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Current trends in autonomous vehicles

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Abstract

The development of autonomous vehicles has been very progressive in the last few years. Autonomous driving technologies promise numerous improvements to vehicular traffic: an increase in both highway capacity and traffic flow because of faster response times, less fuel consumption and pollution thanks to more foresighted driving, and hopefully fewer accidents thanks to collision avoidance systems. In addition, drivers can save time for more useful activities. Despite many successful attempts and prototypes, autonomous transport is not deployed to the extent it is presented. This article describes basic principles of autonomous vehicles, used technologies but also ethical aspects in autonomous transportation.

Keywords: autonomous vehicles, lidar, radar, ethics of autonomous vehicles.

Introduction

Autonomous vehicles include cars, trucks (or industrial vehicles) where drivers are not required to take control of the safe operation of the vehicle. These vehicles combine sensors and software to provide vehicle navigation and control. Fully autonomous vehicles have not yet been fully integrated into transport. However, there are partially autonomous vehicles that are commonly found in transport - vehicles with different degrees of automatic steering, such as brake assist, lane assist, parking assist, sensing of surrounding traffic and pedestrians. This group includes:

- Cars and trucks
- Public transport vehicles
- Logistics vehicles in production

Levels of autonomous vehicles

Different types of vehicles allow a different degree of so-called. "Self-riding" skills. These abilities are often represented by levels on a scale from 0 to 5 as follow [1]:

- Level 0 - includes all systems fully controlled by humans.
- Level 1 - some systems such as automatic brake assist, or lane assist can be operated/controlled directly by the vehicle itself.
- Level 2 - At the same time, the vehicle offers at once at least 2 automated functions (e.g. acceleration and steering) but requires human supervision to ensure safe operation.
- Level 3 - the vehicle can manage all safety functions under certain conditions, but the driver must take control of the vehicle when prompted.
- Level 4 - The vehicle is fully autonomous, but only within the specified driving scenarios.
- Level 5 - The vehicle is capable of fully autonomous driving in any situation.

Technologies of autonomous control

Various autonomous control technologies have been and are being developed by many global companies such as Google, Tesla, Uber, Mercedes, researchers, technology companies and manufacturers in the automotive industry.

Of course, the specific details and each manufacturer may vary, but it is possible to assume that the elemental elements, which are needed to ensure the functionality of the autonomous control,

are very similar. From the point of view of the technological equipment of the vehicle, it is necessary to implement elements that sense the surroundings of the vehicle, such as:

- Light Detection And Ranging (LiDAR)
- Radar (Radio Detection And Ranging)

LiDAR

This device acts as the vehicle eye. It provides a 360-degree view of the surroundings and helps vehicles to drive safely. The constantly rotating LiDAR system emits thousands of laser pulses every second. These impulses collide with surrounding objects and are reflected back. The resulting light reflections are then used to create a point cloud. The vehicle's on-board computer records each point thus reflected and translates this fast-updating point cloud into an animated 3D view. 3D image is created by measuring the speed of light and the distance, which the light beam overcomes. This helps to determine the position of the vehicle towards other surrounding objects. The 3D display monitors the distance between the passing vehicle as well as the vehicle ahead of the autonomous vehicle. LiDAR helps to slow down or stop the vehicle and vice versa, if the road ahead is clear, the vehicle will be informed that it can accelerate [2].

Figure 1 - Processed point cloud from LiDAR technology. The colors represent the distance from the surrounding objects. [3]

LiDAR is also included in a new development called Pre-Scanning (Pre-Scan). In pre-scanning, the laser scans the road surface several times per second. This information is then inputted to the on-board car computer and processed in a fraction of a second, while there is individually adjusted the suspension stiffness on each wheel. With the help of LiDAR technology, autonomous vehicles move smoothly and avoid collisions by effectively monitoring obstacles ahead. This improves road safety and makes autonomous vehicles less vulnerable to accidents by eliminating the risk of driver inattention [2].

RADAR

The main difference to LiDAR technology is that Radar uses radio waves instead of lasers to capture objects. This gives the radar the ability to directly measure the speed of surrounding objects, offering a critical advantage in the automotive environment. To achieve the same result, LiDAR systems would have to rely on a very complex analysis. In addition, when radar waves travel through the air, less energy is lost compared to light waves, which means that the radar can work at longer distances. Radar has been used for years for military purposes in aircraft and battleships.

Radar maintains functionality in all weather and light conditions. However, this technology is traditionally limited by low resolution. This disadvantage causes, that radar is sensitive to false alarms and can be unable to reliably identify stationary objects. However, in recent years this technology has evolved and allows high-definition work.

Ethical aspects of autonomous vehicles

One of the greatest challenges nowadays in the field of autonomous vehicles is the ethical aspect. As mentioned in [4], the ethical aspect of autonomous vehicles raises a large number of questions, such as:

- What happens in case of sudden deterioration of weather conditions during operation? Will the vehicle automatically park and wait until the weather improves?
- Will passengers be allowed to drive? If so, in what situations?
- Will it be necessary to hold a driving license for the use of an autonomous vehicle?
- Will the police be able to intervene, and in what way if the vehicle rides dangerously?
- Will the police be able to stop an autonomous vehicle to check passengers?

And of course the most discussed topics are:

- How should an autonomous vehicle react in a crisis situation, where passengers and other road users are at risk - which group of people should it prefer and to what extent?
- Who will be liable for damages caused by a collision of an autonomous vehicle? Will it be the vehicle owner, manufacturer or supplier of autonomous control software?

Conclusion

The area of autonomous vehicles is undoubtedly very popular and the topic addressed

both among vehicle manufacturers and researchers but also among people in general. Despite its very promising potential, the development and deployment itself is unfortunately hampered by legislative, ethical and infrastructure constraints that are not easy to bridge. Today's technology allows us to move faster than ever before and autonomous vehicles deployed in various test facilities around the world are direct proof of this.

With the rapid development of artificial intelligence, there are justified concerns about how machines will act in moral decisions and how to interpret the ethical principles that should control machine behavior. [5]

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