Engineering Technology Trends Vol 2 Issue 2 2024

Original Research Article

Open Access

Omniscient Pte.Ltd.

Research on Key Technologies of Intelligent Connected Vehicles

Guo-Meng Zhang*

Shandong Vocational College of Science and Technology,Weifang,Shandong,261053,China

***Correspondenct to:** Guo-Meng Zhang,Shandong Vocational College of Science and Technology,Weifang,Shandong,261053,China,Email:136564907@qq.com

Abstract: As the core of future transportation, intelligent connected vehicles (ICVs) have a profound impact on industrial development and transportation efficiency through breakthroughs and applications in key technologies. Faced with challenges in this field, by delving into forward-looking technologies, overcoming key component difficulties, establishing a comprehensive testing and evaluation system, and optimizing infrastructure services, we can provide strong support for the rapid development of ICVs. These measures not only promote innovation and upgrading in the automotive industry but also contribute to the intelligence and greenification of future transportation.

Keywords: intelligent connected vehicles (ICVs); key automotive technologies; measures

Introduction

With the rapid advancement of technology, intelligent connected vehicles (ICVs) have become the core of future transportation. By deeply integrating traditional automotive technology with modern information technology, ICVs can achieve real-time interaction and collaboration between vehicles and the surrounding environment. This development is of great significance as it helps improve road safety, reduce environmental pollution, enhance traffic efficiency, and drive industrial innovation. ICVs are not only an important direction for the future of transportation but also a critical indicator of China's technological innovation and industrial competitiveness.

1. Overview of Intelligent Connected Vehicles (ICVs)

Intelligent connected vehicles, as modern automobiles that combine advanced information technology, communication technology, and control technology, have been experiencing rapid development in recent years. According to the latest data, the sales of intelligent connected vehicles have shown a significant growth trend in recent years. For example, from 1.5 million units in 2018 to 2 million units in 2019, the market size of intelligent connected vehicles experienced rapid expansion within just one year. By 2020, this number had soared to 3 million units, representing a 50% year-on-year increase. In 2021, the global sales of intelligent connected vehicles reached an astonishing 4.5 million units, an increase of 60% compared to the previous year. The latest data shows that in 2022, the sales of intelligent connected vehicles have surpassed the milestone of 6 million units, achieving consecutive years of high-speed growth. This trend reflects the continuous maturity of intelligent

© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, sharing, adaptation, distribution and reproduction in any medium or format, for any purpose, even commercially, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

connected vehicle technology and the increasing market acceptance. With the deep integration of the automotive industry and information communication technology, intelligent connected vehicles have not only changed the form and function of traditional automobiles but also provided people with safer, more comfortable, and efficient modes of transportation. Through intelligent connectivity technology, automobiles are no longer just a means of transportation but have become mobile intelligent terminals capable of providing various intelligent services to meet people's growing travel needs. As shown in the following figures: **Figure 1** depicts the data chart, and **Figure 2** illustrates the development trend graph.

Year	Sales (10,000 vehicles)
2018	150
2019	200
2020	300
2021	450
2022	600

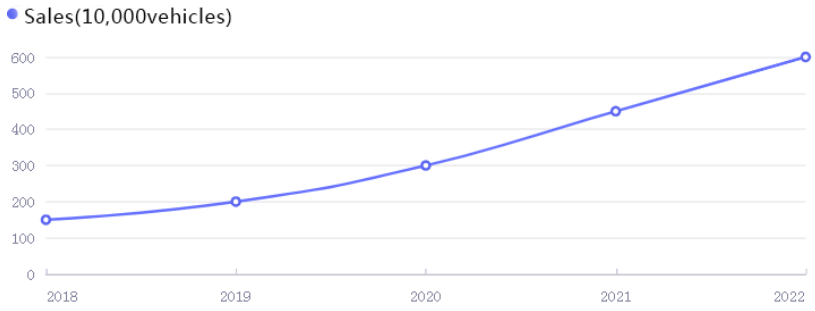

Figure 1: Data Chart

Figure 2: Development Trend Graph

2. Key Technologies Analysis of Intelligent Connected Vehicles

Intelligent connected vehicles integrate multiple functions such as environmental perception and planning decision-making, with environmental perception, communication, and cloud platform technologies being its core. Environmental perception technology collects data on roads, vehicles, pedestrians, etc., through sensors, forming the basis for the vehicle's "observation" of the environment. Communication technology enables vehicles to exchange real-time information with other traffic participants, including location, speed, obstacles, etc., allowing vehicles to make more accurate judgments and decisions. Cloud platform technology is responsible for integrating, analyzing, and processing massive data, issuing control commands, and realizing functions such as remote control and fault diagnosis. The three work together to promote the intelligent development of intelligent connected vehicles.

2.1 Environmental Perception Technology

Environmental perception technology is the most basic and crucial part of intelligent connected vehicles. By integrating sensors such as radar, lidar, cameras, and ultrasonic sensors, intelligent connected vehicles can obtain three-dimensional information about the surrounding environment, including obstacles, road signs, traffic signals, etc. These sensors have different working principles and characteristics, providing rich environmental information for subsequent decision-making and control. Sensor fusion is a key technology in environmental perception. Due to the different advantages and disadvantages of different sensors, it is necessary to fuse their data through certain algorithms to improve the accuracy and reliability of perception. The diagram below illustrates the sensors.

Sensor fusion technology involves aspects such as data fusion, target tracking, scene classification, etc., which require comprehensive judgment based on different sensor data. In addition to sensor fusion, target recognition and tracking are also core components of environmental perception technology. By analyzing and processing the obtained environmental information, intelligent connected vehicles need to identify targets such as obstacles, pedestrians, and vehicles, and track and predict their movements. This requires the use of computer vision, machine learning, and other technologies to improve the accuracy and real-time performance of target recognition.

2.2 Communication Technology

Communication technology is crucial for enabling information exchange among vehicles, between vehicles and infrastructure, and between vehicles and pedestrians in intelligent connected vehicles. Intelligent connected vehicles rely on efficient and

reliable communication technology to achieve real-time transmission and sharing of information, thereby enhancing driving safety and efficiency. Vehicular networking technology is a key technology for realizing intelligent connected vehicles. Through vehicular networking technology, vehicles can exchange information with surrounding vehicles, infrastructure, and pedestrians to achieve cooperative perception and control. Vehicular networking technology includes V2X communication, short-range wireless communication, and other technologies, among which V2X communication is the most important. V2X communication enables information exchange among vehicles, between vehicles and infrastructure, and between vehicles and pedestrians, allowing vehicles to obtain real-time information about the surrounding environment, including road conditions, traffic signals, obstacles, etc. Through V2X communication, vehicles can anticipate road conditions ahead, avoid potential hazards and congestion, thereby improving driving safety and efficiency.

2.3 Intelligent Decision-Making Technology

Intelligent decision-making technology is the core component of intelligent connected vehicles, responsible for making rapid and accurate decisions based on various information obtained by the vehicle to guide its driving. Intelligent decision-making technology processes data from perception systems and other systems, makes decision judgments based on preset algorithms and rules, and outputs control commands. Intelligent decision-making technology needs to consider decision problems in different scenarios, such as road congestion, intersections, lane changes, etc., and develop corresponding decision algorithms for these scenarios. In scenarios like road congestion, intelligent decision-making technology needs to select appropriate routes and speeds based on traffic conditions and its own driving needs. In intersection scenarios, intelligent decision-making technology needs to determine whether to turn and whether to yield. To achieve the accuracy and real-time performance of intelligent decision-making technology, efficient algorithms and data processing technologies are required. Artificial intelligence technologies such as machine learning and deep learning are widely applied in the field of intelligent decision-making, as they can improve the accuracy and reliability of decisions through learning from large amounts of data.

3. Key Issues in Intelligent Connected Vehicle Technologies

3.1 Lack of Unified Technical Standards

The lack of unified technical standards has posed significant challenges to the development of intelligent connected vehicles. In the current market environment in China, the absence of unified industry standards and specifications has led to compatibility issues among various components and systems of intelligent connected vehicles, making it difficult for vehicles of different brands and models to achieve true interoperability. Due to the different technical solutions and standards adopted by various automotive companies, there are differences in technology and link compatibility among intelligent connected vehicles, leading not only to conflicts between different systems but also resulting in resource wastage. For example, different vehicular communication systems may use different communication protocols and data formats, making it difficult for vehicles to effectively share and transmit information among themselves. The diagram below illustrates the standards of different countries' technologies.

technical standard	Country / region
ISO26262	Europe
SAEJ3016	the United States
ISO21448	International Standardization Organization
CISPR25	Europe
IEEE802.11p	the whole world
ETSITS102637-5	Europe
ETSITS102637-7	Europe

3.2 Safety and Reliability Concerns

While intelligent connected vehicles offer convenience, they also bring new challenges in terms of safety and reliability. With the deep integration of vehicles and networks, we need to pay attention not only to traditional mechanical vehicle safety but also to network security and data security. Firstly, intelligent connected vehicles collect a large amount of data through various sensors, including vehicle status, surrounding environment, and driving trajectories. This data is exchanged in real-time between in-vehicle systems, vehicles and the cloud, and vehicles and infrastructure. If this data is tampered with or

maliciously attacked, it could lead to loss of vehicle control, traffic accidents, or even endanger lives. Secondly, the operation of intelligent connected vehicles relies heavily on various software and electronic control units. Software failures, viruses, or hacker attacks could lead to the loss of critical vehicle functions such as braking, steering, or engine control.

4. Application Measures for Key Technologies Research in Intelligent Connected Vehicles

4.1 Breakthrough in Key Advanced Technologies

In breaking through key advanced technologies, it is essential to focus on the research and development of critical technologies such as complex system architecture, complex environment perception, and intelligent decision-making control. These technologies are the core of achieving autonomous driving and intelligent control in intelligent connected vehicles, requiring substantial human and material resources for research and development. Firstly, in terms of complex system architecture, in-depth research and exploration are needed to construct more efficient and reliable system architectures to meet the requirements of intelligent connected vehicles for data processing, transmission, and storage. Additionally, scalability and upgradeability of the system need to be considered to meet the growing computational and communication demands in the future. Secondly, in intelligent decision-making control, a comprehensive consideration of knowledge and technologies from various fields such as vehicle dynamics, control theory, and artificial intelligence is required to achieve more efficient and safer vehicle control.

4.2 Promoting Breakthroughs in Core Components

Promoting breakthroughs in core components is a crucial step in the development of intelligent connected vehicles. For key areas such as automotive-grade chips, artificial intelligence algorithms, lidar, in-vehicle operating systems, intelligent computing platforms, and wire-controlled execution systems, a series of key projects need to be organized and implemented to concentrate efforts on research and innovation. Additionally, to achieve efficient and safe operation of intelligent connected vehicles, it is necessary to promote the implementation of common cross-cutting technology solutions such as 5G vehicle-to-vehicle wireless communication networks, multi-source fusion perception, high-precision spatiotemporal reference services, and spatiotemporal digital twins of traffic systems. These technologies are essential foundations for realizing autonomous driving and intelligent control of vehicles, requiring enhanced research and application to improve the perception and decision-making capabilities of vehicles. Finally, achieving integrated automatic driving fusion perception and planning control of "vehicle-road-network-cloud-map" is an important goal for the development of intelligent connected vehicles.

Conclusion

In conclusion, intelligent connected vehicles, as the core direction of future transportation, integrate traditional automotive technology with modern information technology, providing new solutions to address issues such as road safety, environmental pollution, and traffic congestion. With the rapid development of technologies such as 5G communication, big data, and artificial intelligence, research and application of key technologies in intelligent connected vehicles have garnered widespread attention globally. Breakthroughs in this field are not only crucial for the future development of the automotive industry but also have far-reaching implications for the overall sustainable development of society.

References

[1] Zhao F, Liu Z. Strategic value and advantages and disadvantages analysis of China's development of intelligent vehicles. *Modern Economic Research*. 2019(4):83-84.

[2] Zhang Y, Liu H, Li B, et al. Research on the development of intelligent connected vehicle technology and standards. *Shanghai Automotive*. 2019(8):143-144.

[3] Ran B, Tan H, Zhang J, et al. Current status and trends of intelligent connected transportation technology development. *Journal of Automotive Safety and Energy Saving*. 2018;9(2):119-130.