Future of Autonomous Driving

Abstract

The edge of technology nowadays is designing and developing self-driving cars that a lot of modern companies from different industries try to be prior in the existing competition. In this article, I try to explain self-driving cars from different aspects.

Introduction

The self-driving car was invented at the end of the 20century, but it didn't success project at the time because of obstacles of technology, after developing technology in different aspects the old dream gets a new life. The needed technologies for self-driving cars must support 4 steps, perception, localization, prediction, and decision-making.

Another topic I will follow in this article is the levels of vehicle autonomy, which is important for companies to achieve a higher level than others to reach the full automation of self-driving cars.

Perception

The self-driving cars use different sensors to understand the environment and each of these sensors has some pros and cons. The first and essential sensor that exists on all of them is the camera. The different types of cameras use coverage of 360 degrees wide-range view and 200 meters short-range view. Addition of these tasks, Tesla uses technology with more cameras to create a birds-eye view that avoids Tesla self-driving cars to use the Lidar that uses by other companies for this task. The Lidar helps to improve input data in foggy and rainy weather and in addition it creates a birds-eye view that helps to find a parking spot. Another sensor that is very important for the recognition environment in bad weather situations is Radar. But radar has big cons to getting noisy input with no needed details that can affect the prediction and decision-making steps.

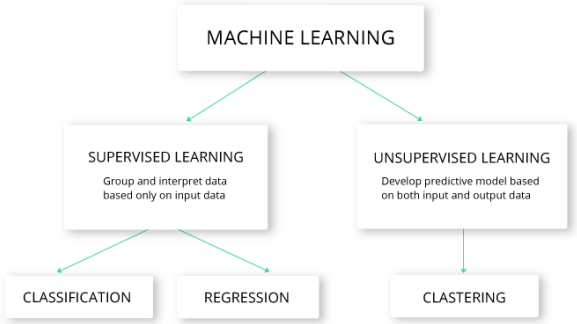
All input information is sent to the main processor for the remaining steps.

Localization

The first task after getting all information from different sensors creates the inputs with meaning for the prediction step.

Prediction

In this step, different kinds of algorithms are used for better prediction and to give the less possible actions to the next steps,



The main used algorithm in the prediction part is CNN (Convolutional Neural Networks) to recognize input images and decrease the noise. The different companies have different strategies to use different ML algorithms, some of them combine input images before to give ML algorithms others use them in the separated algorithms and combine the result at the end.

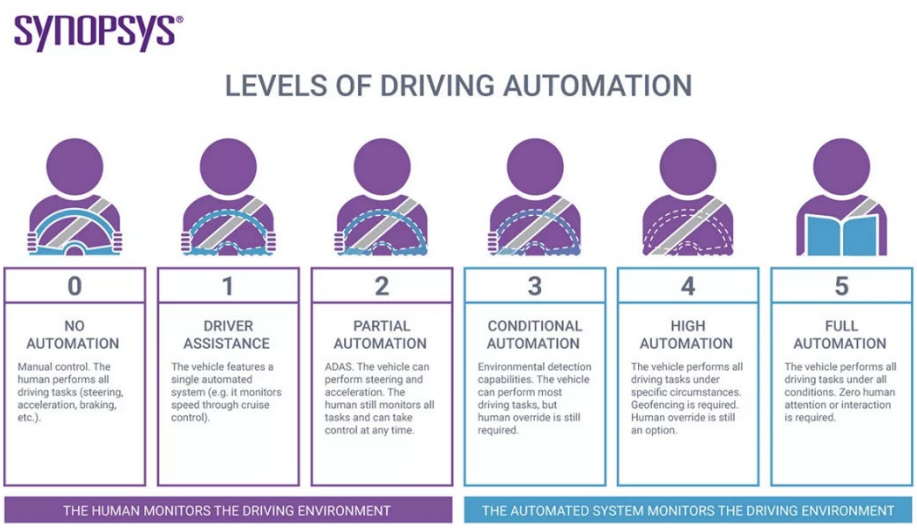
Decision-Making

The important point of using supervised algorithms is to give a label to each sample that needed human contribution, so for the decision-making step based on the basics of the self-driving car that likes an agent in Reinforcement Learning the method the companies use the Markov decision process (MDP) to gain better result. The agent in Deep Reinforcement Learning (DRL) uses the **Policy** to make an **Action** that this policy is defined by the machine when trying to get the most possible **Rewards** from the rules that exist in the **Environment**.

The important rule for a self-driving car is to be safe for the driver, passengers, and pedestrians. Finding the best possible route to arrive at the destination, and following the driving rules are the other important rules that are defined for a self-driving car.

The 6 Levels of Vehicle Autonomy

These levels are defined from 0 (fully manual) to 5 (fully autonomous). Each level is classified by how much a driver is required to intervene and how attentive they need to be when behind the wheel of an autonomous vehicle.



Level 0 (No Driving Automation)

Most includes all the existing cars in the world street and the driver should control steering, acceleration, and braking.

Level 1 (Driver Assistance)

The system control one aspect of the driving part. As a sample in accelerating the system control the speed based on distance from the front car

Level 2 (Partial Driving Automation)

At this level, the vehicle can control both steering and acceleration/decelerating, and this level is known as the hands-off level. The whole responsibility for any problem is with the driver at this level. Tesla Autopilot and Cadillac (General Motors) Super Cruise systems both qualify as Level 2.

Level 3 (Conditional Driving Automation)

Known as the eyes-off, at this level the vehicle takes the most important decision based on the information collected from other vehicles and route signs. At this level, the driver must be awake and have control of the car in specific situations. Audi has declined the A8L stays at this level.

Level 4 (High Driving Automation)

This level is known as the mind-off and the driver can sleep around journeys, but in this level, the driver needs to act out of a specific area. NAVYA, Waymo, Magna, and Volvo & Baidu have announced that their self-driving cars exist on this level. All of these cars have specific limitations and most of them are speed limitations. Current self-driving taxis exist on this level.

Level 5 (Full Driving Automation)

This level of self-driving cars no needs the driver and all decision are made by the vehicle. Till now, no company announce a vehicle at this level.

Conclusion

Still, this new technology has a long way to be accessible in the market, but it has taken great steps. Some important obstacles in front of it,

- The software security
  instead of the obstacles to providing better algorithms to predict and decision-making, software security and creating a safe domain for connection between vehicles are important
- The driver and passenger feel
  A car with a driver provides a sense of safety and comfort for passengers where the driver can control the car well and meet safety standards.
- Mixing of self-driving cars with full-manual cars
  The most problem is the full manual cars are unpredictable and can change the mind without any rule

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