HIGH SCHOOL EDITION
Journal of Student Research
Volume 12 Issue 1 (2023)

V2V Network for Autonomous Vehicles

Rithvik Thummalapenta

Reqelford International School, India

ABSTRACT

Autonomous vehicles are still an imperfect technology, and they still have certain situations where they do not know what to do. To solve this problem, or at least make this problem better, we are proposing a Vehicle to Vehicle Network. This paper will describe every aspect of the network.

Introduction

Autonomous vehicles are a technology companies have been trying to develop for years, and they have also made great progress in this space. However, it is still an imperfect technology. There are situations encountered when driv-ing on roads where computers do not know what to do or simply cannot react fast enough.

This is why I propose a framework for a Vehicle-to-Vehicle Com- munication system. Regardless of their manufacturer, all vehicles will be connected to this network, where they can share informa- tion via WLAN. This information includes speed, acceleration rate, deceleration rate, and their position compared to other cars on the road. This information sharing between vehicles allows them to react to situations preemptively.

For example, suppose a car was about to brake suddenly. In that case, it could send that information to the other cars in its vicinity, allowing all the cars to brake simultaneously, preventing serious accidents. There are also use cases for the network in emergencies. For example, if an emergency vehicle is coming on a road, it can send information to other nearby vehicles to make way for it. Law enforcement could also use this, with police officers, where they could force vehicles to pull over to the side of the road if they do not do so when asked.

Also, communication does not have to be limited to between vehicles. Objects like stop lights could also com-municate with the vehicles, making it much easier to manage traffic. The vehicles could also be sent information to reroute, like in the case of ongoing construction.

Unlike the current V2X and V2V technologies currently being developed, this network relies on self-driving car tech-nology, but at the same time provides an extra layer of security, making the technology safer to use.

Research Problem. The problem that we are trying to solve here is how to make autonomous vehicles more efficient and safe to use. The way that this network will do that is by giving the vehicle more information than it normally would get. This information is about other vehicles, like their speed and position. Having this sort of data allows the computer to make more informed decisions.

Background

So far there have been only two types of protocols that were devel- oped.

These are the V2V and V2X protocols.[1] V2V is where vehicles communicate and transmit data to other vehi-cles. V2X is where vehicles communicate and transmit data to anything, like another vehicle, stop-light, phones, etc. However, these protocols have been designed for manually driven cars. The technology is

supposed to work with the infotainment system in modern cars to provide alerts to the driver. The driver would then make a decision according to the alert.

The network in this paper is meant to be a technology that works with self-driving technology. It will provide information along with the data that the autonomous vehicle will get from its various sensors. This allows it to make more informed and safer decisions. This network will allow for self-driving technology to become a safer technology as a whole.

Communication Between Vehicles

This section will explain the different aspects of the communication that happens between the autonomous vehicles in the network. [3]

Transmission Protocol

The transmission protocol that will be used to send information between vehicles is TCP (Transmission Control Protocol). TCP was chosen as the transmission protocol because it is the most secure and the data is guaranteed to reach the destination. The vehicles will be able to send information to each other via WLAN (IEEE.802.11). The transmis-sion of information will be local, so it will be limited to nearby cars (multiple cars on the same highway), etc. We can safely assume autonomous cars have internet connectivity, thus they will be able to connect to the WLAN, and therefore the network.

Encryption

We decided that encryption for the data was unnecessary as the data being transferred from vehicle to vehicle is not so sensitive that it has to be encrypted each time before being sent to another destination on the network. However, it is also not information that you would want to be transmitting all the time. To solve this problem, the network will have different modes for transmitting information as you can see below.

API for Vehicle Network

To convert the data being sent between vehicles to the correct format, there will be an API that will con-vert data to the correct format and then send it to other vehicles. This is so that the car does not have to process more data and can focus more on driving and such.

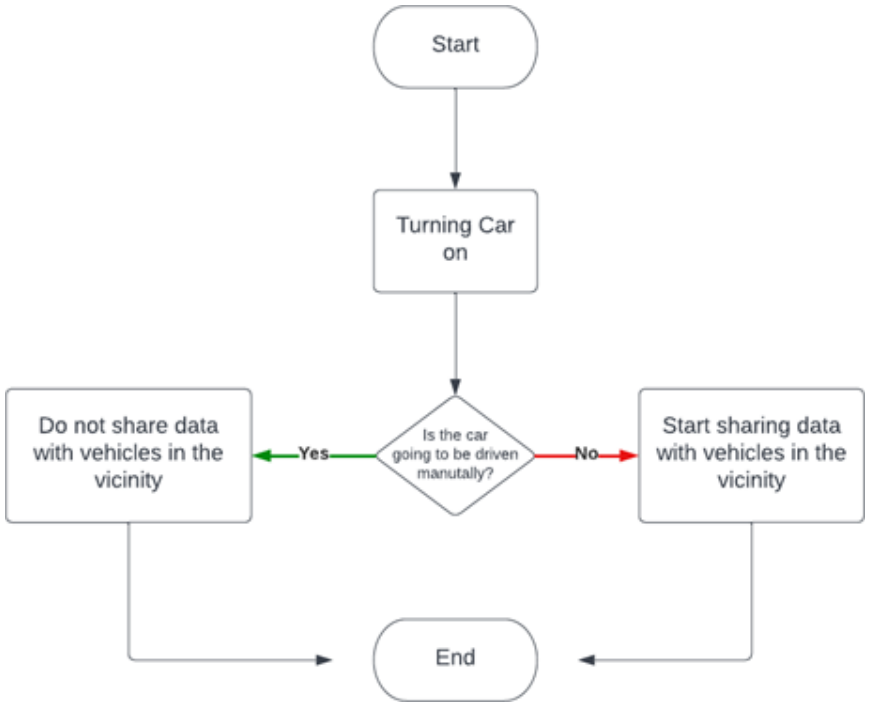

Figure 1. Flowchart for Vehicle mode initialization

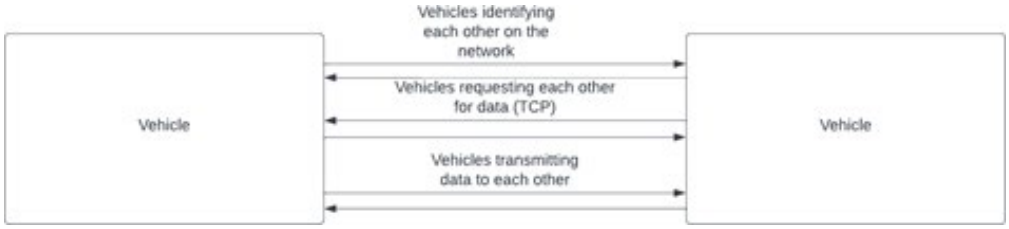

Figure 2. Establishing Communication Between Vehicles

Modes of the Network

The car will stop connecting to the network when the car is in manual mode (When the car is being driven by the driver and not the computer), seeing as the driver will not need all this information. It will also protect the privacy of the driver as the vehicle is not transmitting information to every single car in the vicinity all the time.

V2V Network Concept

This section will provide an overview of the V2V network in this paper.

V2V Network

As mentioned above, the network will essentially serve as an extra layer of security for autonomous vehicle technology. It is not like the current V2V protocols being developed where the network is being used as an alert system' for the driver.[2] Instead, the self- driving technology incorporated in the vehicle will take the data that it was provided by the network and make decisions based on the data given to it by other vehicles as well as the data it already has. This lessens the risk of car accidents because the vehicle has more data to work with, allowing it to make a more efficient and safe decision than it normally would have.

Data Transferred Through the Network

- Acceleration of cars ($m/s2$)
- Position of cars on the road
- Speed of car (m/s)
- What lanes the car will be going into
- Deceleration of the car or how fast it will be braking ($m/s2$)

Use Cases

Besides preventing car crashes, the network could be used for cars to also follow commands. For example, emergency vehicles like am- bulances or fire trucks could send information on the V2V network for the other vehicles to move aside. Police vehicles could also use this technology to make certain cars on the road pull over if they do not stop when asked to. Giving these vehicles this control also helps save lives.

Conclusion

As mentioned before, the main purpose of the network is to increase the safety of autonomous vehicle technology by providing infor- mation it would not normally get, like the speed and acceleration of nearby vehicles. However, along with improving the safety of this technology, it can also be used to give commands to vehicles. Examples are communicating to vehicles to let emergency vehicles through a road or law enforcement vehicles communicating with vehicles and asking them to pull over. Right now this network is only in the form of a whitepaper because this is a very recent space in cars.

Acknowledgments

I would like to thank my advisor for the valuable insight provided to me on this topic.

References

[1] Ramya Daddanala, Vekata Mannava, Lo'ai Tawalbeh, and Mohammad Al-Ramahi. 2021. Vehicle to Vehicle (V2V) Communication Protocol: Components, Benefits, Challenges, Safety and Machine Learning Applications. CoRR abs/2102.07306 (2021). arXiv:2102.07306 https://arxiv.org/abs/2102.07306

[2] Albert Demba and Dietmar P. F. Möller. 2018. Vehicle-to-Vehicle Communication Technology. In 2018 IEEE International Conference on Electro/Information Technol- ogy (EIT). 0459–0464. https://doi.org/10.1109/EIT.2018.8500189

[3] Øyvind Risan and Evtim Peytchev. 2010. A Vehicle-to-Vehicle Communication Protocol for Collaborative Identification of Urban Traffic Conditions. In Ad Hoc Networks, Jun Zheng, David Simplot-Ryl, and Victor C. M. Leung (Eds.). Springer Berlin Heidelberg, Berlin, Heidelberg, 482–494.