA: 2.5

Skills/Knowledge

Hardware Languages: VHDL, Verilog
Software Languages: C, C++, Java, HTML, MatLab
Engineering Tools: Xilinx, ModelSim, PSpice, MS Office 2003,
Environments: DOS, Windows(98,99,XP,Vista,8, 10, 11), MS-DOS, UNIX, Linux

Work Experience

Service Agent: 150 N Sunrise, Roseville, CA July 2015 – Present
Maintain and service rental vehicles

Projects

X86 Architecture Processor Unit: Made full simulated CPU with own Program Counter, Hazard Detection Unit, ALU, Control Unit and buffers to complete various inputs that were fed into the input using a Finite State Machine. 2018

Robotic Arm with Controller: Designed a robotic operational arm using VHDL and an Arduino for processing. Contained limiters to limt motion of arms and was able to lift roughly 2ish pounds. 2016

Asteriods (Game): Made, from scratch, own replica of Asteroids game usingeclipse and eclipse plugin(CodeOne). 2018

Punchlist:

1. Functioning Model Car
2. Functioning code to transmit a message
3. Remote control
4. Sequence functions to control AVs
5. V2V communication
6. AV autopilot with random risk assessment
7. Cloud communication and V2V communication (for Driving)
8. Non-AV add-on
9. 3-d Mapping for better collision avoidance