Asia Pacific Science Press

Journal of Advances in Engineering and Technology
ISSN(O):3005-7507
ISSN(P):3005-7493
Vol. 1 No.3 (2024)

Artificial Intelligence in Transportation

Siru Wang*

Beijing No. 5 High School, Beijing 100007, China

Corresponding author : Siru Wang

Abstract: In recent years, the gradual maturation of artificial intelligence (AI) and big data technology has promoted the deep integration of the "AI + transportation" model, which has been widely used in many transportation segments, and the intelligent transportation has been increasingly emphasized, on the one hand, it is an important method for the intelligent management of transportation, and on the other hand, it improves the efficiency of the implementation of the traffi c management system. This paper analyzes the mainstream technology and application of artifi cial intelligence in the fi eld of transportation by reviewing various types of literature and summarizing the summary of information, compares and evaluates the advantages and disadvantages of the application of diff erent artifi cial intelligence technologies in the field of transportation, summarizes the progress of intelligent transportation, summarizes the advantages of different applications and the technical shortcomings and bottlenecks of the development of diff erent applications, puts forward proposals for the application of artificial intelligence technology in the field of transportation, and looks forward to the future direction of development, in order to promote the further development of intelligent transportation.

Keywords: Artificial Intelligence; Big Data; Intelligent Transportation

Published: Dec 12, 2024

DOI: https://doi.org/10.62177/jaet.v1i3.98

1.Introduction

With the improvement of people's living standards, cars have gradually become the standard of urban families, and the increase of cars has led to traffi c congestion and traffi c accidents and other problems, the traditional traffi c management has been unable to meet the growing demand for travel. All sectors of society are committed to fi nding solutions to improve the effi ciency of the transportation system.[1] The gradual maturation of artifi cial intelligence technology makes it an important part of the program.[2] Today more than forty countries in the world position the development of artificial intelligence as a national strategy, and the rapid development of artificial intelligence brings new opportunities and challenges for transportation. The application of artifi cial intelligence in intelligent transportation systems has also greatly improved the travel experience. Through intelligent navigation systems, travel recommendations and personalized service provision, AI can provide users with the best travel plans and services according to their needs and traffi c conditions. Whether it is route optimization during traffic congestion or vehicle positioning and tracking, AI is able to respond in real time and provide corresponding solutions, providing travelers with a more effi cient and convenient travel experience.

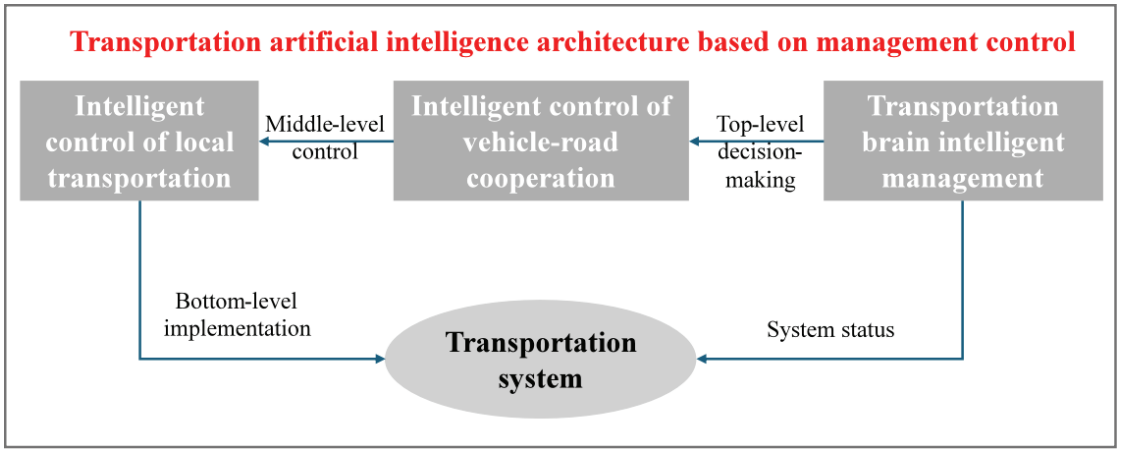
Big data refers to a collection of data with huge scale, complexity and variability, and fast speed. Huge scale brings the characteristics of large data volume, complexity and variability brings the characteristics of many kinds, and fast speed data collection brings the characteristics of low value density. Big data includes the collection and storage of data, as well as

processing and analysis, so it will involve machine learning, data processing and other artificial intelligence technologies. By applying big data technology, valuable information and knowledge can be effectively extracted to provide decision support and optimization solutions for intelligent transportation systems. Big data plays an important role in traffic flow prediction. By analyzing historical data, it is used to predict future conditions in traffic and take measures in advance to reduce congestion and optimize traffic flow. In addition, big data can be used for congestion regulation and road condition monitoring, etc. By obtaining and processing data in real time, traffic signal optimization and road condition monitoring are carried out to promote a convenient and efficient travel experience.

Intelligent transportation integrates IoT, big data, cloud computing and other artificial intelligence technologies to analyze traffic information and provide real-time traffic information services.[3] Nowadays, the gradual maturity of artificial intelligence and big data technology promotes the in-depth integration of the "AI+Transportation" model, which enables intelligent transportation to be widely used. This method has been increasingly valued and has become an important method to improve the efficiency of the transportation system and promote the intelligent management of urban transportation. In summary, the study of the application of artificial intelligence in the field of transportation has become an urgent need.

Artificial intelligence is a technology or system that allows machines to have intelligence and learning ability. It enables machines to perceive the environment, understand language, reason and judge, learn and make autonomous decisions by imitating and simulating human perception, thinking and behavior.[4] The concept of artificial intelligence originated at the Dartmouth Conference in the 1950s, and with the development of computers, people began to study how to make computers have human intelligence. After decades of development, AI technology has gradually matured and achieved outstanding results in many fields. Artificial intelligence technology has become one of the key driving forces leading the development of technology with its powerful computing ability and intelligent decision-making ability.[5] Intelligent traffic management framework , as shown in Fig. 1, includes intelligent decision-making of traffic state, vehicle-road cooperative traffic system control, which realizes the three functions of the underlying traffic control function, information communication and collaborative division of labor, and constitutes the intelligent control of the traffic system. As in Figure 1.

Figure1: Transportation artificial intelligence architecture based on management control



2.Overview of artificial intelligence technology

Artificial intelligence technology has a wide range of applications and impacts in many fields, including but not limited to the following. Natural language processing is the study of the technology of computer understanding of natural language. It includes text analysis, understanding semantics, speech recognition, etc., and is used in customer service systems, voice assistants, machine translation, and other fields. Machine Vision: Machine vision is a technology that realizes the understanding and analysis of images and videos by simulating the human visual system. It can be applied to image recognition, target detection, face recognition, intelligent monitoring and other fields. Machine Learning: Machine learning is a technology that allows machines to improve their performance through data and experience. It includes fields such as generative AI, reinforcement learning, supervised learning, unsupervised learning, etc. It is widely used in systems such as

data mining, risk assessment and intelligent recommendation. AUTOMATIC DRIVING: Autonomous driving is a technology that uses perception, cognition, decision-making, and control technologies to realize unmanned vehicle driving. Through deep learning and sensor fusion and other technologies, it realizes the functions of environment perception, path planning and vehicle control. Augmented Reality: Augmented Reality integrates the real world and virtual information, it superimposes virtual information in the user's field of view through technologies such as machine vision and computer graphics, and is widely used in the fields of gaming, education, and healthcare. The core technologies of artificial intelligence include deep learning, reinforcement learning, computer vision, and natural language processing. Deep learning is a machine learning method that mimics the structure and workings of human neural networks. Learning and classification of large-scale data is achieved through the connection and weight adjustment of multi-layer neural networks. Reinforcement learning makes optimal decisions through rewards, punishments and trial and error, maximizing the accumulation of rewards by interacting with the environment and continuously optimizing actions. Computer vision analyzes and processes videos and images to extract useful information, including feature extraction, target detection, and semantic segmentation of images. Natural Language Processing transforms natural language into a form that can be processed and understood by computers, including methods such as text categorization, entity recognition, and sentiment analysis. Machine learning is a subfield of artificial intelligence and it is one of the ways to realize artificial intelligence, while deep learning is a subset of machine learning, as shown in Figure 2, where neural network models are commonly used to solve complex problems.

Figure2: Relationship between Artificial Intelligence, Machine Learning and Deep Learning

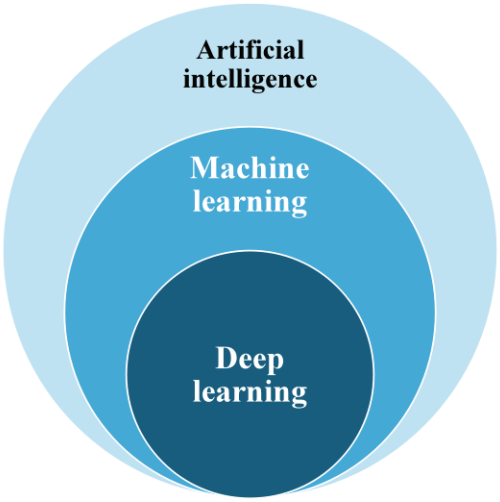


Figure 2 depicts the relationship of artificial intelligence with machine learning and deep learning, where AI systems have the ability to learn autonomously and have multimodal perception, combining multiple pieces of information, such as vision, speech, and behavior, to make decisions and reasoning. Deep learning has made great breakthroughs in the field of pattern recognition, such as image and speech recognition, but still has limitations in reasoning and understanding. Future developments will explore the combination of deep learning with traditional methods such as symbolic reasoning and rule engines. Artificial intelligence technology will focus more on the needs and habits of individual users to provide personalized intelligent services and experiences. Federated learning will be widely used in scenarios such as mobile devices and the Internet of Things to protect the privacy and security of user data.

3.Application of artificial intelligence technology in transportation

Big data technology in intelligent transportation refers to the collection, storage, management, and analysis of huge-scale traffic data to extract high-value information from it, in order to support traffic decision-making, optimize traffic flow, and enhance traffic services and other goals. These data mainly include vehicle location, speed, driving trajectory, passenger demand and many other aspects. Intelligent transportation systems need to deal with numerous vehicle and passenger data, and the data scale is huge. The data comes from various sources, including sensors, traffic cameras, in-vehicle devices, and other channels. Traffic data is time-sensitive and needs to be collected and processed in real time in order to respond to

traffic conditions in a timely manner. Traffic data involves multiple dimensions of information, such as time, space, speed, etc., and needs to be analyzed and processed in multiple dimensions. Data acquisition is the basis of big data technology in intelligent transportation. Data collection technology includes the application of devices such as sensors, satellite navigation systems, traffic cameras, etc., through which traffic data can be acquired in real time. Big data technology requires strong storage and management capabilities. Relational databases cannot meet the storage needs of massive data, and today it has become common practice to use technologies such as distributed file systems and columnar databases to store and manage traffic data. Collected RAW data usually suffers from various problems such as missing values and noise. Data cleaning and preprocessing techniques involve methods such as data cleaning, data mining, and missing value filling to ensure the quality and accuracy of the data. Data analysis and mining technology is the core aspect of big data technology, which includes methods such as machine learning, data mining, visualizing data and statistical analysis of data for extracting valuable information and knowledge from traffic data. Due to the real-time nature of traffic data, real-time processing of data has become an important demand for big data technology in intelligent transportation. Real-time processing techniques include methods such as streaming processing and complex event processing to achieve timely response to real-time data. Mining and analysis of historical traffic data is used to predict the future status of traffic flow and provide traffic optimization solutions, such as dynamic traffic signal control and congested area warning. By analyzing traffic data, it can monitor real-time road congestion, accidents, etc., and provide drivers with the best driving routes and various road condition data to reduce travel time. Using passengers' location information and needs, public transportation routes and frequency arrangements can be optimized to provide more convenient and efficient public transportation services. By analyzing parking lot usage and vehicle traffic, intelligent parking space navigation and parking lot reservation systems can be implemented to reduce space-seeking time when parking. Big data technology can help traffic management authorities to detect traffic violations and accident risks in a timely manner and provide instant warnings to ensure traffic safety. As shown in Table 1, the big data fusion mining of transportation GPS in Shenzhen can solve the problems of single data, small coverage of data statistics, and poor data quality, which improves the reliability and accuracy of transportation system assessment.

Table 1 Big data processing of transportation GPS in Shenzhen city

Data Source	Advantages	Disadvantages
Cab	24-hour operation, 15,000 vehicles all day long, adequate coverage in the center of the city	Uneven spatial distribution, insufficient coverage outside the city center
Shuttle buses	Uniform distribution throughout the city, 15,000 devices during the daytime	Uneven time distribution, insufficient data coverage at night (only 2,000 devices uploading data in the early morning)
Buses	Evenly distributed citywide, 12,000 devices during the day	Uneven time distribution, insufficient data coverage at night, speed needs to be corrected

Table 1 shows the advantages and disadvantages of big data processing data of transportation GPS in a city. As shown in the figure, cabs operate throughout the day, the number of about 15,000, of which there is sufficient coverage within the central city and insufficient coverage outside the central city, and the citywide shuttle buses are evenly distributed, 15,000 during the day, and the nighttime data is only 2,000, and the time distribution is uneven. Buses are evenly distributed throughout the city, 12,000 during the day, but the number is insufficient at night. Meanwhile, transportation data involves sensitive information such as personal privacy and business secrets, and the protection of data security and privacy is an important issue. Meanwhile, the quality and consistency of traffic data are crucial for data analysis and decision support. However, errors and inconsistencies may exist in the data collection process, requiring data cleaning and correction. Big data analysis requires certain professional knowledge and skills, and it has become a challenge to cultivate talents with big data analysis capabilities. Big data in intelligent transportation often involves data from multiple departments and organizations, and how to achieve data sharing and cooperation has become a challenge, requiring the establishment of unified data standards and sharing mechanisms.[6] The effect of big data analysis depends largely on the selection and design of algorithms and models,

and how to improve and optimize algorithms and models becomes the key to further enhance the performance of intelligent transportation systems .

Artificial intelligence and big data technology have promoted the development of the transportation field, and today smart transportation applies information and communication technology to the field of transportation to realize the intelligence and automation of the transportation system. By sensing, collecting and processing traffic data, smart transportation systems can provide real-time traffic information and services to optimize traffic flow, improve traffic safety and environmental protection. The concept of smart transportation can be traced back to the 1960s. With the rapid development of computer and communication technologies, people began to try to apply these technologies to transportation systems to improve transportation safety and efficiency. Intelligent transportation system develops along with high technology, and its development direction is intelligence. Intelligent transportation relies on elements such as vehicles, people, things and infrastructure to create a new type of urban transportation system, and at the same time establishes a matching legal system to promote the development of transportation in the direction of smarter and fairer. As shown in Figure 3, after decades of development, smart transportation has gradually become an important direction to lead the development of transportation. Sensor technology is the foundation of the smart transportation system, which collects various traffic data in the environment through sensing, such as traffic flow, speed, location, environmental weather and other information. Common sensors include cameras, radar, geomagnetic sensors and so on. Smart transportation system relies on a large number of communication technologies to realize the collection and transmission of real-time data. Such as vehicle networking technology, Internet of Things technology, wireless and mobile communication technology. Smart transportation systems need to analyze and process a large amount of traffic data to provide real-time traffic information and decision-making support. Data analysis techniques include machine learning, data mining, statistical analysis and other methods.

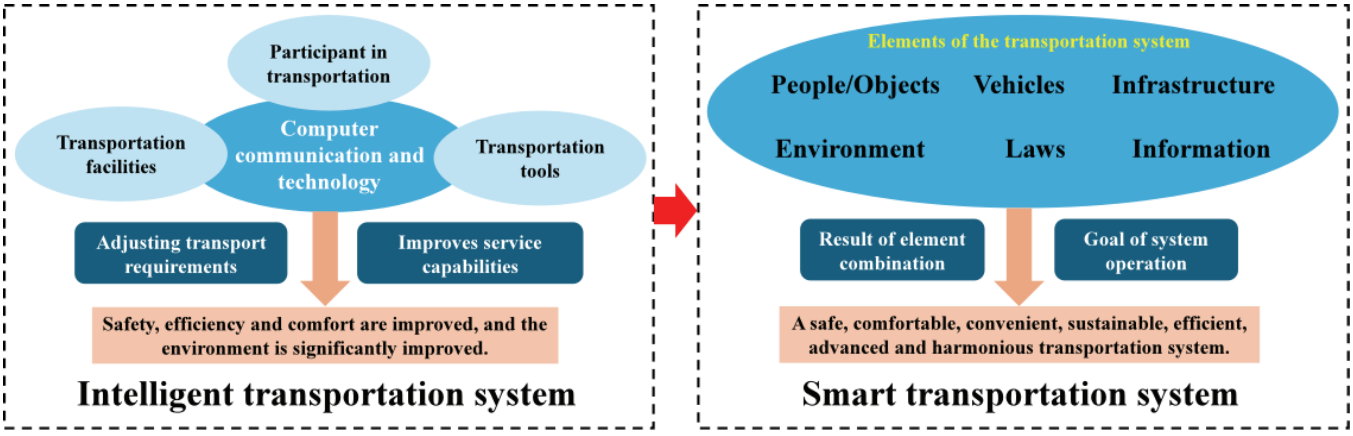


Figure 3 Intelligent transportation system and smart transportation system

Artificial intelligence technology is widely used in the field of transportation, such as image recognition, speech recognition and other technologies. It can help the smart transportation system to realize the functions of vehicle detection, traffic signal optimization, road condition prediction and so on. As technology continues to advance, some cutting-edge technologies such as blockchain, IoT, and edge computing are also beginning to be used in smart transportation systems to provide more efficient and safe transportation services. Smart transportation systems can optimize traffic signal control, reduce traffic congestion, and provide services such as vehicle navigation and path planning through real-time data collection and analysis. Through sensors and image recognition and other technologies, the smart transportation system can monitor real-time traffic violations and accidents, and provide timely warning and treatment. Smart transportation system can monitor the location and operation of bus vehicles in real time and provide services such as bus information query and bus transfer recommendation, which is convenient for urban residents to travel. Smart transportation system can provide intelligent parking navigation, parking space search and other services through vehicle identification and real-time data analysis to reduce urban parking problems. Smart transportation system detects traffic violations and abnormalities on the road through cameras and sensors and other equipment, providing real-time monitoring and alarm services. Autonomous driving technology is an important

development direction for intelligent transportation, realizing autonomous driving and automated transportation of vehicles through deep learning and sensor fusion, etc. The wide application of 5G technology will provide a higher-speed, low-latency communication network for smart transportation, while the popularity of the Internet of Things (IoT) will interconnect transportation equipment and vehicles. The development of big data and artificial intelligence will enhance the data analysis and decision support functions of the smart transportation system to provide more accurate traffic management and services. Smart transportation systems will work to reduce traffic congestion, optimize traffic routes, and promote electric and new energy vehicles to achieve green transportation goals.[7] The rise of shared mobility will change the way of urban travel, and the smart transportation system will promote the integration of public transportation and shared mobility, providing the integration and recommendation of multiple travel modes .

4.Conclusion

Artificial intelligence technology has a profound impact on various industries with its powerful computing ability and intelligent decision-making ability. Intelligent transportation, i.e., the application of AI in the field of transportation, as an innovative mode of transportation, plays an important role in improving transportation efficiency, ensuring transportation safety, and improving travel services. With the continuous progress of technology and the expansion of application scenarios, intelligent transportation brings more intelligent, convenient and sustainable development to the urban transportation system. By collecting, storing, managing and analyzing massive traffic data, it can achieve the goals of traffic flow optimization, road condition monitoring and guidance, public transport service optimization, intelligent parking management and many other aspects. However, the development of AI technology still faces challenges and difficulties, and smart transportation also faces challenges in data privacy protection, system security, and laws and regulations, and still faces issues such as data privacy protection, data quality and consistency, and talent cultivation in the process of applying big data technology. It is expected that in the future, while artificial intelligence technology continues to progress, it should be able to fully consider various issues of ethics, law and society, and make positive contributions to the development of human society, and intelligent transportation can fully consider these issues and continue to promote innovation and development in the field of transportation, and the big data technology can bring more far-reaching impacts to intelligent transportation and promote the efficient, safe and sustainable development of the transportation system.

nce and adapt to the needs of different teams by adjusting his role, which further proves his outstanding ability and flexibility in multiple positions. These traits have gradually established LeBron as a more complete basketball player in terms of data dimensions and overall comprehensiveness.

Although Michael Jordan is undoubtedly one of the most influential players in basketball history, his six championships and unparalleled competitive spirit have established his position as a basketball “myth”, LeBron has surpassed the traditional shooting guard role through his comprehensiveness and career continuity and has become an all-around symbol of contemporary basketball. Whether it is scoring, assists, or defense, LeBron has demonstrated top-notch abilities in all aspects, combined with his leadership performance, forming a unique basketball style. Readers can further think about who is the greatest player in basketball history and form their own opinions based on the data and analysis provided in this article.

Funding: No

Conflict of Interests:

The author(s)declare(s) that there is no conflict of interest regarding the publication of this paper.

References

[1] A. Cheng, G. Jiang, X. Teng, W. Xu, Y. Li, L. Wu, Y. Chiu, Changes in low-carbon transportation efficiency of Chinese roads after considering the impact of new energy vehicles, Transport Policy. 159 (2024), 10.1016/j.tranpol.2024.09.020.

[2] G. Sariyer, S.K. Mangla, M.E. Sozen, G. Li, Y. Kazancoglu, Leveraging explainable artificial intelligence in understanding public transportation usage rates for sustainable development, Omega-Int. J. Manage. S. 127 (2024), 10.1016/j.omega.2024.103105.

[3] Y. Zhu, C. Liu, C. Chen, X. Lyu, Z. Chen, B. Wang, F. Hu, H. Li, J. Dai, B. Cai, W. Wang, Privacy-Preserving Large-

Scale AI Models for Intelligent Railway Transportation Systems: Hierarchical Poisoning Attacks and Defenses in Federated Learning, Cmes-Comp. Model. Eng. 141 (2) (2024) 1305-1325, 10.32604/cmes.2024.054820.

[4] F.J.J. Reis, R.K. Alaiti, C.S. Vallio, L. Hespanhol, Artificial intelligence and Machine Learning approaches in sports: Concepts, applications, challenges, and future perspectives, Braz. J. Phys. Ther. 28 (3) (2024), 10.1016/j.bjpt.2024.101083.

[5] A. Waqar, Intelligent decision support systems in construction engineering: An artificial intelligence and machine learning approaches, Expert Syst. Appl. 249 (2024), 10.1016/j.eswa.2024.123503.

[6] S. Abirami, M. Pethuraj, M. Uthayakumar, P. Chitra, A systematic survey on big data and artificial intelligence algorithms for intelligent transportation system, Case Studies On Transport Policy. 17 (2024) 101247, 10.1016/j.cstp.2024.101247.

[7] M. Tang, Z. Fang, C. Fan, Z. Zhang, L. Kong, H. Chen, Z. Zeng, Y. Yang, L. Qi, An AI-driven electromagnetic-triboelectric self-powered and vibration-sensing system for smart transportation, Eng. Struct. 323 (2025), 10.1016/j.engstruct.2024.119275.