International Journal of Scientific Research and Management (IJSRM)
||Volume||12||Issue||04||Pages||1159-1164||2024||
Website: https://ijsrm.net ISSN (e): 2321-3418
DOI: 10.18535/ijsrm/v12i04.ec06

A Survey on Theories and Applications for Self Driving Cars Based on Deep Learning Methods

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Abstract

In today's, Self-driving cars are one of the hot research topics in technology, which has a great impact on social and economic development. Self-driving cars, powered by deep learning algorithms, represent a groundbreaking fusion of artificial intelligence and transportation technology. Deep learning is also one of the current major areas in artificial intelligence research. It has been widely applied in natural language understanding, image processing, etc. In recent years, more and more deep learning methods have been introduced to the solution in the field of self-driving cars and have achieved excellent results. This survey provides information related to self-driving cars and summarizes the application of deep learning methods in the field of self-driving cars. Then the main problems in self-driving cars and their solutions are analyzed based on deep learning methods, such as lane detection, scene recognition and navigation etc. Also briefly described are some representative approaches to self-driving cars using deep learning methods. Finally, future challenges in applications of deep learning for self-driving cars are described.

Keywords: self-driving cars; deep learning methods; scene recognition; lane detection; obstacle detection.

Introduction

Self-driving cars are a much discussed topic today. It is also known as autonomous vehicles (AVs) or driverless cars, represents a transformative technology poised to revolutionize the way we travel. These vehicles, equipped with advanced sensors, artificial intelligence (AI), and communication systems, have the potential to enhance road safety, improve traffic flow, and increase mobility for individuals worldwide.

Self-driving cars have attracted more and more attention due to their significant economic impact. However there are a lots of challenges in self-driving cars , Example; safety problem is the key technology that must be solved efficiently in self-driving cars, otherwise, it is impossible to allow self-driving cars on the road. This paper provide a survey on theories and applications of deep learning for self-driving cars. Other relevant surveys in the field of deep learning and self-driving cars can be used as a supplement to this paper.

Related Information

The concept of autonomous vehicles traces back to the early 20th century, with pioneers like Leonardo da Vinci envisioning self-propelled vehicles. However, significant advancements in the field began in the latter half of the 20th century. In 1987, the U.S. Congress established the Defense Advanced Research Projects Agency (DARPA) to develop autonomous vehicle technology for military purposes. This led to the creation of the DARPA Grand Challenge in the early 2000s, spurring innovation in the private sector.

The levels of autonomy in cars, as defined by the Society of Automotive Engineers (SAE) International, are commonly referred to as the SAE J3016 levels. These levels provide a framework for categorizing the degree of automation in vehicles, ranging from no automation to full automation. Here's an overview of the SAE J3016 levels:

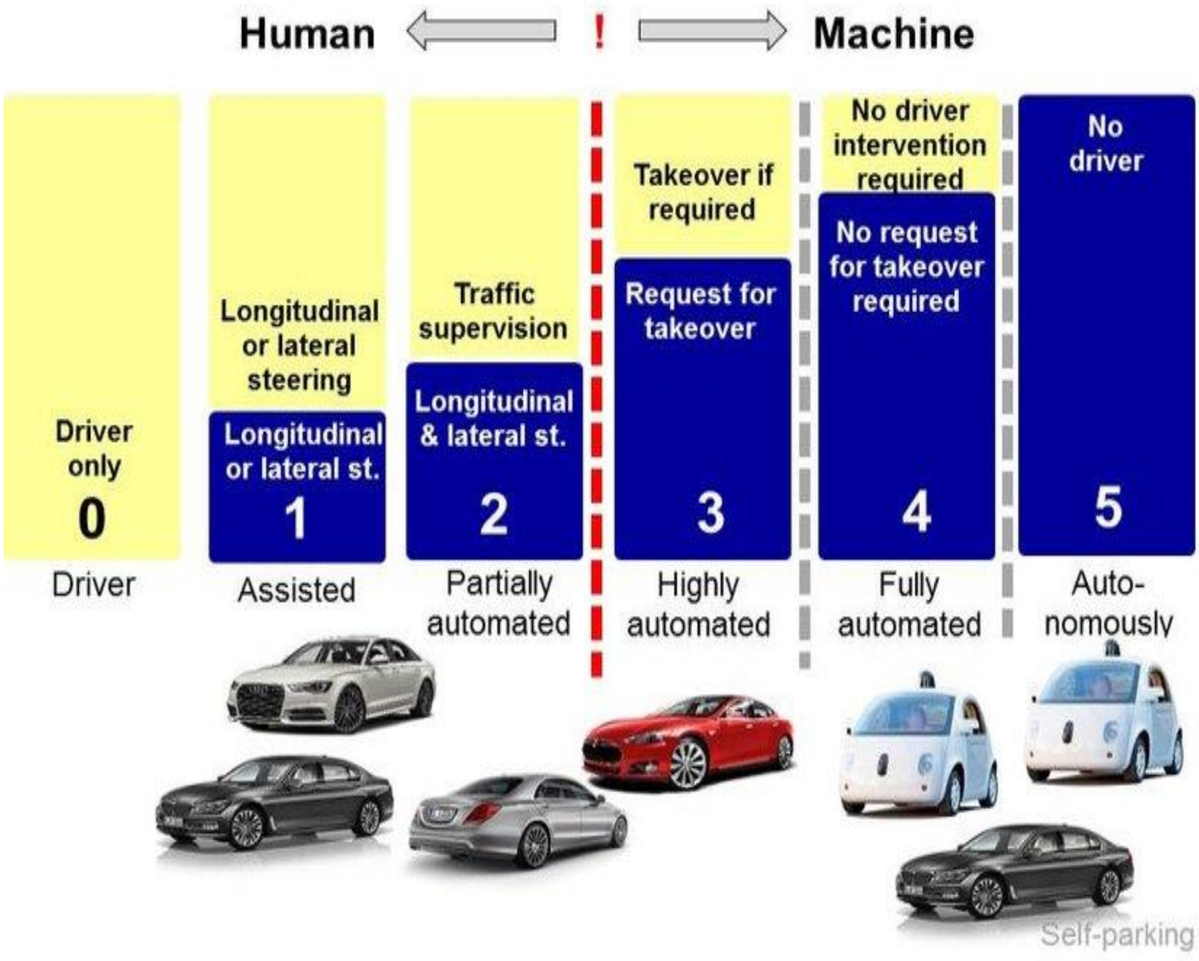

Figure 1. Levels of autonomous driving according to SAE J3016

Level 0, represents a vehicle with no autonomy. **Level 1,** has basic driving assists like adaptive cruise and emergency braking. **Level 2,** consists of partial autonomy while requiring the driver to monitor the system and perform certain tasks. **Level 3,** Under certain conditions the system has full autonomy , but a human operator is still required to take control if necessary. **Level 4,** The vehicles at Level 4 is still a semi-autonomous system with more automation than Level 3. **Level 5,** The vehicles are fully autonomous in all circumstances.

Remark 1 (About Level 5 – Fully autonomous). Level 5, vehicles do not require steering wheels, pedals, or other manual controls, as there is no provision for human driving. These vehicles offer complete autonomy and are designed to operate safely and efficiently without any input from human occupants. These levels provide a standardized framework for understanding the capabilities and limitations of autonomous vehicles, helping to guide the development, testing, and deployment of self-driving technology.

Remark 2 (About Tesla Self-driving cars). “Auto-pilot” technology has made major breakthroughs in recent years. Although the tesla’s autopilot technology is only regarded as Level2 stage by the national highway traffic safety administration (NHTSA), as one of the most successful companies in autopilot system application by far, Tesla shows us that the car has basically realized automatic driving under certain conditions (see Figure 2b).

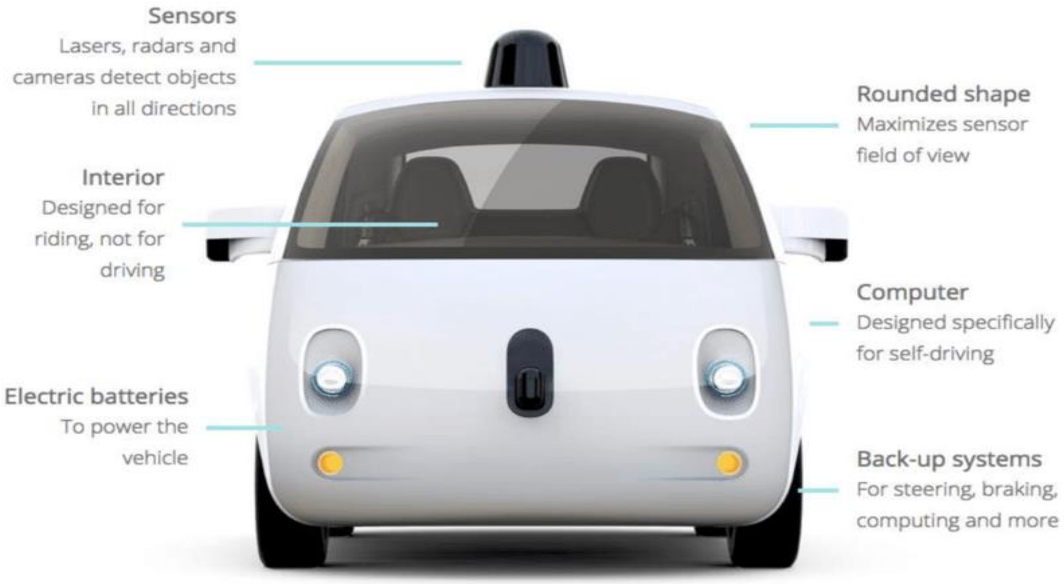

Figure 2(a). Google's self-driving car.

Figure 2(b). Tesla's self-driving car.

Self-driving cars offer a range of potential benefits, including: 1. Safety improvements; **2**. Traffic efficiency and congestion reduction.; **3.** Environmental impact; **4.** Accessibility.

Self-driving cars rely on a combination of sensors, including cameras, LiDAR (Light Detection and Ranging), radar, and GPS, to perceive their surroundings. These sensors provide real-time data about nearby objects, road conditions, and traffic patterns, enabling the vehicle to make informed decisions. AI algorithms process this data to navigate the vehicle, anticipate potential hazards, and execute driving maneuvers safely.

The overall technical framework of self-driving cars with a level3 or higher autonomy system is divided into four parts **;** First is the driving environment perception system, the autonomous decision system, the control execution system and the monitor system. The architecture of it is shown in Figure 2.

Remark 3; According to the autonomous driving levels, the car from Label 0 to Label 2 mainly requires the driver to monitor the environment . Advanced Driver Assistant System (ADAS) are intelligent systems that reside inside vehicles classified from Level 0 to Level 2 and assist the driver in the driving process.

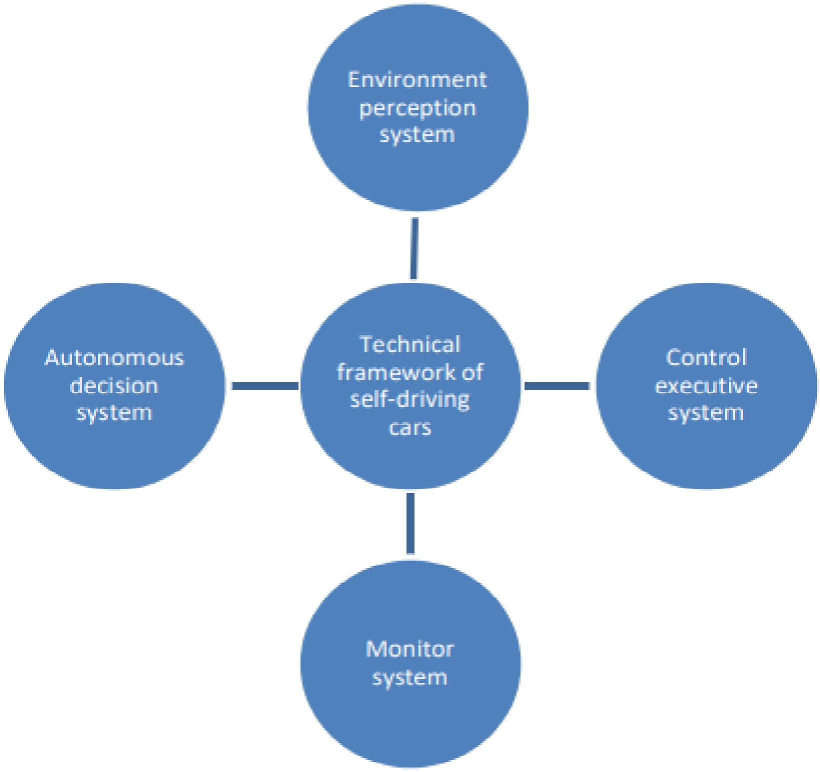

Figure 3 . The overall technical framework of self-driving cars with a level3 or higher autonomy system

Ethical and Regulatory Considerations for Autonomous Vehicles

Safety

Ensuring the safe operation of self-driving cars to for the safety of passengers and other road users..

Privacy

Addressing concerns around data collection and use in autonomous vehicles.

Liability

Defining clear legal framework for liability in autonomous vehicle accidents.

Challenges and Concerns

Despite their potential benefits, self-driving cars face several challenges and concerns, including:

1. Legal and regulatory hurdles: The regulatory landscape for autonomous vehicles varies across jurisdictions, posing challenges for widespread deployment and adoption. Uncertainty surrounding liability, insurance, and safety standards creates barriers to entry for manufacturers and developers, slowing the pace of innovation in the industry.

2. Ethical dilemmas: Autonomous vehicles raise complex ethical questions regarding decision-making in life-threatening situations. The trolley problem, a thought experiment in moral philosophy, illustrates the challenges of programming self-driving cars to make split-second decisions that prioritize human safety while minimizing harm.

3. Cybersecurity risks: As self-driving cars become increasingly connected and reliant on digital systems, they become vulnerable to cyber attacks and malicious interference. Hackers could potentially exploit vulnerabilities in autonomous systems to gain unauthorized access, disrupt operations, or cause physical harm, posing significant risks to safety and security.

4. Public acceptance and trust: Public perception of self-driving technology is influenced by factors such as media coverage, user experience, and cultural attitudes toward automation. High-profile accidents involving autonomous vehicles, such as the Uber crash in Tempe, Arizona, in 2018, erode trust and confidence in the technology, highlighting the need for transparency, accountability, and effective risk communication.

Conclusion

Self-driving cars represent a transformative technology. Its have the potential to reshape the future of transportation. Despite significant advancements in technology and ongoing efforts to address challenges and concerns, the widespread adoption of autonomous vehicles remains a complex and multifaceted endeavor. As we navigate the opportunities and challenges of self-driving cars, it is to prioritize needed safety, ethics, and public trust while fostering collaboration and innovation across industry, government, and academia. By working together, we have the possibility to unlock the full potential of self-driving technology and create a safer, more efficient, and more accessible transportation system for all.

References

1. Bojarski, Mariusz, et al. "End to end learning for self-driving cars." arXiv preprint arXiv:1604.07316 (2016).
2. Chen, Congcong, et al. "Deepdriving: Learning affordance for direct perception in autonomous driving." Proceedings of the IEEE international conference on computer vision. 2017.
3. Li, Jie, et al. "End-to-end deep reinforcement learning for lane keeping assist in autonomous driving." IEEE Intelligent Vehicles Symposium (IV). 2017.
4. Zhang, Yuke, et al. "Learning deep control policies for autonomous aerial vehicles with MPC-guided policy search." IEEE Robotics and Automation Letters 3.2 (2018): 787-794.
5. Pan, Xingchen, et al. "Virtual to real reinforcement learning for autonomous driving." Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2018.
6. Chen, Xiaozhou, et al. "End-to-end learning of driving models from large-scale video datasets." IEEE Transactions on Intelligent Transportation Systems 21.4 (2019): 1502-1514.
7. Ma, Chao, et al. "Deep reinforcement learning for autonomous driving: A survey." arXiv preprint arXiv:2008.03835 (2020).
8. Kato, Shohei, et al. "End-to-end multi-modal multi-task vehicle control for self-driving cars with visual perception." IEEE Robotics and Automation Letters 5.2 (2020): 3246-3253.

9. Wu, Zheng, et al. "Recent advances and future trends in reinforcement learning for autonomous vehicle control." IEEE Transactions on Intelligent Transportation Systems (2020).
10. www.researchgate.net (Figure : 1 and Figure : 2(a))
11. Wired.com (Figure : 2(b))