Research on New Energy Vehicle Operation Monitoring Cloud Platform Based on Big Data and Artificial Intelligence

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Abstract: ***This article studies a new energy vehicle operation monitoring cloud platform based on big data and artificial intelligence, aiming to improve the operational efficiency and management level of new energy vehicles. By integrating big data analysis and artificial intelligence technology, the platform achieves real-time monitoring and fault prediction of vehicle operating status, optimizing charging strategies and energy management. This study not only provides accurate data support for new energy vehicle operators, but also promotes energy conservation, emission reduction, and environmental protection, laying a solid foundation for the sustainable development of the new energy vehicle industry.***

Keywords: Big data; Artificial intelligence; New energy vehicles; Monitor cloud platform.

1. INTRODUCTION

With the rapid development of the new energy vehicle industry, how to efficiently and accurately monitor the operating status of vehicles and optimize energy management has become a focus of industry attention. The new energy vehicle operation monitoring cloud platform based on big data and artificial intelligence has emerged, aiming to achieve real-time monitoring of vehicle status, fault warning, and intelligent scheduling through deep mining of vehicle operation data and the use of advanced artificial intelligence algorithms. This study aims to explore the construction and application of the platform, providing strong support for the intelligent transformation of the new energy vehicle industry. In sports analytics, Zhu, Yu, and Li (2025) proposed SAGCN, a spatiotemporal attention-weighted graph convolutional network integrated with IoT for precise adolescent tennis motion analysis [1]. Similarly, in logistics, Zhang (2024) applied cohesive hierarchical clustering to dynamically adapt the supply and demand of power emergency materials [2]. The impact of emerging AI on business innovation is explored by Zhou and Cen (2024), who investigated the effect of ChatGPT-like technologies on user entrepreneurial activities [3]. Graph-based methods are proving highly versatile. Yang, Wang, and Chen (2024) developed GCN-MF, a graph convolutional network combined with matrix factorization for recommendation systems [4]. In computer vision, Chen et al. (2022) tackled a fundamental perception task with a one-stage framework for object referring with gaze estimation [5]. Beyond digital systems, the drive for sustainability is examined by Wu et al. (2025), who analyzed how supply chain digitalization and energy efficiency contribute to carbon neutrality targets [6]. A prominent technical thread across these studies is the focus on robust model adaptation. Peng, Zheng, and Chen (2023) addressed source-free domain adaptation for human pose estimation [7], while Peng et al. (2023) also contributed RAIN, a method applying regularization on both input and network for black-box domain adaptation [8]. This emphasis on adaptive, interactive systems extends to robotics, as seen in Guo and Tao's (2025) work on modeling and simulation analysis of robot-environment interaction [9]. Finally, in the critical field of medical monitoring, We et al. (2025) worked towards intelligent anesthesia depth monitoring by leveraging multimodal physiological data [10], showcasing the application of complex data fusion in high-stakes scenarios.

2. OVERVIEW OF NEW ENERGY VEHICLE OPERATION MONITORING TECHNOLOGY

New energy vehicle operation monitoring technology, as a key means to ensure its safe, reliable, and efficient operation, is gradually becoming an important support for the development of the automotive industry. This technology integrates advanced methods such as sensor monitoring, data acquisition, and intelligent diagnosis to monitor and analyze various performance indicators of new energy vehicles in real time. Sensor monitoring technology, as the core, is widely distributed in various parts of vehicles and can capture key parameters such as temperature, pressure, and speed in real time, providing accurate data for performance evaluation. Data collection technology summarizes and integrates these data, and processes them through intelligent algorithms to form visual monitoring reports, helping car owners and maintenance personnel to intuitively understand the vehicle status. Intelligent diagnostic technology further utilizes artificial intelligence and big data analysis to conduct in-depth analysis of vehicle performance, detect potential faults in advance, and provide scientific basis for preventive maintenance. This not only improves the safety of the vehicle, but also extends its service life and reduces maintenance costs. With the integration and application of technologies such as the Internet of Things and cloud computing, new energy vehicle operation monitoring technology has achieved remote monitoring and diagnosis, allowing car owners to grasp the vehicle's condition in real time and enjoy convenient and efficient monitoring services no matter where they are.

3. NEW ENERGY VEHICLE OPERATION MONITORING DATA PROCESSING BASED ON BIG DATA AND ARTIFICIAL INTELLIGENCE

3.1 Data preprocessing and cleaning of new energy vehicles

In the new energy vehicle operation monitoring system based on big data and artificial intelligence, data preprocessing and cleaning are the first step and crucial part of the entire data processing process. New energy vehicles generate massive amounts of data during operation, including but not limited to battery status, motor efficiency, vehicle travel trajectory, environmental temperature and humidity, etc. Although these data contain rich information, they are often accompanied by problems such as noise, missing values, and outliers, which directly affect the accuracy and efficiency of subsequent data analysis. Data preprocessing mainly includes the standardization of data formats, calibration of timestamps, and preliminary screening of data. Since different sensors or systems may adopt different data formats and coding standards, these data need to be converted into a unified format for subsequent processing before data analysis. Due to the real-time requirements of vehicle operation data, time stamp calibration is particularly important to ensure that each data point can accurately correspond to the actual time point. Data cleaning is the process of processing noise, missing values, and outliers in data. Noise is usually caused by random errors due to sensor accuracy limitations or environmental factors, and needs to be eliminated through filtering algorithms or smoothing methods. Missing values need to be filled in according to the characteristics of the data and business logic. Common filling methods include using mean, median, mode, or based on predicted values of other related variables. For outliers, it is necessary to combine business knowledge and statistical methods for identification and processing to avoid their adverse effects on data analysis results.

3.2 Data Mining and Analysis Techniques

In the operation monitoring system of new energy vehicles, data mining and analysis technology is the key to achieving intelligent monitoring and diagnosis. Based on big data and artificial intelligence, data mining technology can deeply explore the potential value in data, reveal the operating rules of vehicles, and provide strong support for optimizing vehicle performance and improving driving experience. Association rule mining is an important technique in data mining, which can help us discover the association relationships between different data items. In the field of new energy vehicles, association rule mining can be used to analyze the correlation between vehicle performance parameters, such as the correlation between battery power and range, the relationship between environmental temperature and battery efficiency, etc. These correlations not only help us gain a deeper understanding of vehicle performance, but also provide guidance for vehicle maintenance. Cluster analysis is another commonly used data mining technique that can group similar data objects into different clusters. In the operation monitoring of new energy vehicles, cluster analysis can be used to identify vehicle groups with similar operating characteristics or classify vehicle failure modes. Through cluster analysis, we can discover similarities and differences between different vehicles or fault modes, providing clues for subsequent fault diagnosis and prediction. Time series analysis is a technique for analyzing time series data, which can help us understand the trends and periodic patterns of data over time.

3.3 Application of Prediction and Diagnostic Algorithms

Prediction and diagnostic algorithms based on big data and artificial intelligence are one of the core technologies for monitoring the operation of new energy vehicles. Prediction algorithms mainly include machine learning algorithms and deep learning algorithms. Machine learning algorithms such as support vector machines (SVM), random forests, etc. can establish prediction models by training historical data to predict vehicle performance in the future. Deep learning algorithms such as recurrent neural networks (RNN), long short-term memory networks (LSTM), etc. can handle long-term dependencies in time series data and have better performance in predicting the changing trends of vehicle performance parameters. Diagnostic algorithms are mainly used to identify and locate vehicle faults. These algorithms usually combine expert knowledge and domain rules to compare real-time data with normal data to identify whether there is a fault in the vehicle and the specific location of the fault. Some advanced diagnostic algorithms can also provide corresponding maintenance suggestions or warning information based on the type and severity of the fault, helping car owners and maintenance personnel take timely measures to solve problems.

4. DESIGN AND IMPLEMENTATION OF NEW ENERGY VEHICLE OPERATION MONITORING CLOUD PLATFORM

4.1 Data Storage and Management System

The primary task of designing and implementing a cloud platform for monitoring the operation of new energy vehicles is to build an efficient and scalable data storage and management system. In terms of data storage, cloud platforms typically adopt distributed storage architectures such as Hadoop HDFS, Ceph, etc. to meet the storage needs of large-scale data. These systems can utilize the storage resources of multiple servers and ensure high availability and reliability of data through data redundancy and fault tolerance mechanisms. In order to improve data access speed, cloud platforms will also introduce data caching technologies such as Redis, Memcached, etc., which store hot data in memory, reduce disk I/O operations, and improve data access efficiency. The data management system is responsible for tasks such as organizing, indexing, and querying data. In the new energy vehicle operation monitoring cloud platform, the data management system needs to support complex data models, including structured data (such as vehicle basic information, mileage, etc.) and unstructured data (such as fault logs, video images, etc.). For this purpose, cloud platforms can adopt a combination of NoSQL databases (such as MongoDB, Cassandra) and relational databases (such as MySQL, PostgreSQL) to select suitable storage solutions based on the characteristics of the data. In order to improve data query performance, cloud platforms will also introduce search engine technologies (such as Elasticsearch) and query optimization algorithms to ensure that users can quickly obtain the information they need. Data quality is a prerequisite for data analysis and decision support. In data storage and management systems, it is also necessary to establish a comprehensive data quality control mechanism. This includes steps such as data cleaning (removing noise, filling in missing values, etc.), data validation (checking data integrity and consistency), and data auditing (tracking data sources and change history).

4.2 Data visualization display and real-time monitoring

Data visualization design aims to present complex data information in an intuitive and understandable form through graphics, charts, and other methods. In the new energy vehicle operation monitoring cloud platform, visual design needs to cover multiple aspects, including vehicle position distribution, driving trajectory, energy consumption analysis, fault diagnosis, etc. To achieve this goal, cloud platforms can introduce professional visualization tools such as ECharts, Tableau, etc., providing rich chart types and interactive functions to meet the different needs of users. Real time monitoring is one of the core functions of the new energy vehicle operation monitoring cloud platform. In order to achieve real-time monitoring, the cloud platform needs to integrate real-time data processing technologies (such as Kafka, Spark Streaming, etc.) to quickly process and analyze real-time data streams from vehicles. The cloud platform also needs to build a real-time data display interface to present the processing results to users in real time. These interfaces can be accessed through various methods such as web browsers, mobile apps, etc., making it convenient for users to understand the operation of vehicles anytime and anywhere. In the process of data visualization display and real-time monitoring, user interaction experience is equally important. Cloud platforms need to design concise and clear operating interfaces, provide friendly user guidance and help documents, and reduce user learning costs. The cloud platform also needs to support multiple query and filtering methods to help users quickly locate the data they care about.

4.3 Cloud Security and Privacy Protection

With the widespread application of cloud platforms for monitoring the operation of new energy vehicles, the issues of cloud security and privacy protection are becoming increasingly prominent. In order to ensure the security and privacy of user data, cloud platforms need to take a series of measures to strengthen security protection. Data encryption is one of the important means to protect data security. In the new energy vehicle operation monitoring cloud platform, the cloud platform needs to encrypt, store and transmit sensitive data to ensure that the data is not stolen or tampered with during transmission and storage. Cloud platforms also need to implement data isolation to ensure that the data of different users or vehicles is independent of each other, avoiding data leakage and confusion. Access control and permission management are important mechanisms for protecting data security. Cloud platforms need to establish comprehensive user authentication and authorization mechanisms to verify and authorize user identities, ensuring that only legitimate users can access relevant data. Cloud platforms also need to record and monitor user behavior, promptly detect and handle abnormal behavior. Security auditing and monitoring are important means to ensure the security of cloud platforms. Cloud platforms need to establish a sound security auditing mechanism to record user behavior and system operation status, providing a basis for investigating and handling security incidents. The cloud platform also needs to introduce real-time monitoring technology to continuously monitor and analyze the operating status of the system, and timely detect and deal with potential security threats. When designing and implementing a new energy vehicle operation monitoring cloud platform, compliance and legal compliance issues also need to be considered. The cloud platform needs to comply with relevant laws, regulations, and industry standards (such as GDPR, HIPAA, etc.) to ensure the legal collection, use, and processing of user data. The cloud platform also needs to sign data protection agreements and privacy policies with users, clarify the rights and obligations of both parties, and protect the legitimate rights and interests of users.

5. SUSTAINABLE DEVELOPMENT STRATEGY OF NEW ENERGY VEHICLE OPERATION MONITORING CLOUD PLATFORM

5.1 Energy conservation, emission reduction and environmental protection

In the sustainable development strategy of the new energy vehicle operation monitoring cloud platform, energy conservation, emission reduction, and environmental protection are one of the core elements. With the increasing global awareness of environmental protection and the severity of climate change issues, promoting the green development of the new energy vehicle industry has become a demand of the times. Firstly, cloud platforms should reduce energy consumption by optimizing data processing and storage efficiency. Secondly, cloud platforms should support energy efficiency management for new energy vehicles, providing users with energy-saving and emission reducing driving advice through real-time monitoring and analysis of vehicle energy consumption data, and promoting green travel. Cloud platforms can also be linked with charging infrastructure to optimize charging strategies, reduce peak valley load differences in the power grid, and achieve efficient energy utilization. In addition to energy conservation and emission reduction, cloud platforms should also pay attention to the treatment and recycling of waste from new energy vehicles. By establishing a comprehensive waste recycling system, promoting the recycling of key components such as waste batteries, and reducing environmental pollution, cloud platforms can strengthen cooperation with environmental organizations to jointly promote the green development of the new energy vehicle industry chain and enhance the environmental protection level of the entire industry.

5.2 New Technology Application and Research and Development Direction

In order to maintain the competitiveness of the new energy vehicle operation monitoring cloud platform, continuous technological innovation and research and development are indispensable. With the rapid development of technologies such as artificial intelligence, big data, and the Internet of Things, cloud platforms should actively introduce these advanced technologies to enhance their data processing and analysis capabilities. For example, using artificial intelligence algorithms to intelligently diagnose and predict vehicle faults, improving the accuracy and efficiency of fault diagnosis; By analyzing big data to uncover potential value in vehicle operation data, we aim to provide users with more personalized services. The application of IoT technology can achieve seamless connection between vehicles and cloud platforms, improving the real-time and accuracy of data transmission. In the future, the research and development direction of cloud platforms should focus on improving the security, reliability, and scalability of the platform. In terms of security, strengthen data encryption and access control mechanisms to ensure the security and privacy of user data; In terms of reliability, optimize system architecture and fault tolerance mechanisms to improve system stability and availability; In terms of scalability, design a flexible and scalable system architecture that supports the processing and storage needs of massive amounts of data. Cloud platform should also pay attention to the development trend of new technologies, such as blockchain and edge computing, and explore its application potential in the field of new energy vehicle operation monitoring.

5.3 Future Development Plan and Strategic Cooperation

In order to achieve sustainable development of the new energy vehicle operation monitoring cloud platform, the cloud platform should clarify its own development goals and positioning, and formulate reasonable development plans based on market demand and technological development trends. This includes expanding market share, improving service quality, and strengthening technological innovation. Cloud platforms should establish a comprehensive operational management system to ensure stable operation and sustainable development of the platform. This includes developing standardized operational processes, establishing a professional technical team, and strengthening communication and feedback with users. Cloud platforms should also pay attention to the formulation and promotion of industry standards, actively participate in industry exchanges and cooperation, and promote the standardized development of new energy vehicle operation monitoring. In order to accelerate its own development pace and enhance competitiveness, cloud platforms should actively seek strategic cooperation with upstream and downstream enterprises in the industrial chain. This includes collaborating with new energy vehicle manufacturers to jointly promote the intelligent and networked development of new energy vehicles; Cooperate with charging infrastructure operators to achieve convenient and intelligent charging services; Collaborate with research institutions and universities to jointly carry out new technology research and application promotion. Through strategic cooperation, cloud platforms can fully utilize the resources and technological advantages of all parties to achieve win-win development.

6. CONCLUSION

The research on a new energy vehicle operation monitoring cloud platform based on big data and artificial intelligence has important practical significance and broad application prospects. With the continuous advancement of technology and the deepening expansion of applications, this platform will further improve the operational efficiency and intelligence level of new energy vehicles, promoting the healthy and rapid development of the new energy vehicle industry. In the future, we look forward to seeing more innovative technologies integrated and breakthroughs, jointly promoting the new energy vehicle industry towards a greener and smarter future.

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