Original Research Article

Research on autonomous driving technology of new energy vehicles integrating big data of Internet of vehicles

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Abstract: The fusion strategy of autonomous driving technology of new energy vehicles and big data of Internet of Vehicles is studied. This paper analyzes the development status of new energy vehicles and autonomous driving technology, the technical principle and processing process of big data of Internet of Vehicles, and discusses the key links such as data acquisition and preprocessing, data transmission and storage, data mining and analysis, intelligent decision-making and control in detail. It aims to achieve a more efficient, safe and intelligent automatic driving system for new energy vehicles through the organic combination of technology, and to promote the development of intelligent transportation system.

Keywords: New energy vehicles; Autonomous driving technology; Internet of vehicles; Big data

1. Introduction

With the aggravation of global environmental problems and energy crisis, new energy vehicles, as a green transportation vehicle, have been widely concerned and developed rapidly. At the same time, the rise of autonomous driving technology marks the intelligent trend of future traffic. As an important part of the intelligent transportation system, the big data technology of the Internet of Vehicles can provide strong support for the autonomous driving of new energy vehicles. Through the Internet of vehicles technology, the vehicle can realize the information interaction with the external environment, so as to improve the safety and efficiency of driving. Big data technology can process and analyze massive vehicle data, extract valuable information, and assist in intelligent decision-making. The strategies and methods of this fusion systematically explored aim to provide reference and reference for related research and practical applications.

2. Overview of Autonomous Driving Technology for New Energy Vehicles

2.1. Development Status of New Energy Vehicles

In recent years, the development of new energy vehicles has attracted much attention, and its market size has shown a rapid growth trend. With the aggravation of global environmental problems and energy crisis, reducing carbon emissions and seeking renewable energy have become the consensus of governments and enterprises. The active guidance and support of government policies, such as car purchase subsidies, tax reduction, charging facilities construction and other measures, have effectively promoted the popularization of new energy vehicles. According to the latest statistics, the number of new energy vehicles in the world has exceeded 10 million, of which the Chinese market accounts for half. Technological progress is also an important factor to promote the development of new energy vehicles. The continuous innovation of battery technology, the improvement of range and the acceleration of charging speed make the performance and use convenience of new energy vehicles significantly improve[1]. The increased consumer awareness of environmental protection and the demand for low-cost travel also further promote the market growth of new energy vehicles. At the same time, the development of new energy vehicles also faces many challenges, such as battery recycling and processing problems, the coverage and improvement of charging infrastructure, the overall cost control of electric vehicles, etc. How to further optimize technology and policies to promote the sustainable development of new energy vehicles is still the focus of attention in the future[2].

2.2. Development History of Autonomous Driving Technology

The development of autonomous driving technology has experienced the gradual evolution process from assisted driving to fully autonomous driving. As early as the 1990s, ADAS (Advanced Driver Assistance System) began to be applied in some high-end models, which marked the embryonic stage of autonomous driving technology. With the progress of technology, autonomous driving technology has gradually evolved into five levels, from L1 to L5, representing different levels of automation respectively. The L1 and L2 levels are mainly driver assistance systems, including adaptive cruise control (ACC), lane keeping assist (LKA) and other functions. These technologies provide some degree of assistance during driving, but still require driver monitoring throughout the process. The L3 level is conditional autonomous driving, where the vehicle can be autonomous under certain conditions but requires the driver to take over the in complex situations[3]. The L4 level is highly autonomous, and the vehicle can drive independently in most cases and require manual intervention in only a few complex situations. The L5 level is fully autonomous, allowing the vehicle to drive autonomously in all cases. In recent years, with the rapid development of artificial intelligence, big data and Internet of Things technology, autonomous driving technology has made significant progress, and major technology companies and automakers have increased their investment to take the leading in this field[4].

2.3. Classification and Principle of Autonomous Driving Technology

Autonomous driving technology mainly includes three core parts: perception, decision-making and execution. Perception technology is the basis of autonomous driving. Use various sensors installed on the vehicle, such as radar, lidar, camera, to obtain environmental information around the vehicle in real time. These sensor data are used to form a comprehensive perception map of the vehicle environment through data fusion technology. Decision technology is the core of autonomous driving. Based on the data provided by the sensing system, artificial intelligence and machine learning algorithms are used to analyze and judge to generate the optimal driving strategy. The decision system needs to consider many factors, such as road traffic rules, vehicle status, and the behavior of pedestrians and other vehicles, to ensure the safety and efficiency of driving[5]. The executive system is responsible for transforming the decision results into specific driving operations, and realizing automatic driving through the control of the actuators such as steering, acceleration and braking of the vehicle. According to the degree of automation, autonomous driving technology can be divided into four levels: assisted driving (L1 and L2), conditional autonomous driving (L3), highly autonomous driving (L4) and fully autonomous driving (L5). Each level of technology implementation and application scenarios vary, but both rely on an organic combination of advanced perception, decision-making, and execution systems.

2.4. Application of Autonomous Driving Technology in New Energy Vehicles

As an important carrier of autonomous driving technology, new energy vehicles have natural advantages and potential. New energy vehicles are usually equipped with a large number of electronic control units and sensors, which provide a good hardware foundation for the application of autonomous driving technology. The power system control of new energy vehicles is relatively simple, and it is easier to achieve accurate acceleration and braking control, which is crucial for the stable operation of autonomous driving technology. At present, Tesla, Google Waymo and other companies have realized some autonomous driving functions in new energy vehicles, such as autonomous parking and autonomous driving on highways. The application of autonomous driving technology in new energy vehicles can not only significantly improve traffic safety, reduce the occurrence of traffic accidents, but also optimize the energy consumption management of vehicles and improve energy utilization efficiency. For example, through the intelligent driving strategy, autonomous vehicles can choose the optimal driving route, avoid congestion, and reduce unnecessary energy consumption. Autonomous driving technology can also improve the user's driving experience, making driving more convenient and comfortable.

3. Overview of the Big Data Technology of the Internet of Vehicles

3.1. Development Status of the Internet of Vehicles

As a specific application of the Internet of Things (IoT) in the transportation, the development of the Internet of Vehicles (IoV) has made remarkable progress in recent years. The Internet of Vehicles realizes real-time information exchange and sharing through various communication modes, such as vehicle and vehicle (V2V), vehicle and infrastructure (V2I), V 2 I), vehicle and network (V2N), vehicle and pedestrian (V2P), and builds an intelligent traffic network system. At present, the Internet of Vehicles technology has been widely studied and applied in the world, and the major automobile manufacturers, technology companies and government agencies are actively involved in it, promoting the rapid development of the Internet of Vehicles technology. With the popularization of 5G communication technology, the communication speed and reliability of the Internet of vehicles have been greatly improved, making real-time data transmission and processing possible. The application scenarios of Internet of vehicles technology include intelligent traffic management, intelligent driving, fleet management, vehicle remote monitoring and maintenance, etc. These applications not only improve traffic efficiency, reduce the occurrence of traffic accidents, but also provide users with a safer and more convenient travel experience.

3.2. Principle of Big Data Technology

Big data technology refers to a series of technologies and methods to collect, store, process, analyze and visualize large amounts of large, diversified and high-speed generated data. The core of big data lies in its 4V characteristics: Volume (large amount of data), Velocity (fast data generation and processing speed), Variety (diverse data types), and Veracity (data accuracy and credibility). In the environment of big data, the traditional data processing technology is difficult to cope with the processing demand of massive data processing, so it is necessary to adopt distributed computing, parallel processing, data mining, machine learning and other advanced technologies. Data collection is the first step of big data processing. Get data through sensors, log files, social media and other channels. The data storage requires efficient storage system, such as Hadoop, NoSQL database, to meet the storage requirements of large-scale data; data processing includes data cleaning, data conversion and data fusion to ensure the quality and consistency of data through statistical analysis, data mining and machine learning; data visualization shows the analysis results in charts and other forms to assist decision-making. The application of big data technology in various fields has shown great potential, providing strong support for scientific research, business decision-making, social management and so on.

3.3. Big data Processing Process of Internet of Vehicles

The processing process of the big data of the Internet of Vehicles covers the key links such as data collection, preprocessing, storage, analysis and visualization. Data collection through vehicle sensors, road facilities and mobile devices and other channels to obtain real-time information about vehicle operation status, traffic conditions and driving behavior. Subsequently, data preprocessing washes the raw data, denoises, and transforms the format, aiming to improve data quality and consistency. For storage requirements, efficient distributed storage systems such as Hadoop and Spark are used to deal with massive data. In the data analysis stage, data mining and machine learning techniques are used to deeply explore the data and reveal underlying laws and knowledge to support intelligent decision-making and optimization, such as forecasting maintenance requirements, optimization of vehicle scheduling and path planning. The final data visualization will show the analysis results in the form of charts or maps, which is easy for users to understand and apply. This process is interlinked, forming a complete data processing closed loop, ensuring the efficient use of data and the maximization of value.

3.4. Application of Big Data of Internet of Vehicles in New Energy Vehicles

The application of big data of the Internet of vehicles in new energy vehicles is mainly reflected in real-time monitoring, energy consumption management optimization, intelligent driving support and market analysis. Through real-time collection and analysis of vehicle operation status, battery status, mileage and other data, it can not only find and solve potential problems in time to ensure the safe operation of the vehicle, but also analyze the driving data to find out the best driving route and driving behavior, so as to reduce energy consumption and improve the endurance. In addition, the big data of the Internet of Vehicles, through real-time monitoring and analysis of road traffic conditions, provides accurate navigation and driving assistance for intelligent driving, and enhances driving safety and convenience. At the same time, it is also used to deeply analyze users' driving habits and preferences, provide market insight for enterprises, and help optimize product design and marketing strategy.

4. Big Data Fusion Strategy of New Energy Vehicle Autonomous Driving Technology and Internet of Vehicles

4.1. Fusion Framework Design

The design of the fusion framework should cover multiple levels of data collection, transmission, storage, processing and application to form an efficient and reliable technical architecture. The data collection layer obtains multi-dimensional data such as vehicle operation status, traffic environment and driving behavior through various sensors and vehicle-connected devices. The data transmission layer requires high bandwidth and low latency communication networks, such as 5G technology, to ensure the real-time transmission and interaction of data. The data storage layer adopts distributed storage systems, such as Hadoop and NoSQL databases, to solve the storage and management problems of massive data. At the data processing layer, big data analysis, machine learning and artificial intelligence technologies are used to deeply dig and analyze the collected data and extract valuable information and knowledge. Finally, the application layer applies the analysis results to the automatic driving and vehicle management through the intelligent decision-making and control system, so as to realize the intelligent and automatic driving experience,as shown in **Table 1**.

Table 1. Table of fusion framework design strategies.

Level	Description	Technology
Data Collection	Collects multidimensional data on vehicle operation status, traffic environment, and driving behavior through various sensors and V2X devices	Sensors,Internet of vehicles equipment
Data Transmission	Requires high bandwidth, low latency communication networks such as 5G technology to ensure real-time data transmission and interaction	5G technology
Data Storage	Uses distributed storage systems such as Hadoop and NoSQL databases to solve massive data storage and management issues	Hadoop, NoSQL databases
Data Processing	Utilizes big data analytics, machine learning, and artificial intelligence technologies to deeply mine and analyze collected data to extract valuable information and knowledge	Big data analytics, Machine learning, Artificial intelligence
Application	Applies analysis results to autonomous driving and vehicle management through intelligent decision-making and control systems to achieve intelligent and automated driving experiences	Intelligent decision-making systems, Control systems

3.2. Data Acquisition and Preprocessing

Data collection involves a variety of sensors and equipment, including lidar, cameras, GPS, accelerometers, etc., which obtain real-time information about the vehicle's surroundings, the vehicle's own status and traffic flow. Data preprocessing is a necessary step to ensure the accuracy and integrity of the data. Data preprocessing includes data cleaning, denoising, format conversion and missing value filling. Through cleaning, noise and outliers in data, format conversion unified data format, and missing value filling to solve the problem of incomplete data. The pre-processed data are more consistent and reliable, which lays a solid foundation for the subsequent data analysis and mining. High-quality data collection and preprocessing not only improve the accuracy of data analysis, but also can effectively improve the decision-making level and safety of the autonomous driving system. The establishment of an efficient data collection and preprocessing process is an important prerequisite for the realization of intelligent new energy vehicles ,the data cleaning formula is as follows:

$$D_{clean} = \frac{D}{D_{noise}}$$

Where, D is the original data set, Dnoise is the noise and outlier dataset, and Dclean is the cleaned dataset.

3.3. Data Transmission and Storage

Data transmission needs to rely on high bandwidth and low latency communication network. The application of 5G technology greatly improves the efficiency and reliability of data transmission. Real-time information exchange between vehicles and external environment is realized through V2V (vehicle communication), V2N) and V 2 N (vehicle and network communication). In terms of data storage, it is necessary to adopt a distributed storage system due to the huge amount and various types of data. Technologies such as Hadoop, Spark and NoSQL database can effectively handle the storage and management of large-scale data, ensuring the high availability and high reliability of data. Storage systems also need to be well scalable to counter the growing volume of data. The efficient operation of data transmission and storage ensures the smooth flow of data from collection to application, and provides a solid foundation for big data analysis and intelligent decision-making. By optimizing the data transmission and storage scheme, the overall performance of the system and the data processing efficiency can be improved, and the deep integration of the autonomous driving of new energy vehicles and the big data of the Internet of vehicles can be promoted.

3.4. Data Mining and Analysis

Data mining includes pattern recognition, association analysis, cluster analysis, predictive analysis and other technologies, which can find potential patterns and trends from complex data sets. For example, by mining vehicle sensor data, common driving patterns and behaviors can be identified and driving strategies optimized, and traffic flow data can predict traffic congestion and adjust driving routes. Machine learning and artificial intelligence technologies play an important role in data mining, and deep learning algorithms can process unstructured data, such as images and videos, to achieve a higher level of intelligent analysis. The results of data analysis are not only used for real-time decision-making, but also for long-term strategy optimization, such as vehicle maintenance prediction, energy consumption management optimization, etc. The efficient data mining and analysis provide reliable support for the autonomous driving system, and improve the intelligent level and decision-making ability of the system ,the typical formula for classification problems in pattern recognition is as follows:

$$y = f(x) + \varepsilon$$

Where y is the target variable, x is the feature vector, f is the model, and ϵ is the error term.

3.5. Intelligent Decision-making and Control

Intelligent decision-making and control form the core objective of integrating autonomous driving technology of new energy vehicles with Internet of Vehicles big data. This process aims to translate data analysis outcomes into driving strategies for automated and intelligent vehicle management. Leveraging big data analysis and real-time environmental perception, the system devises optimal driving strategies encompassing path planning, speed control, and obstacle avoidance decisions.

The control system executes these decisions by manipulating the vehicle’s steering, acceleration, and braking actuators to enable autonomous driving. Ensuring safety and stability in complex traffic environments demands high reliability, real-time responsiveness, self-learning capabilities, and continual optimization of decision algorithms and control strategies through ongoing analysis of driving data.

Intelligent decision-making and control not only enhance the autonomous driving capabilities of new energy vehicles across diverse scenarios, but also boost traffic efficiency, safety, and foster the advancement of intelligent transportation systems. As the system undergoes continuous refinement, the prospects for autonomous driving technology in new energy vehicles will expand further.

4. Conclusion

This paper systematically discusses integrating autonomous driving technology of new energy vehicles with Internet of Vehicles big data. It analyzes their current development status, technical principles, and data processing processes. A framework for efficient integration is proposed, emphasizing data acquisition, preprocessing, transmission, storage, mining, analysis, and intelligent decision-making. This integration enhances vehicle safety, energy efficiency, and user experience while advancing intelligent transportation systems. As technology advances and applications deepen, merging autonomous driving and Internet of Vehicles big data promises more intelligent, convenient travel. Continuous innovation and optimization will further expand the prospects of intelligent transportation systems.

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