Modern Industry Practice

ELEC5032M

Essay on:

Connected and Autonomous Vehicles

Submitted by -

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Abstract

Connected and Autonomous Vehicle are the future of commutation. It is made possible by technologies such as path planning which utilizes vehicular communication with its surrounding. Sensors such as Lidar, Radar and Cameras used for the perception and visualization of the environment are crucial for sensing real time data [1]. Machine learning algorithm make it possible for real time path planning such as lane detection technique as discussed in [2].

Advance Driver Assistance System (ADAS) is the cumulation of above technologies which is required for achieving autonomous driving. These self-driving cars will change the way people travel and make the commutation smoother, economic and faster. According to Gartner more than 700,000 Autonomous vehicles will be plying by 2023.[3]

Levels of autonomous vehicle

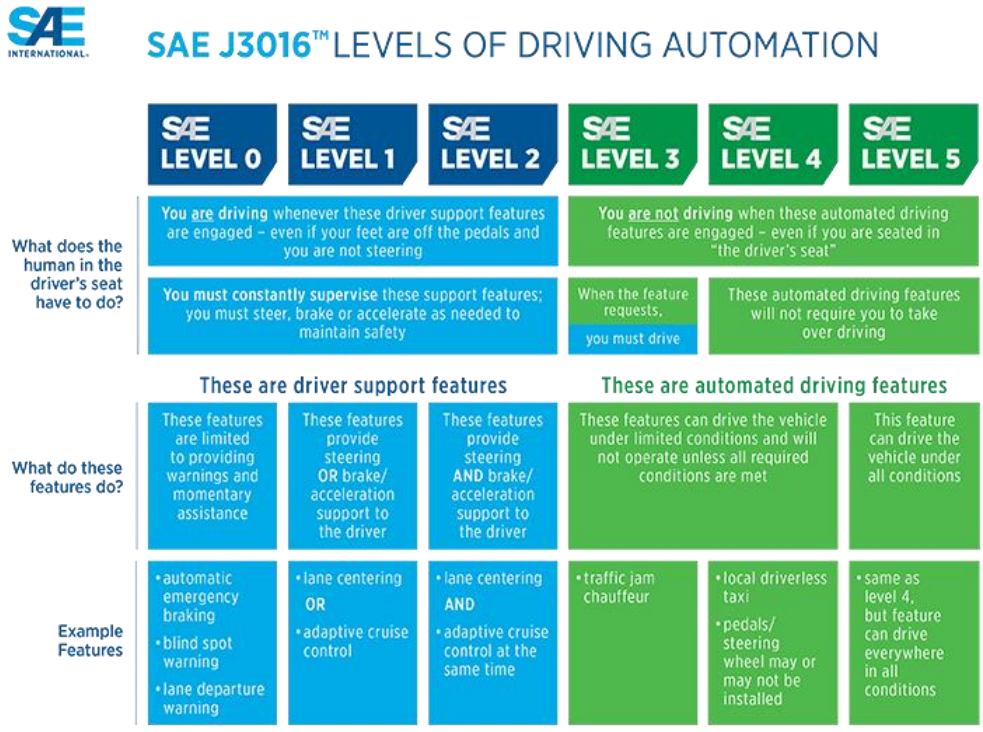

Figure 1. Level of Autonomous Vehicle taken from [4]

According to SAE International, the autonomous vehicles can be categorized into 6 levels i.e. from with level 0 having no automation while level 5 being fully autonomous.

Each level of Autonomous vehicle taken from [4] and [5] are discussed below:

No Automation (Level 0) – Conventional cars belongs to this category. Car is fully controlled by a human and no assistance is provided to the driver.

Driver Assistance (Level 1) – Many cars running in U.K. comes under this category. For some scenarios the car can either control the acceleration or the steering one at a time, but the driver is responsible for majority of driving. Features such as self-parking and lane change assist falls under this category. [6]

Partial Automation (Level 2) – Some cars such as Tesla falls under this category. Driver is supposed to pay attention to the surrounding and take control of vehicle when necessary. The ADAS installed in the vehicle can control the driving in simple situations such as highway commute.

Conditional Automation (Level 3) – These cars will be able to drive completely without human intervention in simple conditions, but under challenging circumstances and bad weather, human intervention will be required. According to BMW group, by 2021 production of level3 cars will start [7]

High Automation (Level 4)- These cars will be able to navigate without a driver in most of the challenging situations.. Alphabet's Waymo used by google falls under this category.[6]

Full Automation (Level 5) – This will be the pinnacle of self-driving technology. These cars will be able to self-operate under all weather and road conditions. Volkswagen claims to start production of Level 5 vehicle between 2025 to 2030 [8]

Vehicular Communication.

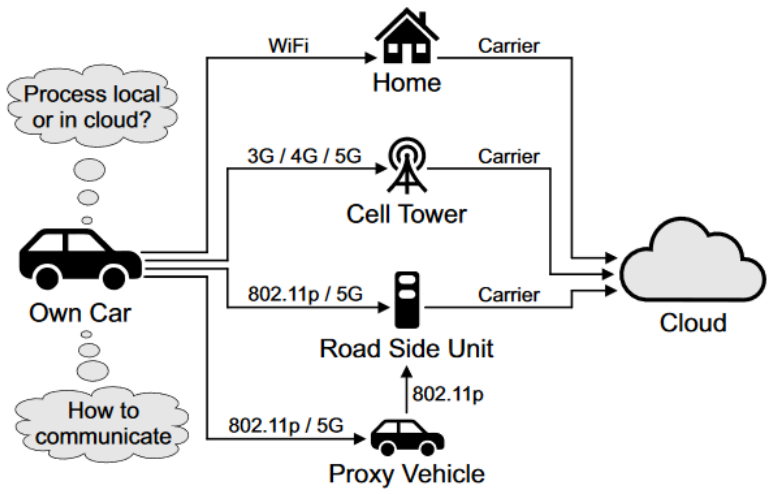

Figure 2. V2X communication. [9]

For Self-driving cars the communication between vehicle and its surrounding is very important which can improve safety, efficiency and management of traffic as a whole. 5G internet will play a crucial role in unlocking its full potential. According to a directive from EU in 2010 intelligent transport systems (ITS) can be defined as the exchange of information by a vehicle with other vehicles, infrastructure, pedestrians and other modes of transports. [10]

Different communication protocols taken from [17] & [18] are discussed below:

Vehicle to Infrastructure (V2I) : Data is shared between a vehicle and nearby buildings, structures like traffic lights, parking lots, etc. This kind of communication can help in intimating the vehicle about sharp turns, free parking space, status of traffic etc.

Vehicle to Vehicle (V2V): Data is shared between all nearby vehicles. This can help the vehicle to drive synchronously in a column hence braking and acceleration can become smooth and ride will be safer and economic.

Vehicle to Cloud (V2C): This technology is used in automobiles today in form of modern navigation system. GPS and cellular tower are used to detect the position and optimal routing calculation is performed according to the traffic condition.

Vehicle to Pedestrian (V2P): The cell phone and smart watches of pedestrian can communicate with the vehicle and thus signal the pedestrian and also the car of any possible collision.

Vehicle to Everything (V2X): This is the consolidated technology integrating other communication categories thus making the intelligent transport systems (ITS). Since everything will be interconnected whole system will be streamlined and efficient.

Challenges in achieving complete autonomous mobility.

Ethical Dilemmas

Although autonomous vehicle will be safer, but the major concern that the scientists and law makers are facing today is to decide what actions should an autonomous vehicle take in an event of an inevitable collisions. The paper[11] discuss the challenges the regulatory bodies are facing. The most important questions are who should be allowed to set such regulation, who should be held responsible in case of a fatal accident and whose life should be given priority in such cases.

Privacy

Due to use of communication technology in these vehicles, collection and distribution of data has to be regulated. One major concern will be to decide what data can be shared and which can't be shared. Big firms have been panelised for breaching privacy [12].

Cybersecurity

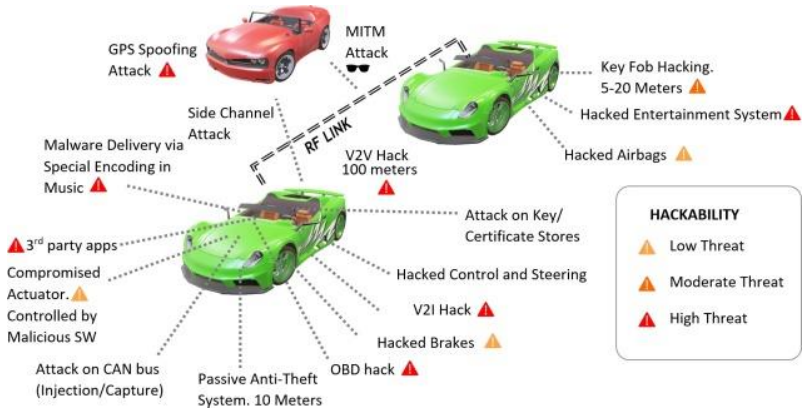

Figure 3. Cyber-attack on vehicle. [13]

Autonomous vehicles have to be protected from unauthorised access by hackers, thieves, etc. In [14] article the author discusses the possibility of complete gridlock in cities by hacking certain number of cars bringing the whole city to a standstill.

Job loss

Due to lack of drivers in autonomous vehicles they can run for extended period of time stopping only for refuelling and maintenance, the company doesn't have to pay for the driver hence saving money. According to a research, about 300,000 jobs will be lost in US. [15]

Effect of Solar storm

In level 4 and level 5 autonomous vehicles, the path planning and self-driving capabilities will depend on the global positioning systems or cellular tower. Major solar storms have been known to disrupt the GPS satellite or network grids, disruption to GPS and cellular tower can cause the autonomous vehicle to come to a standstill in the affected area. This paper discusses the risk of Solar storm which might cause the regional/global blackout of GPS and mobile tower hence barring trip planning, bring autonomous vehicles to halt. [16]

Conclusion

Connected and autonomous vehicle is a disruptive technology which will change the way of our commutation. These cars are categorised in different levels according to their automation capabilities, companies are working to develop cars belonging to different levels. Vehicular communication will play a major role in development of self-driving car and 5G wireless will be an important factor to achieve complete automation. One of the major issues that manufacturers and law maker are facing is related to ethical decision making which includes the privacy and safety of the rider and other people on the road.

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