Science Module: Connected Vehicles

Provides an overview of systems that allow vehicles to communicate with infrastructure and other road users.

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HAL — Humans and Autonomy Lab

WHAT IT DOES

A connected transportation system in which autonomous driving systems can communicate information with each other and their environment would enhance road safety by improving the ability of the driving system to accurately coordinate its decisions with the conditions of its environment and predict dangers in its environment.

RELEVANT SCIENCE

Vehicle to everything (V2X) communication is the transfer of information between vehicles and any entity that may affect it or that it may affect. This communication would be powered by a network technology that connects all devices, creating constant communication between vehicles and other technology. The various forms of communication between the vehicle and its surroundings is illustrated in the figure below.

V2X Examples (Huawei)

- Vehicle to infrastructure (V2I) communication is the transfer of information from the vehicle to the highway and traffic system. This communication is primarily short-range and may include the sharing of information between vehicles and traffic lights, traffic signs, and even parking meters.
- Vehicle to vehicle (V2V) communication is the transfer of information from the vehicle to other vehicles. This communication is primarily short range and may allow vehicles to share information about speed and acceleration to speed up traffic flow, warn each other about dangers that other vehicles cannot yet perceive, or detect each other around turns or intersections before vehicle sensors themselves can detect each other.
  - Platooning is when a group of vehicles travel in synchronization by matching each other's speed, accelerating, and braking.
- Vehicle to pedestrian (V2P) communication is the transfer of information between vehicles and pedestrians. This communication is primarily short range and will identify pre-crash scenarios, make vehicles and pedestrians more aware of each other, communicate vehicle intent, and enhance the overall safety of their interactions.
- Vehicle to device (V2D) communication is the transfer of information between vehicles and any electronic device to which the vehicle is connected. This communication may include vehicle connectivity to mobile apps carried by other road users.
- Vehicle to home (V2H) is the transfer of information between vehicles and applications in the home.

One major roadblock to the existence of a connected transportation system is the lack of networks to support such a system. Existing wireless networks were not designed with bandwidth to support the massive quantity of data that systems would need to send and receive. Instead, system communication will require a network with greater data processing capacity, but it is uncertain whether the funding and development of this network ought to be left to private entities such as automotive manufacturers and cellular networking companies or to public entities such as the government. Both public and private entities have been involved in developing stronger network technologies, but there is no consensus on what type of network will be used to support driving

system connectivity.

Communication Networks (ABI Research)

- [Fifth generation networking (5G)](#) is the next generation of wireless networking architecture designed to replace its 4G LTE predecessor. Since this network will have improved capacity for data collection, storage, and processing, it will be the first wireless network able to support V2X communication. Signals are transferred to and from devices over long ranges through cellular towers. The network communications supported by 5G are depicted above. Various cell phone carriers are independently developing the infrastructure for 5G networks, but there is not complete agreement between carriers about which technologies will comprise the final network.
- [Distributed short range communications (DSRC)](#) is another radio-based communication network that can support V2X communication. DSRC is designed for short or medium range communication between vehicles and other vehicles or infrastructure. The direct communications supported by DSRC are depicted above. Radio signals are transmitted through on-board units (OBUs) on vehicles or roadside units (RSUs) on infrastructure. DSRC is [expected to come before](#) 5G since it requires less extensive infrastructure, but it is unclear whether it will be used as the primary communication network or as a supplementary network once 5G is ready.

BACKGROUND

Further reading:

- https://www.autotrader.com/car-shopping/self-driving-cars-what-is-v2x-te...
- https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/v2v_fact_sheet...
- https://www.wheelsmag.com.au/features/1709/explained-v2x-vehicle-to-ever...
- http://www.middleeast.siemens.com/pool/news_press/siemens-vehicle-to-x-c...
- https://spectrum.ieee.org/cars-that-think/transportation/self-driving/au...
- http://viodi.com/2017/07/07/dsrc-or-5g/
- https://5g.ieee.org/tech-focus/june-2017/cellular-v2x

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