Review: Vehicle-to-Vehicle Communication

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1 Background

Self-driving vehicles are evolving rapidly in recent years. Companies such as Toyota, Google, Uber, and Tesla are expecting to have their driverless technology ready by 2020, at the latest.[1] Yet, the safety of these self-driving vehicles still remains a controversial topic today. In particular, Tesla's fatal car accident happened earlier this year has put more pressure on researchers and regulators to keep roads safe while promoting a technology some say could save lives.

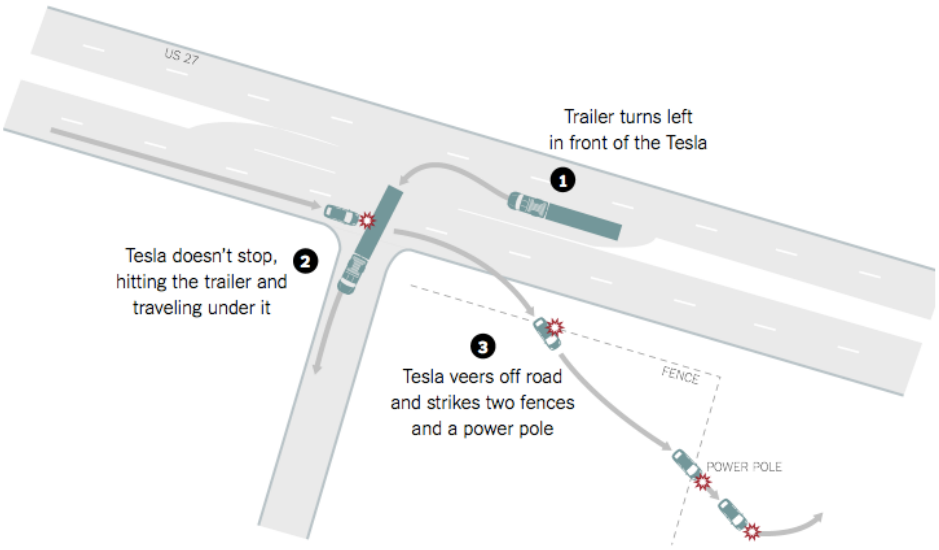

Figure 1. How the Accident Happened[2]

Tesla later explained that the accident was due to the fact that the automation failed to see a white truck against the bright sky.[3] But what if the Tesla and the truck it hit had been able to talk to each other right before the accident?

Then the crash -- and the death -- might have been avoided entirely. This is basically the concept of **Vehicle-to-Vehicle Communication**, known as **V2V.** It serves an important role in optimizing the current limits of autonomous technology.

2 What is V2V ?

V2V allows vehicles to securely broadcast their position, speed, steering-wheel position, brake status, and other data to at least 1,000 feet in any direction, through barriers such as heavy snow or fog. Meanwhile, surrounding vehicles process the data that they receive at 10 times per second. Each time the computer calculate the chance of an impending collision. This two-way wireless communication is known as DSRC (Dedicated Short Range Communications), which permits very high data transmission critical in communications-based active safety applications. Bicycles and pedestrians can also be linked using portable devices such as smartphones or tablets, so that the drivers know where they are located.[3]

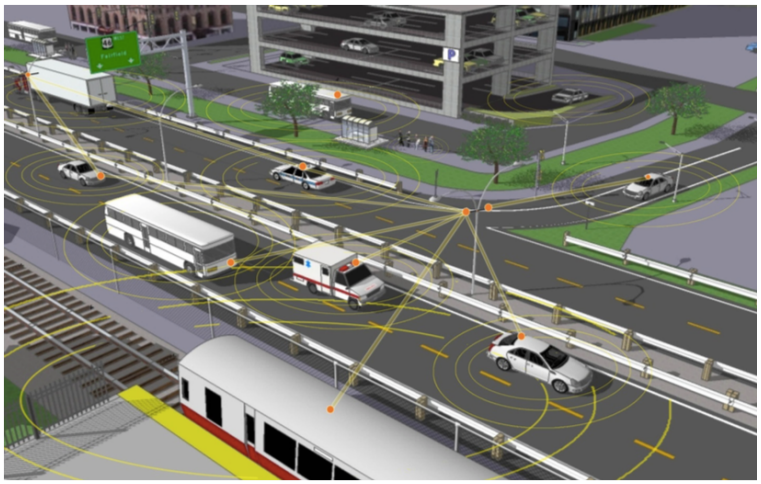

Figure 2. Visual Representation of V2V Communication

3 Why do we need V2V ?

Vehicles nowadays are already connected in many ways: satellite-based GPS navigation, in-vehicle Wi-Fi hotspots, smartphone apps that remind you where you parked, etc.[3] However, there exists only a small amount of connections between the data that these applications transmit and the physical responses of vehicles.

What majorly affect the vehicles' collision warning systems nowadays are obstacle detections using radar or ultrasound, such as forward-collision warning, backup cameras, rear-cross traffic alert, and lane-departure warning.[4] However, these detections have a limited range of only a few car lengths, and they cannot see past the nearest obstruction.

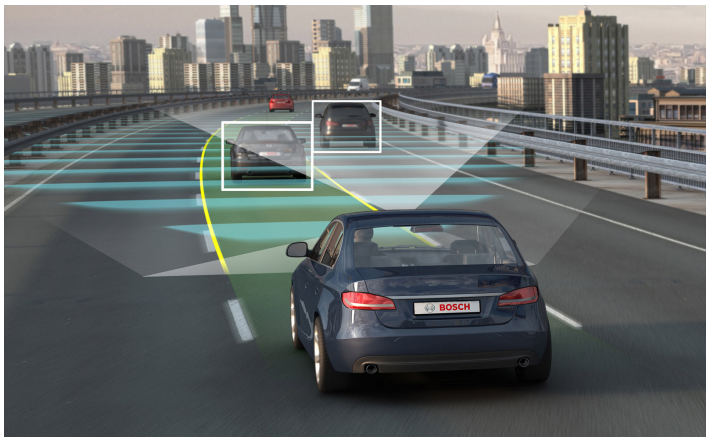

Figure 3. Limitations of Current Obstacle Detections

In contrast, V2V simply networks cars together wirelessly with minimal signal

interference, which avoids situations like the Tesla crash where the detection failed due to strong reflection and has better reliability in extreme weathers.

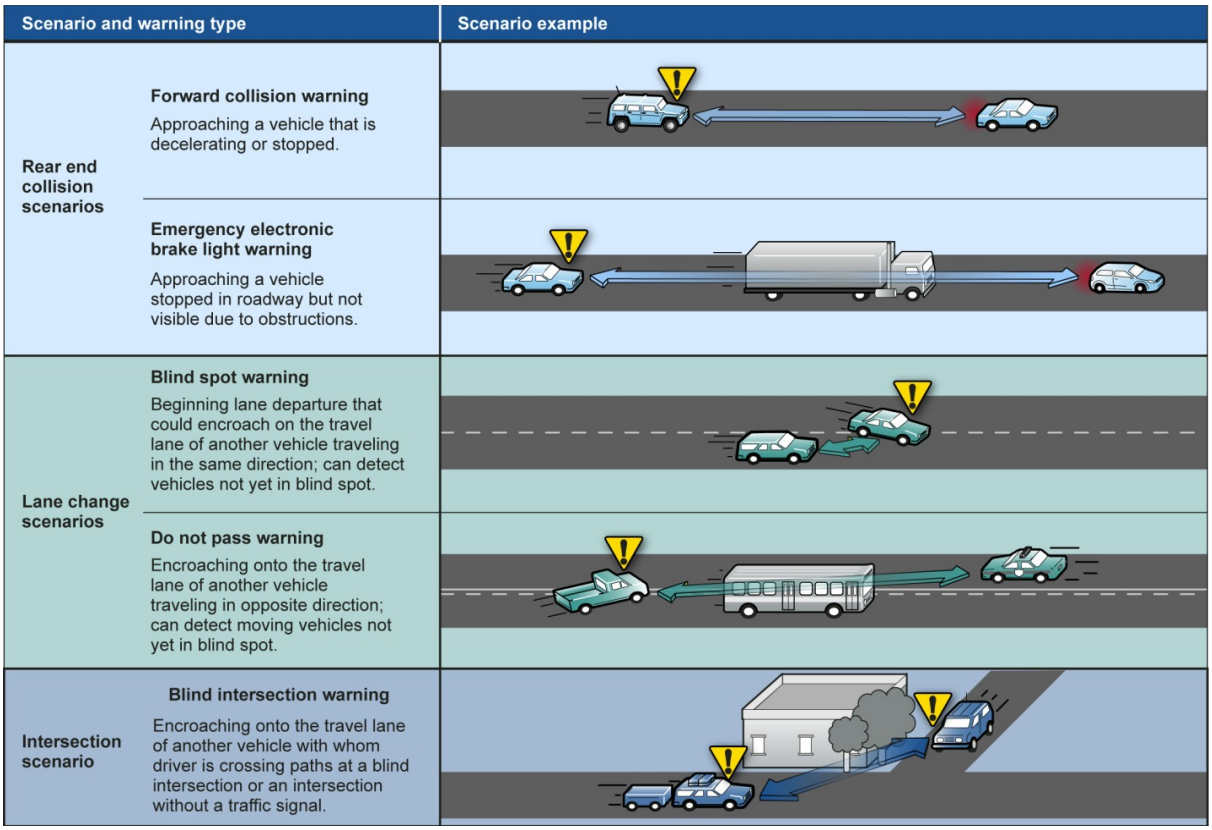

Figure 4. Examples of Crash Scenarios and Vehicle-to-Vehicle Applications

4 Expectations and Challenges

To evaluate the effectiveness of V2V, between 2012 and 2014, the National Highway Traffic Safety Administration and the University of Michigan equipped nearly 3,000 cars with experimental transmitters. Results showed that V2V could prevent more than 500,000 accidents and more than 1,000 fatalities in the US every year.[5] Moreover, the benefits of connected and automated vehicles go well beyond safety. They hold the potential to significantly reduce fuel use and carbon emissions through more efficient traffic flow. V2V developers are expecting the extensive application of this technology to be achieved in less than one year.

Nevertheless, one critical challenge that this technology faces right now is the requirement of a significantly large sample space. If the size is small, those tested vehicles equipped with V2V will have few cars to talk to, limiting the value of this technology. Additional challenges of V2V include better data processing algorithms, potential privacy violations, and cyberattack vulnerabilities.

References

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[3] Peng, Huei. “Saving Lives by Letting Cars Talk to Each Other.” The Conversation, September 11, 2016. https://theconversation.com/saving-lives-by-letting-cars-talk-to-each-other-59221.

[4] “Cars With Advanced Safety Systems.” Consumer Reports, November 18, 2016. http://www.consumerreports.org/car-safety/cars-with-advanced-safety-systems/.

[5] Knight, Will. “Car-to-Car Communication.” MIT Technology Review, n.d. https://www.technologyreview.com/s/534981/car-to-car-communication/.