Self-driving car

History, Technology, Challenges, Testing, Applications, Impact, Incidents, In fiction.

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What is the Self-driving car

A self-driving car, also known as an autonomous vehicle (AV or auto), driverless car, or robot car is a vehicle that is capable of sensing its environment and moving safely with little or no human input.

Self-driving cars combine a variety of sensors to perceive their surroundings, such as radar, lidar, sonar, GPS, odometry, and inertial measurement units. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage.

Tesla Autonomous Car

History

Experiments have been conducted on automated driving systems (ADS) since at least the 1920s trials began in the 1950s. The first semi-automated car was developed in 1977, by Japan's Tsukuba Mechanical Engineering Laboratory, which required specially marked streets that were interpreted by two cameras on the vehicle and an analog computer. The vehicle reached speeds up to 30 kilometers per hour (19 mph) with the support of an elevated rail. On March 5, 2021, Honda began leasing in Japan a limited edition of 100 Legend Hybrid EX sedans equipped with the newly approved Level 3 automated driving equipment which had been granted the safety certification by the Japanese government to their autonomous "Traffic Jam Pilot" driving technology, and legally allow drivers to take their eyes off the road.

Technology

The characteristics of autonomous vehicles, like digital technology, are distinguishable from other types of technologies and vehicles. These characteristics mean autonomous vehicles can be more transformative and agile to possible changes. The characteristics include hybrid navigation, homogenization, and decoupling, vehicle communication systems, reprogrammable and smart, digital traces, and modularity.

1. Hybrid navigation

- There are different systems that help the self-driving car control the car, including the car navigation system, the location system, the electronic map, the map matching, the global path planning, the environment perception, the laser perception, the radar perception, the visual perception, the vehicle control, the perception of vehicle speed and direction, and the vehicle control method.

2. Homogenization and decoupling

- Homogenization indicates the fact that all digital information assumes the same form. During the ongoing evolution of the digital era, certain industry standards have been developed on how to store digital information and in what type of format. This concept of homogenization also applies to autonomous vehicles. In order for autonomous vehicles to perceive their surroundings, they have to use different techniques each with their own accompanying digital information (e.g. radar, GPS, motion sensors, and computer vision).

3. Digital traces

- Autonomous vehicles are equipped with different sorts of sensors and radars. As said, this allows them to connect and interoperate with computers from other

autonomous vehicles and/or roadside units. This implies that autonomous vehicles leave digital traces when they connect or interoperate. The data that comes from these digital traces can be used to develop new (to be determined) products or updates to enhance autonomous vehicles' driving ability or safety.

Challenges

❖ Possible technological obstacles for automated cars are:

- Artificial Intelligence is still not able to function properly in chaotic inner-city environments.
- A car's computer could potentially be compromised, as could a communication system between cars
- Susceptibility of the car's sensing and navigation systems to different types of weather (such as snow) or deliberate interference, including jamming and spoofing
- Avoidance of large animals requires recognition and tracking, and Volvo found that software suited to caribou, deer, and elk was ineffective with kangaroos.
- Autonomous cars may require high-definition maps to operate properly. Where these maps may be out of date, they would need to be able to fall back to reasonable behaviors.
- Competition for the radio spectrum desired for the car's communication.
- Field programmability for the systems will require careful evaluation of product development and the component supply chain
- Current road infrastructure may need changes for automated cars to function optimally. Social challenges include:
- Uncertainty about potential future regulation may delay deployment of automated cars on the road.
- Employment – Companies working on the technology have an increasing recruitment problem in that the available talent pool has not grown with demand. As such, education and training by third-party organizations such as providers of online courses and self-taught community-driven projects such as DIY Robocars and Formula Pi have quickly grown in popularity, while university level extra-curricular programmers such as Formula Student Driverless have bolstered graduate experience. Industry is steadily increasing freely available information sources, such as code, datasets and glossaries to widen the recruitment pool.

❖ Human factor

- Self-driving cars are already exploring the difficulties of determining the intentions of pedestrians, bicyclists, and animals, and models of behavior must be programmed into driving algorithms. Human road users also have the challenge of determining the intentions of autonomous vehicles, where there is no driver with which to make eye contact or exchange hand signals. Drive.ai is testing a solution to this problem that involves LED signs mounted on the outside of the vehicle, announcing status such as "going now, don't cross" vs. "waiting for you to cross".
- In order for people to buy self-driving cars and vote for the government to allow them on roads, the technology must be trusted as safe. Self-driving elevators were invented in 1900, but the high number of people refusing to use them slowed adoption for several

decades until operator strikes increased demand, and trust was built with advertising and features like the emergency stop button.

Testing

The testing of vehicles with varying degrees of automation can be carried out either physically, in a closed environment, or, where permitted, on public roads (typically requiring a license or permit, or adhering to a specific set of operating principles), or in a virtual environment, i.e. using computer simulations. When driven on public roads, automated vehicles require a person to monitor their proper operation and "take over" when needed. For example, New York state has strict requirements for the test driver, such that the vehicle can be corrected at all times by a licensed operator; highlighted by Cardin Cube Company's application and discussions with New York State officials and the NYS DMV.

Applications

- **Autonomous trucks and vans**
  - Companies such as Otto and Starsky Robotics have focused on autonomous trucks. Automation of trucks is important, not only due to the improved safety aspects of these very heavy vehicles, but also due to the ability of fuel savings through platooning. Autonomous vans are being used by online grocers such as Ocado.
- **Transport systems**
  - In Europe, cities in Belgium, France, Italy, and the UK are planning to operate transport systems for automated cars, and Germany, the Netherlands, and Spain have allowed public testing in traffic. In 2015, the UK launched public trials of the LUTZ Pathfinder automated pod in Milton Keynes. Beginning in summer 2015, the French government allowed PSA Peugeot-Citroen to make trials in real conditions in the Paris area. The experiments were planned to be extended to other cities such as Bordeaux and Strasbourg by 2016. The alliance between French companies THALES and Vale (provider of the first self-parking car system that equips Audi and Mercedes permit) is testing its own system. New Zealand is planning to use automated vehicles for public transport in Tauranga and Christchurch.
- **Tesla Autopilot**
  - is a suite of advanced driver-assistance system features offered by Tesla that has lane centering, traffic-aware cruise control, self-parking, automatic lane changes, semi-autonomous navigation on limited access freeways, and the ability to summon the car from a garage or parking spot. In all of these features, the driver is responsible and the car requires constant supervision. The company claims the

features reduce accidents caused by driver negligence and fatigue from long-term driving. In October 2020, Consumer Reports called Tesla Autopilot "a distant second" (behind Cadillac's Super Cruise), although it was ranked first in the "Capabilities and Performance" and "Ease of Use" category.

Impact

There are many influences on many areas, including.

- **Automobile industry**
- **Health**
- **Welfare**
- **Urban planning**
- **Traffic**
- **Insurance**
- **Labor market**
- **Energy and environmental impacts**
- **Self-parking**
- **Parking space**
- **Privacy**
- **Terrorist scenarios**
- **Taxis**
- **Car repair**
- **Rescue, emergency response, and military**
- **Interior design and entertainment**
- **Telecommunication**
- **Hospitality industry and airlines**

Incidents

❖ **Tesla Autopilot**

- On 20 January 2016, the first of five known fatal crashes of a Tesla with Autopilot occurred in China's Hubei province.[271] According to China's 163.com news channel, this marked "China's first accidental death due to Tesla's automatic driving (system)". Initially, Tesla pointed out that the vehicle was so badly damaged from the impact that their recorder was not able to conclusively prove that the car had been on Autopilot at the time; however, 163.com pointed out that other factors, such as

the car's absolute failure to take any evasive actions before the high-speed crash, and the driver's otherwise good driving record, seemed to indicate a strong likelihood that the car was on Autopilot at the time. A similar fatal crash occurred four months later in Florida.[272][273] In 2018, in a subsequent civil suit between the father of the driver killed and Tesla, Tesla did not deny that the car had been on Autopilot at the time of the accident and sent evidence to the victim's father documenting that fact.

❖ Waymo

- According to Google's accident reports as of early 2016, their test cars had been involved in 14 collisions, of which other drivers were at fault 13 times, although in 2016 the car's software caused a crash.
- In June 2015, Brin confirmed that 12 vehicles had suffered collisions as of that date. Eight involved rear-end collisions at a stop sign or traffic light, two in which the vehicle was side-swiped by another driver, one in which another driver rolled through a stop sign and one where a Google employee was controlling the car manually. In July 2015, three Google employees suffered minor injuries when their vehicle was rear-ended by a car whose driver failed to brake at a traffic light. This was the first time that a collision resulted in injuries. On 14 February 2016, a Google vehicle attempted to avoid sandbags blocking its path. During the maneuver, it struck a bus. Google stated, "In this case, we clearly bear some responsibility because if our car hadn't moved, there wouldn't have been a collision. Google characterized the crash as a misunderstanding and a learning experience. No injuries were reported in the crash.

Waymo | The Google self-driving car

❖ Uber

- In March 2017, an Uber test vehicle was involved in a crash in Tempe, Arizona when another car failed to yield, flipping the Uber vehicle. There were no injuries in the accident.
- On 18 March 2018, Elaine Herzberg became the first pedestrian to be killed by a self-driving car in the United States after being hit by an Uber vehicle, also in Tempe. Herzberg was crossing outside of a crosswalk, approximately 400 feet from an intersection. This marks the first time an individual outside an auto-piloted car is known to have been killed by such a car.

In fiction

❖ In film

The automated and occasionally sentient self-driving car story has earned its place in both literary science fiction and pop sci-fi.

- The film Logan (2017), set in 2029, features fully automated trucks.
- Blade Runner 2049 (2017) opens with LAPD Replicant cop K waking up in his modern Spinner (a flying police car, now featuring an automatic driver and separable surveillance roof drone) on approach to a protein farm in northern California.
- Upgrade (2018), set in a not-too-distant future, highlights the hazardous side to automated cars as their driving systems can get hijacked and imperil the passengers.
- In Child's Play (2019) Chucky hijacks a self-driving "Kaplan Car" for the murder of Mike's mother, making it crash into normal cars at a department store's parking lot.
- In the film Spies in Disguise (2019), Lance Sterling's car is capable of driving autonomously.

❖ In literature

- Intelligent or self-driving cars are a common theme in science fiction literature. Examples include:
- In Isaac Asimov's science-fiction short story, "Sally" (first published May–June 1953), automated cars have "positronic brains" and communicate via honking horns and slamming doors, and save their human caretaker. Due to the high cost of the brain, few can afford a personal vehicle, so buses have become the norm.

- Peter F. Hamilton's Commonwealth Saga series features intelligent or self-driving vehicles.
- In Robert A Heinlein's novel, The Number of the Beast (1980), Zeb Carter's driving and flying car "Gay Deceiver" is at first semi-automated and later, after modifications by Zeb's wife Deity, becomes sentient and capable of fully autonomous operation.

❖ **In television**

- The animated TV series Blaze and the Monster Machines has various self-driving /autonomous cars and trucks.
- Black Mirror episode "Hated in the Nation" briefly features a self-driving SUV with a touchscreen interface on the inside.
- Bull has a show discussing the effectiveness and safety of self-driving cars in an episode call E.J

The report has ended

Notice

This report was submitted by me from the deduction of several articles on self-driving cars with the addition of some of my personal opinions, my understanding and my thinking on the topic.

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