How has machine learning advanced the field of artificial intelligence for vehicles?

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Abstract. The purpose of this review is to highlight recent advancements in autonomous vehicles (AVs) and related infrastructure, primarily from artificial intelligence (AI), which makes AVs more appealing to consumers. It is critically analyzed and reviewed how AI can benefit AVs, structure of AVs, and automotive innovation techniques. The paper provides a quick reference for researchers interested in understanding the use of AI in AV research.

Keywords: Autonomous vehicles, Artificial intelligence, Automotive innovation techniques.

1. Introduction

Due to the increase in the number of vehicles, almost all (metropolitan) cities including the major ones, like Los Angeles, Beijing, New York, are suffering from heavy traffic congestion. Statistics show that, in 2015, 43 cities in China suffered a prolonged travel time of more than 1.5 h every day during rush. [1] These data reflect the inconveniences of traditional transportation. Massive congestion leads to increased emissions of air pollutants, which aggravate the greenhouse effect. In order to solve traffic congestion, the introduction of artificial intelligence has made driverless technology increasingly mature. Cars controlled by machines can greatly avoid road jams and accidents. This has led to the growing importance of driverless technology.

As the core of driverless technology, artificial intelligence determines the availability and ubiquity of the technology. In today's society, the advancement of artificial intelligence (AI) has stimulated the development and deployment of autonomous vehicles in the transportation industry.

Artificial intelligence for vehicles aims at applying both practical and advanced AI techniques to vehicles so that vehicles can perform human-like or even superhuman behaviors [2]. Algorithms such as deep neural networks are designed to mimic the working principle of the brain and trained over large data sets to perform various tasks. Intelligent vehicles combine AI techniques such as environmental perception, map building and path planning and integrate them with multi-scale auxiliary driving services and other functions [2], so that vehicles are able to make intelligent decisions. Thus, autonomous vehicles development focuses on the applications of artificial intelligence, machine learning and automatic control.

2. Discussion

2.1. Advanced Artificial Intelligence

Advanced AI technologies include deep neural network, recurrent neural network, spiking neuron network (SNNs) and transfer learning and reinforcement learning on multi-domain and multi-time level.

Deep neural networks (DNNs), recurrent neural networks 260 (RNNs) and transfer learning combined with reinforcement learning make breakthroughs in traditional AI applications.[3] RNNs can deliver excellent performance in many tasks when trained to predict the next output token given the input and previous tokens. This can be applied successfully in machine translation, speech recognition and so on. Transform learning enables the agent to reuse or transfer the knowledge learning from one task to another. SNN is the brain-like simulator which can efficiently simulate bio-

inspired spiking neural networks consisting of different neural models. SNN can integrate event-driven and time-driven computation schemes. SNN shows promising capabilities in achieving a performance similar to that of living brains due to their more faithful similarity to biological neural networks, notably, in pattern recognition tasks.

2.1.1 Applications

Current AV studies focus on traffic flow, safety, intersection control, emissions, and sharing AVs between multiple users. AVs will also significantly change parking behavior by allowing the vehicles to self-park, a trait that the general public is very enthusiastic about. In a recent survey of 5600 people in 10 countries conducted by the World Economic Forum, 43.5% of the respondents reported that the biggest benefit of AV technology is its self-parking capability. Automatic parking can solve the parking problem in most cities, while saving people the time of parking and waiting for an empty space. AVs parking can increase the space utilization rate in the same space, increase the number of available parking Spaces, and solve the parking problem and avoid man-made collisions.

This image shows the autonomous parking process [5]

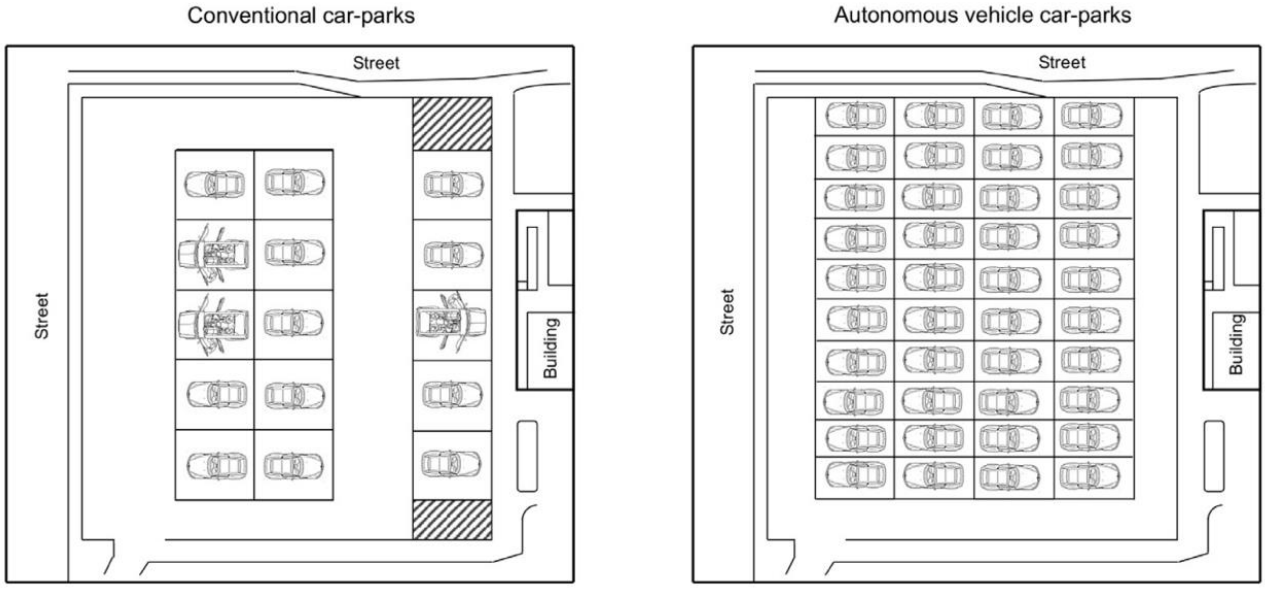


Fig. 1 (a)Conventional parking design. (b)autonomous vehicle parking design

2.2. Structure of autonomous vehicles

1. Perception system: Autonomous vehicles acquire environmental information through the perception system. The system typically includes a variety of sensors such as radar, cameras, LiDAR, and ultrasonic sensors. These sensors are able to sense objects around the vehicle, road signs, lane lines and pedestrians. The data collected by the sensing system is used to build an accurate model of the vehicle's surroundings.

2. Decision and planning system: The decision and planning system uses the data provided by the perception system to understand the scene and make decisions. It analyzes perception data, identifies other vehicles, pedestrians, road signs and traffic signals, and makes decisions about different driving situations. The decision-making process may include path planning, lane keeping, overtaking, parking, etc.

3. Control system: The control system is responsible for converting the control instructions generated by the decision-making and planning system into actual operations. It controls the vehicle's acceleration, braking, steering and shifting, ensuring safe and efficient driving as directed by the planning system. The control system usually includes electric steering system, electronic braking system and electric drive system.

4. User interface: Self-driving cars provide user interfaces that enable drivers and passengers to interact with the vehicle. User interfaces may include in-vehicle displays, voice commands, and

gesture recognition. Through the user interface, the driver can enter a destination, select a driving mode, or monitor the autonomous driving process.

In addition, the overall architecture of autonomous vehicles also needs to have real-time data processing and transmission capabilities, so that perceptual data and control commands can be quickly transmitted and processed. Security and reliability are also important considerations in the overall architecture design, including data redundancy, fault tolerance, and security monitoring systems. Overall, the architecture of autonomous vehicles aims to integrate several key components such as perception, decision making, control, and user interface to enable the vehicle to drive itself without the need for human intervention. These components work together to provide a safe, efficient and reliable autonomous driving experience.

2.3. Artificial intelligence vehicles (AIV)

Increasing demand for urban mobility and vehicle population growth leading to traffic congestion and accidents. These cause the need for AI in vehicles to address these issues. AIV aims to apply practical and advanced AI techniques to enable vehicles to perform human-like or superhuman behaviors.

Vehicles can perform human-like, even superhuman, behaviors using artificial intelligence for vehicles (AIV). In order to perform various tasks, algorithms such as deep neural networks are trained over large data sets in order to mimic the working principles of the brain. Integrated with multi-scale auxiliary driving services and other functions, intelligent vehicles incorporate AI techniques such as environmental perception, map building, and path planning. Vehicles are controlled automatically by artificial intelligence and machine learning.

3. Conclusion

Artificial intelligence has played a crucial role in the field of driverless vehicles and is an indispensable component. As society's demand for driverless vehicles continues to grow, standards for artificial intelligence are also increasing. Technical aspects such as Artificial Intelligence will be more widely used with the popularization of 5G. But problems such as a lack of sufficient charging infrastructure are emerging.

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