A Technical Report on the Evaluation of Autonomous Driving with Artificial Intelligence

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Abstract : Ever since the advent of Artificial Intelligence, massive revolution of scientific and technological society has occurred. Under the application of Artificial Intelligence, several relevant technologies have acquired unprecedented rapid development. One of the prominent examples is Autonomous Driving technology, which implements that vehicles can be controlled without humans to travel on roads. This essay aims to introduce the Autonomous Driving technology's operating principles, then evaluate this technology from two criteria, security and accuracy, and finally provide some recommendations to solve issues. The primary research method is referring to some kinds of academic literature from the library, such as professional journals and books. It is found that the implementation of Autonomous Driving technology has a great possibility in theory. Meanwhile, it is no doubt that there are still some weaknesses existing, such as wrong signal's interference to sensors, external attacks to computer and not optimistic adaptation for complex environments. However, these difficulties may be overcome when the technology becomes mature in the future.

Keywords: Artificial Intelligence; Autonomous Driving; Security and Accuracy

Introduction

In recent years, Artificial Intelligence technology, defined as "a capacity of a system, which properly translates outer data, studies such data, and accomplishes precise aims and assignments through those study outcomes and flexible orientation [1]", has acquired rapid development. According to Michael and Andreas [1], AI was founded as an academic subject in the 1950s. For more than half a century, the area of AI was relatively backward in science and lacked actual interest [1]. With the improvement of computer technology and the rise of Big Data, AI is becoming an essential part of people's daily lives and is being used in many areas. One of the popular applications of AI is Autonomous Driving. This technology can manufacture Self-driving cars, which can move with little or no human control and sense the environment to ensure safety. This specific vehicle is manipulated by a complete computer system with AI technology.

Due to the recent progress in studying algorithms and hardware exploitation, when autonomous cars work in organized environments under ideal driving situations, they have proved the technology will have a positive future[2]. Autonomous Driving has numerous advantages, and one is better crowd adaptation. For instance, people who cannot qualify to acquire a driving license or do not like driving can take self-driving vehicles. The Second is easing traffic congestion. The traveling process of an automobile is controlled by computers, which is more normative than man-controlled vehicles on roads. Thus, it can avoid the improper behaves of human drivers and reduce traffic congestion to some degree. Another strength is convenience. It is evident that autonomous vehicles can work independently, which economizes on human resources and provides a more comfortable experience for drivers. However, there are also several drawbacks to Autonomous Driving technology existing. For example, autonomous driving systems may malfunction or behave unexpectedly in cluttered, complex, and unpredictable environments with high uncertainty, resulting in unfortunate outcomes[2].

Thus, self-driving cars' security is the first criterion of Autonomous Driving that people have to consider. In addition, another criterion is accuracy. Self-driving cars are driven mainly in cities, and the urban environment is very complex. According to Rasouli and Tsotsos[3], the capacity to communicate with other road users and understand their purpose is required for self-driving cars. Especially between vehicles and pedestrians who are the most vulnerable road users, such

interactions are necessary[3]. This essay will firstly introduce the operating principles of Autonomous Driving technology, then evaluate it based on two criteria, security and accuracy, and finally, offer some recommendations to solve issues.

1. Operating Principles

1.1 General Operating Principle

The self-driving vehicle is a kind of intelligent car controlled by computers without a human. There are four aspects for autonomous driving, including sensing, mapping, localization, and planning[4]. Firstly, sensors that can identify every object around an autonomous vehicle are installed in it[4]. According to Herrmann et al.[4], the most critical sensors are Lidar, radar, and cameras. The data from a car's environment that are essential for self-driving can be recorded by them. In addition, machine-learning algorithms, the core of Artificial Intelligence, can categorize the objects recognized[4]. Secondly, digital maps are necessary for autonomous driving because the qualifications for all location-based services are created by them[4]. Then, computer systems can create the real-world model base on the collected data. Systems will plan the journey in three process stages, including mission planning, reference planning, and behavioral planning[4].

1.2 Specific Operating Principle

A wide range of technologies are employed in autonomous cars, including radar, cameras, ultrasound, and radio antennas for navigating safety on roads[7].

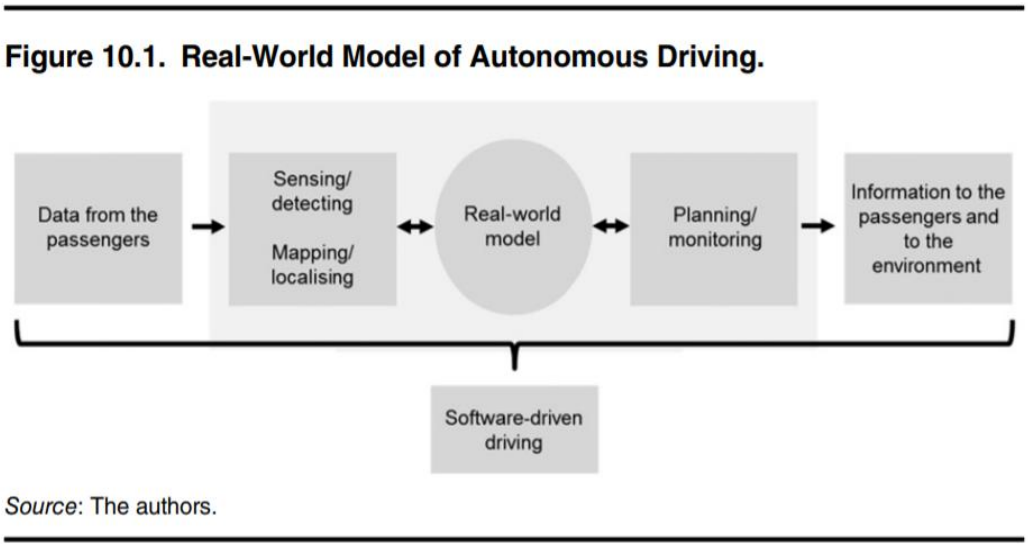

Figure 1: Schematic diagram of Autonomous Driving [4]

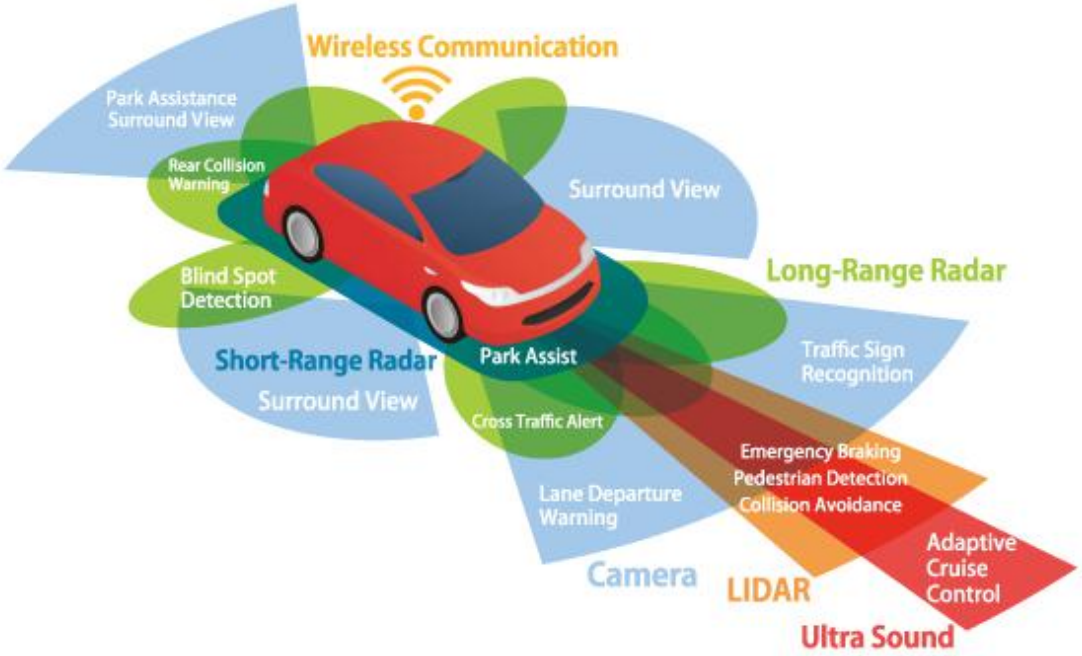

Figure 2: Schematic diagram of Autonomous Driving [7]

2. Critical Evaluation

2.1 Evaluation for Security

There are two evaluative criteria for Autonomous Driving technology, security and accuracy. The first criterion is security, which is the primary criterion for judging the quality of autonomous driving technology. Varieties of functionally rich sensors, such as radars, cameras, and GPS, are equipped in autonomous vehicles to detect the surrounding environments[5]. In autonomous vehicles, these components are employed in conjunction with one another to make the whole system more reliable and robust[7]. For instance, "Autopilot," Tesla's autonomous car technology, uses eight cameras, twelve ultrasonic sensors, and a front-facing radar to offer 360-degree visibility and analyze the surroundings for security[7].

However, the autonomous vehicle relies heavily on sensor data for proper driving operations, which poses some safety risks and inevitably increases potential threats[5]. Once the sensors are disturbed or deceived by the wrong signal, the computer will make a wrong judgment, and self-driving cars will lose the ability to perceive the environment accurately[5]. Furthermore, there are various in-vehicle access and control systems, such as vehicle brakes, keyless access systems, and key control components. These on-board systems ensure the security of physical vehicle access and human-vehicle interaction. If these in-car access and control systems are destroyed, it will lead to serious security vulnerabilities. Finally, on-board network protocols, such as local Internet, controller area network, and FlexRay, may encounter some crises. Any vulnerability of the protocol can be exploited through the remote informatics module and further remotely amplified by the attacker to illegally control the vehicle[5].

2.2 Evaluation for Accuracy

The second criterion is accuracy. Self-driving cars are driven mainly in cities, and the urban environment is very complex. Therefore, it is essential to ensure that the computer system can control the vehicle to keep steering steadily on roads and arrive at the right destination. So far, Autonomous Driving has developed rapidly, and the accuracy of it has increased over the years. An autonomous driving system can work excellently with sensors and GPS in ordinary circumstances. However, the weakness of it is also apparent. According to Liu et al.[6], the autonomous lane keeping system is the pivotal technique for Autonomous Driving accuracy, which includes lane detection, lane tracking and control. On account of different factors such as illumination, general hyper-parameters setting for diverse road situations, and lane boundary

correction, this technique is still challengeable[6]. Furthermore, it is difficult to conduct in embedding systems because of the imbalance in accuracy and processing time[6].

In general, there are still many challenges for Autonomous Driving technology, though it has made significant progress. Obviously, self-driving cars cannot be popularized in society at present.

3. Conclusion

In conclusion, this essay has introduced Autonomous Driving technology's operating principles and then evaluated this technology from two criteria: security and accuracy. For the security of Autonomous Driving, there are enough sensors equipped in vehicles to perceive the surroundings. Nevertheless, it was found that Autonomous Driving technology relies on sensor data heavily. If there are wrong signals disturbing or deceiving those sensors, computers will give incorrect instructions, which may cause some unexpected accidents to the vehicle. In addition, for the accuracy of Autonomous Driving, computer systems may appear to deviation when working in complex environments.

There are limitations to this essay. For instance, all reference materials were from academic journals or books. In this paper, the theoretical information occupies the majority while lacks field survey and test data. Furthermore, the criteria chosen in the paper are the most representative of Autonomous Driving technology. However, they are just a part of it, and there are various evaluation aspects to this technology.

Some recommendations are provided for the improvement of Autonomous Driving. The sensor set, software algorithms, and computing units should be improved constantly to improve autonomous cars' ability to drive under complex conditions[8]. Moreover, adding a group of spare sensors working together may be a good choice. If the two sensors simultaneously clash, the computer system will raise the alarm in time and remind drivers to drive manually. Obviously, people should not leave everything to computers.

Companies can refer to these recommendations in aspects of vehicle structure and computer program to improve Autonomous Driving technology. In short, robust security and accuracy can make Self-driving cars applied in real life.

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