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Research on the Application of Intelligent Transportation in Urban Traffic Management

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Abstract: With the development of economy, cars are increasingly entering the homes of ordinary residents, which leads to heavy traffic and an increase in the accident rate. Traditional forms of transportation are no longer enough to support the current traffic pressure. We should now look for a safer and more efficient traffic management mode. Intelligent transportation is the core component of intelligent transportation system, which guarantees the operation efficiency and safety of urban transportation system by integrating advanced information technology and data communication technology. Therefore, this paper mainly discusses the key technologies and applications of smart transportation in urban traffic management, so as to alleviate traffic pressure and improve urban competitiveness.

1 Introduction

As technology advances and global urbanization progresses, the population of cities continues to grow, leading to an increase in living standards. As a result, many households now own their own cars, contributing to a rise in the number of motor vehicles on the road. While this growth brings vitality to cities, it also leads to traffic congestion, a significant "urban disease"[1]. This issue severely impacts the urban environment and operational efficiency, hindering city development and presenting unprecedented challenges to urban transport systems. Therefore, finding and implementing a greener, safer, and more efficient transportation system has become a top priority for current cities. In recent years, with the emergence of the concept of smart cities, intelligent transportation systems have gradually come into focus. Intelligent transportation is a critical component of smart city development. It represents the advanced stage of intelligent transportation

systems (ITS) and has emerged and developed rapidly against this backdrop. By leveraging the latest advancements in modern information technology and other fields, intelligent transportation can effectively enhance the operational efficiency of urban transport, improve citizens' travel experiences, and promote the healthy development of smart city transportation[2].

Smart transportation is an integral part of smart city development, addressing urban transportation and congestion issues effectively. In terms of smart transportation systems, we leverage artificial intelligence, big data, cloud computing, and IoT technologies to integrate these advantages into urban transportation, enhancing transportation efficiency, ensuring passenger safety, and making travel more convenient.

2 Artificial Intelligence Technology

Artificial intelligence technology is a technical science that studies and develops theories, methods, technologies and application systems for simulating, extending and expanding human intelligence. It is a branch of computer science that aims to enable machines to respond in a manner similar to human intelligence. The practical applications of artificial intelligence in smart transportation are mainly: high-definition video surveillance systems, intelligent maps and smart parking.

2.1Application of HD video surveillance system

The high-definition video monitoring system refers to the combination of computers and cameras through Internet technology, using the camera's image detection and recognition technology to conduct real-time analysis of traffic and road conditions in the city, making it easier for traffic police to control them, so that they can control traffic lights at any time to reduce traffic congestion. It can detect whether someone has violated traffic regulations, and perform facial recognition to send relevant penalties to personal mobile phones, thereby reducing the workload of traffic police. [3]

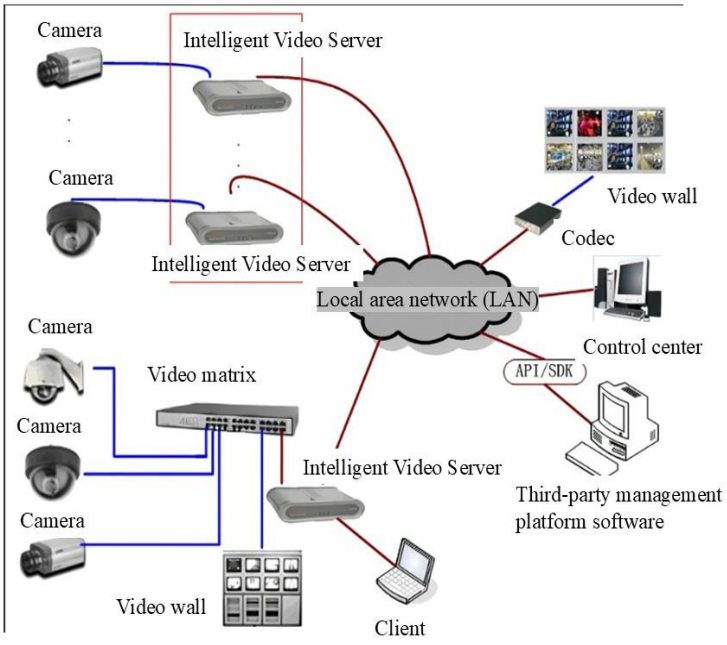

Figure 1 Monitoring system structure diagram

2.2 Application of intelligent maps

In recent years, the rapid development of intelligent maps has provided more convenience for people's travel. With the continuous improvement of the accuracy of real-time data in intelligent maps, it has been widely used in people's daily lives. For example, in-car navigation can cooperate with the data released by the urban transportation system to remind drivers of the road conditions ahead in real time, and can analyze the best route to the destination, which provides a lot of convenience for the public's travel and reduces the pressure of urban transportation.

2.3 Smart parking and its applications

Intelligent parking systems utilize license plate recognition technology to enable automatic vehicle entry and exit. When a vehicle approaches the entrance of a parking lot, cameras quickly identify the license plate number and compare it with information stored in a database. If the vehicle is registered or temporarily permitted to enter, the barrier gate automatically opens, allowing the vehicle to proceed. The same applies when leaving. Additionally, sensor technology and parking space indicator lights provide real-time occupancy information to drivers. Sensors installed above each parking space or on the ground detect whether a spot is occupied, eliminating the need for drivers to search blindly for available spaces. This not only improves space utilization but also reduces congestion caused by vehicles circling around popular parking lots. By knowing the availability of parking spots, drivers can choose appropriate parking facilities, thus alleviating traffic congestion to some extent. Unlike traditional parking lots where manual payment and change handling take several minutes, intelligent parking systems significantly reduce this time to just seconds, greatly speeding up the parking process. Moreover, surveillance equipment within the intelligent parking system continuously monitors the parking area, effectively preventing and combating crimes such as vehicle theft and vandalism. In case of any anomalies, the system promptly alerts both parking staff and law enforcement authorities.

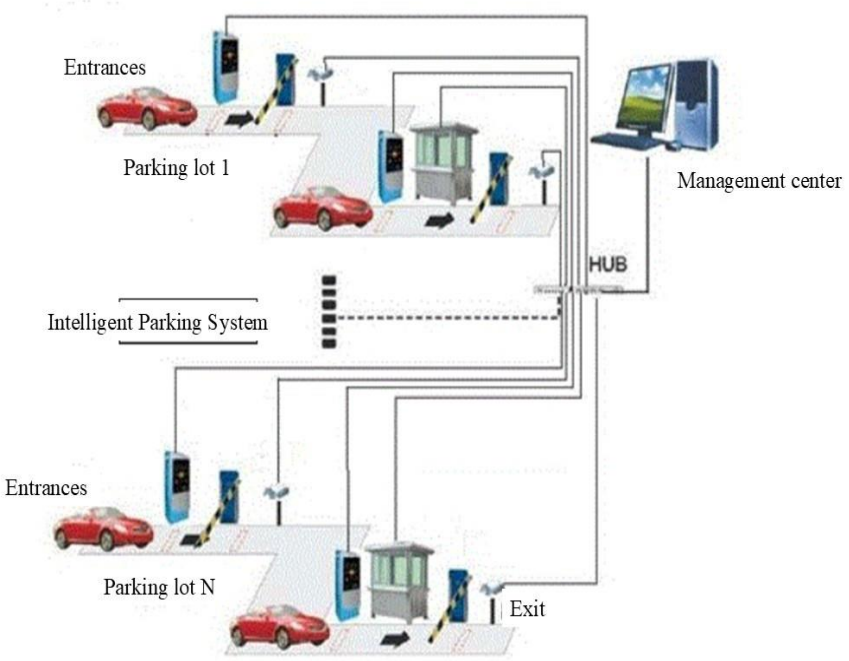

Figure 2 Intelligent Parking System Structure Diagram

2.4 Development Trends and Prospects of Artificial Intelligence Technology

Since the concept of artificial intelligence was officially proposed at the Dartmouth Conference in the United States in 1956, the development of artificial intelligence has not been as smooth as imagined, but rather has experienced ups and downs. Not until the 21st century did humanity enter the era of the Internet and big data, since then artificial intelligence technology has developed rapidly, the literature and patents related to artificial intelligence have surged, and projects related to artificial intelligence have grown year by year. The main driving force behind the rapid development of artificial intelligence technology is the industrial sector. As the performance of artificial intelligence continues to improve, the application scenarios used by the industry are increasing, bringing huge economic benefits. And artificial intelligence still has tremendous potential in smart transportation, such as the currently maturing autonomous driving technology and intelligent traffic light systems.

However, artificial intelligence technology still has its shortcomings. For example, dealing with large amounts of data, privacy protection and data security remain a major challenge for artificial intelligence. Adaptation issues in different cities and environments, as well as compatibility issues with different infrastructures, also need to be addressed gradually.

Artificial intelligence is gradually appearing in all aspects of urban management. With its gradual maturity, it will also promote the transformation of the smart transportation system, making the city's traffic management system more efficient and green.

3 Application of big data and cloud computing technology

Cloud computing is a model that provides scalable and elastic computing resources (including computing power, storage capacity, network bandwidth, etc.) through the network. Users obtain the data they need through cloud services. Big data refers to a collection of data that cannot be captured, managed and processed by conventional software tools within a certain time frame. It is a massive, high-growth and diversified information asset that requires new processing models to have stronger decision-making power, insight discovery and process optimization capabilities.

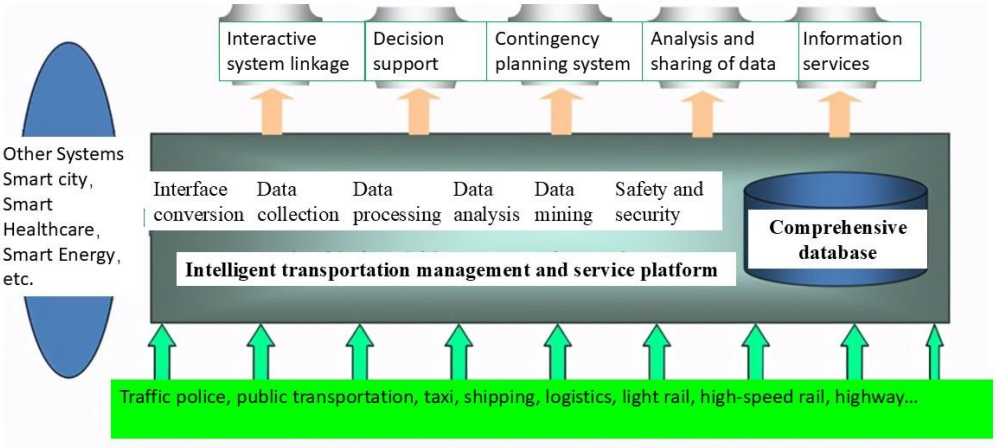

Figure 3 Intelligent Transportation Comprehensive Management Information Service Platform System Architecture

3.1 Characteristics of Big Data and Cloud Computing

It can store a large amount of data of different types. The intelligent traffic management system

needs to collect statistics, analyze, process and send all traffic conditions in the target area. The amount of data it contains is very large. At present, modern technologies such as big data and cloud computing are used in traffic systems for information processing. The data it needs to face includes data generated by safety management, status supervision, emergency response, and danger warning. There are many types of data and the nature is complex. The traditional processing method is very labor-intensive and prone to errors. The advantage of this technology is that it can store a large amount of data and the calculation speed is very fast. .

Data processing is highly real-time. Big data first collects data through equipment and uses cloud platforms for real-time processing, which greatly improves the processing speed and management efficiency. However, traditional methods take a long time, which may miss the best opportunities.

3.2 Application of big data and cloud computing

Through the intelligent management platform, we can monitor the traffic environment and driving behavior in real-time. Due to the current immense traffic pressure and increasingly complex road conditions, violations such as speeding, running red lights, illegal parking, wrong-way driving, and drunk driving occur frequently. By leveraging cloud computing and big data analytics, we can detect these violations in real-time. For instance, when there are instances of running red lights or speeding, traditional methods require police pursuit, which is highly unpredictable. However, by combining the platform with big data, we can use image recognition technology to directly identify the driver of the violating vehicle and send notifications of their misconduct via SMS or other means. This helps regulate drivers' behavior from the root, preventing accidents, and can even be applied to non-motor vehicles like electric bikes without helmets or overloading. If detected, immediate penalties can be imposed, instilling a sense of deterrence. Additionally, cross-referencing with blacklists or criminal records held by law enforcement agencies allows for predicting fugitive paths, greatly facilitating police operations. It enables more effective target management, laying a solid foundation for urban development and safety.

Leveraging big data and cloud computing technologies provides decision-makers with more accurate and reliable data references. The establishment of a smart transportation system can utilize the platform's capabilities in big data collection, processing, analysis, and storage to enhance the execution of managerial decisions. Traditional traffic management platforms focus on post-event management, lacking real-time monitoring and early warning mechanisms. Intelligent management platforms offer comprehensive features, including facial recognition, for in-depth analysis of road conditions, drivers, and traffic accidents. They provide timely warnings about abnormal vehicles, enabling pre-incident prevention, mid-incident control, and post-incident management, while also facilitating collaboration among various departments.

Comprehensive analysis of road conditions helps alleviate traffic congestion. Different regions and times experience varying traffic patterns, with peak periods during holidays and rush hours being significantly busier than normal times. Some traffic facilities are underutilized. By employing the volume data feature analysis technology of the intelligent platform, we can reduce traffic pressure and increase the utilization of previously underused facilities. Moreover, using IoT, surveillance networks, real-time communication, and sensing technologies to collect data, combined with big data analysis and processing techniques, allows for real-time capture of current road conditions, providing data support and analytical assurance for traffic management. For example, traffic authorities can use sensors and detection devices to obtain specific road information, issue alerts for abnormal road segments, and provide real-time data to drivers, allowing them to plan routes and avoid congested areas, thereby improving traffic flow efficiency.

As people's modes of travel and lifestyle habits change dramatically, traditional approaches no

longer meet contemporary needs. We must reform to fully exploit the advantages of intelligent systems. Building an intelligent transportation management system supports cooperation between different units such as traffic and public security departments, enabling swift access to congestion timing, locations, and routes. Big data analysis also aids in forecasting, offering convenience and guidance for urban road, rail transit, and public transport system construction, and providing a more rational basis for planning urban traffic layouts, further advancing the development of smart cities.

4 Internet of Things Technology & Applications

The Internet of Things refers to the real-time collection of various required information such as sound, light, heat, electricity, mechanics, chemistry, biology, location, etc. of any object or process that needs to be monitored, connected, and interacted with through various devices and technologies such as information sensors, radio frequency identification technology, global positioning system, infrared sensors, laser scanners, etc., and through various possible network accesses such as the Internet, narrowband Internet of Things, Zigbee, etc., it realizes ubiquitous connection between objects and objects, people and objects, and realizes intelligent perception, identification and management of objects and processes[4].

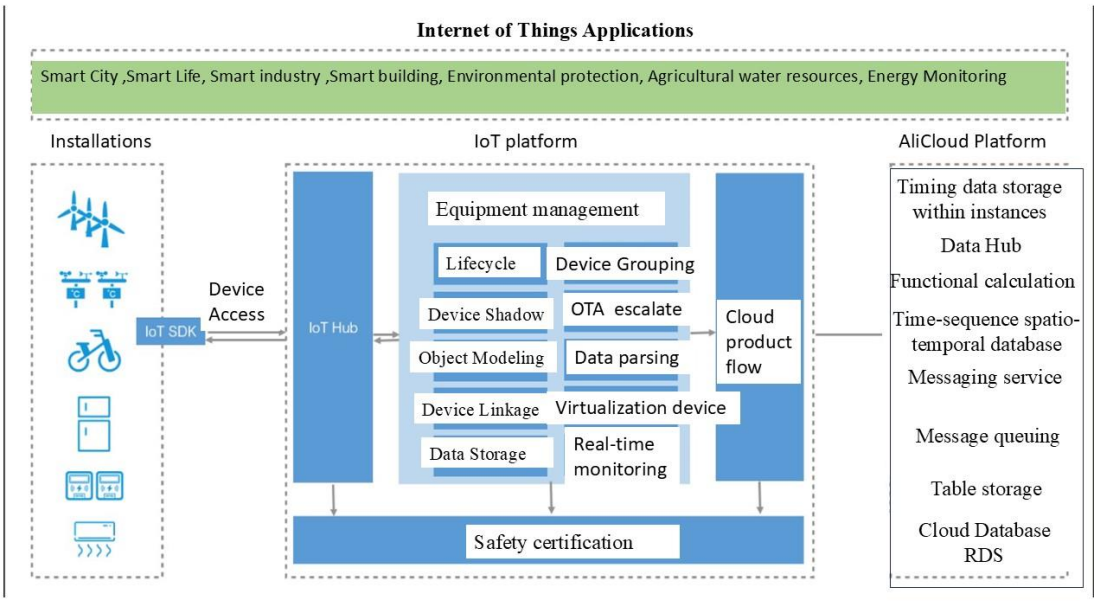

Figure 4 Architecture Diagram of IoT Technology

4.1 Characteristics of IoT technology

Real-time: In smart transportation, we can collect data such as vehicle flow, vehicle speed, and traffic congestion through IoT devices. Moreover, the data processing and transmission rate is extremely high. This allows the traffic management department to obtain real-time data and make quick decisions on traffic diversion based on the data obtained. For example, the duration of traffic lights can be adjusted in time to guide vehicle diversion, thereby reducing traffic pressure. Even in the process of catching criminals, the real-time path of criminals can be obtained in time to help the public security department catch criminals more quickly. [5]

For drivers, real-time traffic information can significantly save travel time. With the help of IoT technology, drivers can receive real-time road conditions through in-car devices, thus choosing the best route.

Accuracy: Data collected by IoT devices has a higher accuracy rate. For example, radar sensors used to measure speed can accurately measure vehicle speeds under different weather and road conditions. These accurate data can help traffic management departments determine if vehicles are speeding or breaking traffic rules, thereby ensuring traffic safety and reducing accident rates.

Automation and Intelligence: IoT technology gives smart transportation systems automation and intelligence. For instance, intelligent traffic signals can analyze real-time traffic flows and automatically adjust signal timings to minimize waiting times.

Moreover, in autonomous driving technology, vehicles can use various sensors to gather information, which is then processed by intelligent algorithms to autonomously recognize road conditions, traffic signs, and other vehicles and pedestrians, and make appropriate driving decisions.

Interconnectivity: Various IoT devices in smart transportation can connect and communicate with each other. Vehicles can exchange information through IoT technology; for example, when a car brakes suddenly, it can immediately send a signal to the following car, alerting the driver to prevent accidents.

Furthermore, vehicles can also interconnect with infrastructure. As a vehicle approaches a traffic light, the light can transmit information such as remaining green time to the vehicle's onboard device, allowing the driver to adjust speed accordingly to avoid frequent stops and starts.

Additionally, systems from different departments can share data through IoT, achieving resource sharing and improving overall operational efficiency of the transportation system.

4.2 Application of Internet of Things Technology in Smart Transportation

In terms of vehicle speed detection, at this stage, the main cause of traffic accidents is speeding. For this reason, we should increase the intensity of vehicle speed detection, and the Internet of Things technology can solve this problem very well. We can use pressure sensors, acceleration sensors, etc. to collect and process data to obtain vehicle speed, but we still have some shortcomings. For example: some drivers will slow down on the speed detection section, but when there is no detection section, they will speed. We can increase the monitoring sections and strive to monitor the entire section, so as to solve the problem at the root.

Application in traffic flow detection After the vehicle is on the road, the traffic flow management is carried out. The Internet of Things technology can drive it to achieve the goal of resource optimization and resource integration, and then solve the problem of traffic congestion. For example, RFID traffic flow detection technology can be introduced. To realize this technology, on the one hand, corresponding RFID readers need to be installed on the road, and on the other hand, RFID tags need to be installed on the vehicle. When a vehicle with a tag passes through the area, the reader can collect the corresponding information to calculate the number of vehicles that have passed. [6] When there are special circumstances, such as a medical vehicle or police car passing by, the information on the label can be used to control the timing of the traffic light and provide convenience.

Application in urban transportation Regardless of which city, the construction of the transportation system is of paramount importance. If there are problems with the construction of the transportation system, it will bring many inconveniences to urban residents. Smart transportation based on the Internet of Things technology is conducive to solving a series of problems in the construction of urban transportation systems, and also improves the efficiency of urban transportation management. Scientific planning of urban transportation routes based on actual conditions can effectively alleviate the traffic congestion caused by excessive urban population, and thus provide effective convenience for people's travel. As an indispensable part of smart transportation, the urban public transportation system can realize the comprehensive management of

vehicles, roads, passengers and other roles, collect and process relevant information in a timely manner, and build a systematic and integrated dispatching platform. In the management of traditional urban public transportation systems, passengers generally cannot know when the required bus will arrive in time, and sometimes they need to spend a lot of time waiting for the bus. With the help of the smart public transportation system, passengers can solve this problem, get the location of the bus in real time, and set off at the right time, thereby greatly reducing the consumption of time. In addition, with the help of the Internet of Things technology, a "one-card" system can be created, which also makes passengers more convenient to a certain extent. Avoid the trouble of not bringing cash or not having enough money in the corresponding payment software. [7]

5 Conclusion

With the development of smart cities and the gradual increase in urban residents, traditional traffic management models struggle to meet current traffic demands. Smart transportation, as a new type of technology, can provide more efficient, safe, and environmentally friendly solutions for urban transportation. In this study, we explored the core technologies of smart transportation and their specific applications in urban traffic management.

Firstly, smart transportation systems can collect and analyze data in real-time, providing more precise decision support for traffic management and enhancing the efficiency of management departments. Secondly, intelligent transportation facilities and management methods can reduce the incidence of traffic accidents and improve the utilization of transportation equipment. Especially during peak hours, smart transportation systems can alleviate traffic pressures and provide convenience to residents. Moreover, smart transportation promotes the development of cities towards greater intelligence and sustainability.

However, there are still shortcomings in smart transportation, and its comprehensive implementation faces challenges, including the unification of technical standards, data privacy and security issues, cross-departmental coordination, etc. Therefore, future development should focus on strengthening the integration of technological innovation and application practice, further improving smart transportation, and promoting the deep integration of smart transportation systems with urban management.

In summary, the application of smart transportation in urban traffic management is highly promising. I believe that with continuous technological advancements and sustained policy support, smart transportation will undoubtedly deliver outstanding performance.

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References

[1] Gao Feng. Research on Intelligent Transportation in Yangzhou under the Background of Transportation Power[J]. Journal of Guangdong Institute of Transportation Technology,2021,20(03):17-21.

[2] Li Xiao. Research on the Problems and Countermeasures of Urban Intelligent Transportation Construction [D]. Qingdao University,2021.DOI:10.27262/d.cnki.gqdau.2021.002590.

[3] Zhou Ruixin. Prospect of Artificial Intelligence Technology in Urban Intelligent Transportation Management[J]. Information Record Material,2020,21(05):1-3.DOI:10.16009/j.cnki.cn13-1295/tq.2020.05.001.

[4] Li-Ping Li,Meng-Lin Sun. Application of cloud computing and big data technology in intelligent transportation[J]. Journal of Economic Research,2020,(16):164-165.

[5] SHI Shushu, SHI Jingyun. Application of Internet of Things Technology in Urban Intelligent Transportation[J]. The application of internet of things technology in urban intelligent transportation [J].

[6] LI Jiayu, ZHU Jiayu, WANG Hanxiao. Application of internet of things technology in intelligent transportation[J]. Wisdom China,2024,(06):87-88.

[7] SAN Yi,GAO Tian,LUO Wenqing,et al. Research on the application of internet of things technology in smart city construction[J]. China Residential Facilities,2021,(08):7-8.