SCIREA Journal of Traffic and Transportation
ISSN: 2995-7818
http://www.scirea.org/journal/TTE
June 10, 2024
Volume 6, Issue 1, February 2024
http://dx.doi.org/10.54647/tte580070

Application of Artificial Intelligence of Generative Content (AIGC) in the Field of Urban Intelligent Traffic Management

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Abstract

This article explores the integration and application of Artificial Intelligence of Generative Content (AIGC) technology in urban intelligent traffic management. Urban intelligent traffic management, through the utilization of advanced technological means, aims to achieve the intellectualization and high efficiency of the transportation system, characterized by informationization, automation, and networking. In China, the practice of intelligent traffic has achieved certain success. As a combination of artificial intelligence and big data, AIGC technology provides powerful technological support for intelligent traffic. AIGC can play a crucial role in intelligent traffic management. Through case study, it is demonstrated how AIGC enables and empowers intelligent traffic. However, it also faces challenges and opportunities related to data security, regulations, and policies. To address these issues, it is recommended to strengthen the research and development of AIGC technology, improve data security mechanisms, and formulate clear regulations and policies to guide its application in intelligent traffic management. Looking ahead, the deep integration of AIGC technology with urban intelligent traffic will drive continuous innovation and development in the transportation industry. This integration promises to further enhance the operational efficiency and management level of the transportation system, ultimately contributing to the sustainable urban development.

Keywords: Artificial Intelligence of Generative Content; AIGC; Intelligent Traffic; Traffic Management

1 Introduction

With the continuous advancement of technology, artificial intelligence (AI) has gradually penetrated various aspects of our lives. Among them, Artificial Intelligence of Generative Content (AIGC), as an emerging branch of AI, has attracted widespread attention in the industry due to its unique generative capabilities and broad application prospects. The core of AIGC technology lies in its ability to train algorithms and models to enable machines to simulate human thinking processes and generate creative and practical content.

Intelligent traffic management, as an essential component of modern urban development, aims to enhance the operational efficiency and management level of the transportation system through informationization and intelligence. In recent years, against the backdrop of new infrastructure construction and the goal of building a transportation power, intelligent traffic management has become crucial in addressing urban transportation issues and improving traffic efficiency. In the field of urban intelligent traffic management, the introduction of AIGC technology will undoubtedly bring revolutionary changes to traditional traffic management models.

The emergence of AIGC technology provides new solutions for urban intelligent traffic management. Through AIGC technology, we can achieve in-depth mining and analysis of traffic data, extract valuable information, and provide scientific evidence for traffic decision-making. In urban intelligent traffic management, AIGC technology can be applied in various aspects such as traffic flow prediction, traffic signal control, and traffic monitoring. By leveraging deep learning and data analysis, it can achieve the intelligence and automation of traffic management.

It is worth noting that currently, AIGC has demonstrated proficiency approaching that of ordinary humans in applications such as text retrieval, image editing, and video content production. However, in the field of urban traffic management, due to the complexity of social engineering, the generality of environmental data, and the volatility of time series data, relying solely on traditional AI for generative calculations is insufficient to meet the actual needs of traffic management. Therefore, amidst this wave of AIGC, how to integrate AIGC

technology with urban traffic management to achieve artificial intelligence in urban traffic management is a crucial topic that needs further research.

2 The Concept of Urban Intelligent Traffic

2.1 Definition and Connotation of Urban Intelligent Traffic

Urban intelligent traffic, as a fusion of modern traffic management concepts and technologies, centers on the utilization of advanced information technologies such as computers, the internet, and wireless communications to provide comprehensive and intelligent support for urban transportation systems. This concept covers various aspects, including traffic system planning and real-time management, and aims to create a scientific, efficient, green, and safe traffic information management system (Gregory, 2009).

The urban intelligent traffic system does not exist in isolation; it is a complex network that integrates multiple technologies, systems, and applications. This system encompasses not only controls, systems, and applications, but also a comprehensive traffic management platform. Its development aims to reduce traffic congestion, improve traffic efficiency, enhance residents' travel conditions, and achieve savings in time and money through technological means (Umar Farooq, 2012).

The construction of urban intelligent traffic systems relies on the comprehensive application of various novel information technologies. These technologies include, but are not limited to, data collection and analysis, prediction and simulation, sharing, and publishing procedures. Through the integrated application of these technologies, urban intelligent traffic systems can provide technical support throughout the entire chain, from access terminals to network layers, data center layers, application layers, information publishing layers, and service centers, forming a flexible and diverse traffic management model to achieve the comprehensive integration of modern traffic information management systems (S Wright, 2004).

In urban intelligent traffic systems, various advanced technologies such as monitoring, sensors, the internet, and control technologies are widely used. The application of these technologies not only enhances the intelligence level of traffic management, but also enables the system to function within a broader scope, performing accurate and effective analysis of collected data to form an intelligent management system (Cai Cui, 2013; Cai Hua, 2014).

It is worth mentioning that urban intelligent traffic systems emphasize a people-oriented design concept. They aim to achieve convenient, diverse, and humanized travel modes, providing the public with more convenient and diverse travel services through the deep integration of internet technology and transportation, thus effectively improving the travel quality of the public (Liu Ruijian, 2015).

In urban intelligent traffic systems, information plays a crucial role. Sensors, as the basis for information acquisition and collection, are widely distributed in every corner of the system. Through the comprehensive application of this information, intelligent traffic systems can complete information collection, integration, and analysis, providing scientific decision-making support for traffic operation and management, thus creating a safer and more efficient travel environment (Xie Xuehui, 2015).

In summary, urban intelligent traffic is a comprehensive traffic management platform that integrates various technologies, systems, and applications. Through the in-depth application of information technology, it achieves the intelligence, efficiency, greenness, and safety of the transportation system. This definition not only highlights the technological core of intelligent traffic but also reflects its important role in improving the travel quality of urban residents and promoting sustainable urban development (Chen Kun, Yang Jianguo, 2014; Shao Chunfu, 2016).

2.2 Characteristics of Urban Intelligent Transportation

Urban intelligent transportation, as an essential part of modern urban development, possesses distinctive and diverse characteristics. Firstly, it embodies a high degree of serviceability and efficiency. This originates from the deep integration of modern transportation service systems with information and data technology (Zhang Zuqun, 2013). Under this context, both transportation participants and managers can enjoy more efficient and convenient services, thereby achieving an overall improvement in transportation efficiency.

Secondly, urban intelligent transportation emphasizes a people-oriented service philosophy. Unlike some Western countries that focus on technology-driven intelligent transportation construction, urban intelligent transportation pays more attention to the actual needs of the public in terms of travel (Jing Wenna, 2014). Through intelligent means, it not only addresses the transportation issues of the general public but also implicitly enhances the quality and convenience of urban life.

Furthermore, urban intelligent transportation possesses significant characteristics such as timeliness, efficiency, stability, sharing, and extensiveness (Leonidas, 2009). These characteristics enable urban intelligent transportation to have significant advantages in addressing congestion, reducing traffic accident rates, improving residents' travel quality, and reducing traffic pollution. Compared with traditional traffic management systems, urban intelligent transportation is not only more intelligent but also more flexible and efficient, better suited to the needs of modern urban development.

2.3 Key Technologies of Urban Intelligent Transportation

In the promotion of urban intelligent transportation management, a series of key technologies play a pivotal role. Firstly, positioning technology serves as the foundation of the intelligent transportation system, encompassing the establishment and application of positioning maps, the processing of GPS technology, and the exploration of emerging positioning technologies (Drane and Rizos, 1998). These technologies provide precise geographical location information for traffic management, a prerequisite for the realization of intelligent traffic systems.

Moreover, the integration of highway perimeter technologies with intelligent transportation systems is also crucial. Through the application of detection and embedding technologies, real-time perception of highway conditions is achieved, effectively reducing highway burden and enhancing traffic efficiency (Prabhu B, Antony A J, Balakumar N, 2017).

In terms of data processing and intelligent analysis, Yuan Yukun et al. (2015) proposed identification and sensing technologies for traffic elements, including wireless sensing technology and intelligent recognition technology, for real-time collection of traffic information. Meanwhile, intelligent transportation cloud technology (cloud computing technology, cloud storage technology, cloud processing technology, cloud control technology) provides powerful support for processing vast amounts of traffic data. Data processing technologies include data fusion, data mining, data activation, and data visualization techniques, providing scientific evidence for traffic management.

In the aspect of traffic data collection and management, Li Qiang and Liu Xiaofeng (2014) emphasized the importance of vehicle data collection, geographic information and spatial data management, and database design management. Additionally, massive data processing and mining technology, traffic condition simulation and prediction technology, as well as web

server information publishing technology, provide comprehensive and precise data support for traffic management.

The rapid development of information and communication technology, big data technology, and cloud computing technology has provided strong support for intelligent transportation construction (He Yongjun et al., 2016). New-generation mobile broadband technology, the Internet of Things, and cloud computing technology are accelerating the construction of intelligent public transportation systems, intelligent taxi systems, and intelligent parking systems, bringing revolutionary changes to urban traffic management.

Figueiredo et al. (2001) reviewed the development history of intelligent transportation systems (ITS), pointing out that advanced communication technology, information, and electronic technology have played a significant role in addressing traffic congestion, improving traffic safety and efficiency, and promoting environmental protection. These technologies have formed various intelligent transportation systems, including advanced traffic management systems (ATMS), advanced traveler information systems (ATIS), commercial vehicle operations (CVO), as well as advanced public transportation systems (APTS), advanced vehicle control systems (AVCS), and advanced rural transportation systems (ARTS).

Moreover, the research by Junping Zhang et al. (2011) also indicates that ITS technology plays an irreplaceable role in intelligent transportation construction. They proposed vision-driven ITS, achieving real-time monitoring of traffic conditions through the detection, tracking, and recognition of traffic objects as well as the analysis of traffic behaviors and vehicle trajectories. Multi-source-driven ITS provides real-time positioning information, enabling the tracking of vehicle movement. While learning-driven ITS optimizes traffic management decisions through techniques such as online learning, data fusion, and rule extraction, promoting the in-depth development of intelligent transportation construction.

2.4 Practice of Intelligent Traffic in China

With the continuous advancement of technology and the acceleration of urbanization, intelligent traffic, as an essential means of modern traffic management, has been widely practiced and applied in China.

The practice of intelligent traffic in Shanghai. As China's economic center and international metropolis, Shanghai faced severe traffic congestion issues in the 1980s. To improve traffic conditions, Shanghai took the lead in introducing intelligent transportation technology,

initiating the exploration and practice of intelligent traffic. In 1985, the Shanghai traffic management department imported the traffic signal adaptive control system (SCATS system) from Australia and gradually began to build the three major systems of highway toll collection, monitoring, and communication (Ye Xing, 2019). This measure brought revolutionary changes to Shanghai's traffic management, effectively alleviating traffic congestion. Entering the 21st century, with the development of big data, cloud computing, and other technologies, Shanghai's intelligent traffic construction entered a new stage. By 2019, the Shanghai comprehensive transportation information platform had become more comprehensive, achieving data sharing and computational utilization, and could collect real-time and accurate traffic data across the city, providing strong support for intelligent decision-making and services (Cuan Qian et al., 2019). This platform assists government departments in public management, satisfying citizens' diverse and personalized travel needs. At the same time, the establishment of monitoring systems, law enforcement supervision systems, and maintenance management systems has extended the reach of intelligent traffic to all aspects of traffic management.

The practice of intelligent traffic in Hangzhou. As China's e-commerce capital and innovative city, Hangzhou is also at the forefront of intelligent traffic construction. In 1996, Hangzhou's public transportation company collaborated with technology manufacturers to pioneer the development and use of GPS dispatch monitoring systems for urban buses, enabling real-time monitoring and dispatch of public transport vehicles. In recent years, Hangzhou has further strengthened its intelligent traffic construction efforts. In 2015, Hangzhou proposed the "1+3+4" project, which aims to build a comprehensive transportation data center, three major platforms, and four major application systems. Through this project, Hangzhou has achieved comprehensive integration and sharing of transportation data, providing strong data support for transportation management (Xing Fan, 2016). Nowadays, Hangzhou has achieved remarkable results in the field of intelligent traffic. China's first "intelligent highway," the Hangzhou-Shaoxing-Ningbo Expressway, is being constructed, which will strive to build a comprehensive perception system for human-vehicle-road collaboration and introduce advanced technologies such as autonomous driving. The "traffic cerebellum" in Xiaoshan optimizes signal timing through big data to improve travel efficiency. Additionally, Hangzhou has launched a "dual-carbon map" to support energy conservation and carbon reduction through intelligent transportation. Government departments and citizens can use this map to

understand regional carbon emission conditions, thus making more "intelligent" choices for travel routes and modes, jointly contributing to the city's green travel.

3 Overview of AIGC Technology

3.1 Development of AIGC Technology

Artificial Intelligence Generated Content (AIGC) is a new content production method that utilizes a collection of technologies for automated content generation. It emerged from the evolution of internet forms and AI technological innovations, resulting in novel generative web information content (Li Baiyang et al., 2022). Zhao Yang et al. (2023) define AIGC as a production method that utilizes AI technology to automatically generate digital content in various forms such as text, images, language, videos, and even virtual reality. Since its inception, AIGC has continuously propelled technological progress in the field of artificial intelligence. Early AIGC primarily focused on assisting in the generation of content with fixed templates, such as in film, entertainment, and industrial modeling. With the rapid development of AI technology, AIGC gradually demonstrated its immense potential and application value. Particularly after the mid-2010s, AIGC underwent explosive growth. During this stage, AIGC gradually shifted from rule-based generation to more intelligent and autonomous generation methods, achieving true content generation and innovation.

In terms of natural language processing, early mainstream models were primarily recurrent neural networks (RNN) with the later introduction of attention mechanisms. However, issues like low sequential processing efficiency and instability in handling long sequences persisted. In 2017, the Google team first proposed the Transformer model based on self-attention mechanisms, significantly improving text processing and generation capabilities.

The emergence of Generative Adversarial Networks (GANs) is undoubtedly an important milestone in the history of AIGC technology development. Through adversarial training between a generator and a discriminator, GANs can generate highly realistic content. As technology evolves, GAN models have continuously derived modified versions such as Deep Convolutional GANs (DCGANs) and Conditional GANs (cGANs). These models not only improve the quality of generated content but also enhance the interpretability of the models.

In addition to GANs, the emergence of technologies such as Variational Autoencoders (VAEs) and flow-based generative models has provided new ideas for AIGC development. These

technologies achieve effective data generation through different methods, further enriching the AIGC technology system.

In recent years, the emergence of CLIP (Contrastive Language-Image PreTraining) technology has further propelled AIGC technological advancements. CLIP achieves effective learning of image and text features by constructing text encoders and image encoders, and can transform image classification tasks into text-image matching tasks, ultimately making predictions through Zero-Shot inference. This technology not only improves AIGC's performance in image recognition but also provides new solutions for multimodal recognition and transformation.

Entering 2022, the popularity of diffusion models has once again driven AIGC technological innovation. Diffusion models achieve efficient text-to-image generation through forward diffusion and reverse generation processes, demonstrating excellent performance in generating high-quality images and other types of data. This has made diffusion models one of the hottest research directions in AIGC.

In terms of classification by basic type, pre-trained models primarily include: (1) NLP pre-trained models such as Google's LaMDA and PaLM, and Open AI's GPT series; (2) computer vision (CV) pre-trained models such as Microsoft's Florence; (3) multimodal pre-trained models that integrate various content forms such as text, images, audio, and video. The versatility of pre-trained models, which are becoming versatile AI models, is mainly attributed to the use of multimodal technology, i.e., machine learning that integrates multimodal representations of images, sounds, languages, and more. Multimodal technology promotes the content diversity of AIGC, giving it more generalized capabilities.

3.2 Current Development Status of AIGC

The application products of AIGC abroad are mainly dominated by the United States, and most of them possess multimodal capabilities, which is also an important direction for the evolution and implementation of AIGC products. From the perspective of market application, ChatGPT4 from OpenAI is in an absolutely leading position. Domestically, with the release of products such as Baidu's "ERNIE Bot," Alibaba's Tongyi Qianwen, iFLYTEK's Spark Cognition, and Zhipu AI's ChatGLM, Meituan, Baichuan Intelligence, Unisound, Tencent, and others have also joined the large model race, resulting in an intense "arms race" surrounding large models.

Regarding the application of domestic AIGC products, they are undergoing accelerated iterations and, similar to foreign AIGC products, gradually infiltrating into industries such as news media, smart cities, biotechnology, intelligent offices, film and television production, intelligent education, smart finance, smart healthcare, smart factories, and daily life services. They are also gradually acquiring multimodal capabilities. However, due to factors such as the blockade of computing power chips and the non-disclosure of algorithms, domestic AIGC products still lag behind similar foreign products in terms of capability output.

3.3 Development Trends of AIGC

First, AIGC will continue to be a crucial driving force for technological transformation. According to IDC predictions, the booming digital economy will spawn a large number of new applications, and the innovative applications of AIGC will also experience significant growth. Especially in the to-B market, with enterprises' pursuit of cost reduction, efficiency enhancement, and innovative digital services, the application of AIGC will become more deeply integrated into every aspect of enterprise production and office work, providing enterprises with strong competitive advantages.

Secondly, medium to large enterprises will increasingly tend to invest in the development of dedicated and self-built large models. These models can provide more precise and valuable services for specific scenarios. With the maturity of technology, enterprises will combine industry characteristics and professional knowledge to develop suitable industry-specific, dedicated, or scenario-based large models to meet the growing business needs.

Furthermore, multimodal large models will become the future development direction. Such models can solve complex cross-industry and cross-domain problems, bringing richer intelligent applications to various industries. Multimodal large models can not only enhance the accuracy of data analysis but also integrate with technologies such as VR/AR and robotics to provide users with deeper and more dimensional new experiences.

Furthermore, the emergence of AI Agents as a significant development direction in AIGC heralds the era of AI assistants for both individuals and businesses. AI Agents possess the capabilities of perception, analysis, decision-making, and execution, allowing them to offer personalized services based on users' interests and needs. The advent of such intelligent agents will empower individuals and small organizations to accomplish complex tasks with the assistance of AI tools, thereby enabling value creation.

Finally, AIGC will accelerate the formation of super entrances and gradually eliminate traditional APP application forms. Future applications will tend to favor concise natural language-based interactions, allowing users to invoke and use various tools through conversations. This "No APP" concept will enable non-software professionals to conveniently access powerful system services, promoting a fundamental change in the form and business of application software.

4 Integration of AIGC Technology and Intelligent Traffic

4.1 The Role of AIGC in Intelligent Traffic Management

With the acceleration of urbanization, issues such as traffic congestion and frequent accidents have become increasingly prominent. Intelligent Traffic has emerged as an effective way to alleviate these issues. AIGC, as a crucial technology in the field of Intelligent Traffic, plays a significant role in traffic management.

Firstly, AIGC plays a pivotal role in Intelligent Traffic management through vehicle-mounted intelligent systems. With the aid of smart sensors and AIGC technology, vehicle-mounted systems can collect and share multimodal data, such as images and voice, in real-time. This allows for automatic generation of specific road, driving, and safety information. Not only does this help drivers gain a more accurate understanding of road conditions, but it also objectively presents dynamic changes in the environment and predicts potential traffic risks, thereby enhancing driving safety and efficiency.

Secondly, AIGC plays an important role in intelligent decision-making systems. By precisely detecting the safety conditions of vehicles, dynamically identifying traffic flow conditions, intelligently monitoring road traffic control, and comprehensively sensing changes in the surrounding environment, AIGC provides comprehensive and accurate data support for traffic managers. Based on this data, AIGC can automatically generate navigation information that satisfies optimal travel routes, assist decision-makers in formulating scientific traffic management plans, and optimize road traffic efficiency.

Furthermore, the application of AIGC in Intelligent Traffic management and dispatch systems is also significant. AIGC can automatically generate dispatch plans that meet the traffic flow demands of different time periods based on collected traffic big data. It can also generate matching travel plans and route suggestions using user trajectory data provided by map

navigation. This not only improves the utilization of road resources and reduces traffic congestion, but also provides users with a more convenient and efficient travel experience.

Lastly, the application of AIGC in Intelligent Traffic management is also reflected in its deep mining and analysis of traffic data. Through analyzing vast amounts of traffic data, AIGC can reveal the patterns and trends of traffic operations, providing strong support for traffic planning and policy formulation. Additionally, AIGC enables real-time sharing and collaborative processing of traffic information, enhancing the intelligence and collaboration levels of traffic management.

4.2 Cases of AIGC Enabling Intelligent Traffic

With the rapid development of technology, the application of AIGC in the field of urban intelligent traffic management has become increasingly widespread (e.g., Li Yuanfeng et al., 2024), bringing significant changes to traffic management. Taking Baidu as an example, its breakthroughs and applications in AIGC technology have provided strong support for intelligent traffic management.

As a leading enterprise in domestic AI technology, Baidu has always been at the forefront of research and applications in the AIGC field. The release of Baidu's Wenxin large model marks a significant breakthrough in Baidu's pre-trained generative large language model technology. The birth of this technology has brought new possibilities to the field of intelligent traffic management.

In the field of traffic management, Baidu has launched several innovative applications based on the Wenxin large model. Among them, the all-domain signal control congestion relief solution is a prominent representative of Baidu's achievements in traffic management. This solution realizes intelligent control of traffic signals through real-time sensing, machine vision, traffic prediction, and other technologies, effectively alleviating urban traffic congestion. At the same time, the solution can automatically generate scheduling plans based on traffic flow demand during different time periods, improving the utilization efficiency of road resources.

In terms of navigation services, Baidu has also fully utilized the advantages of AIGC technology. Combining the Wenxin transportation large model, Baidu Maps provides more accurate and efficient navigation services. Functions such as parking-level navigation, lane-level navigation, tunnel navigation, and traffic light countdown can all be better implemented with the support of AIGC technology. This not only enhances users' travel experience but also provides more refined data support for urban traffic management.

In addition, Baidu has also launched a digital avatar named Jian Lulu, based on the transportation large model, in the highway sector. As a highway industry expert, business assistant, travel companion, and image ambassador, Jian Lulu can answer users' questions in real-time and provide accurate responses. Through the new interactive experience of digital avatars, highway monitoring, emergency command, maintenance management, and other work have been greatly improved. This new interactive mode that crosses systems, functions, APIs, and data makes highway operations more efficient and convenient.

Baidu's practices in the field of intelligent traffic have thoroughly demonstrated the significant enabling role of AIGC technology.

Intelligent Decision-Making. Through the utilization of large-scale transportation models, Baidu is capable of achieving real-time perception and prediction of traffic conditions, providing intelligent decision support for traffic management. This facilitates the optimized control of traffic signals, enhancing road traffic efficiency, and mitigating traffic congestion.

Personalized Services. By leveraging the capabilities of the Wenxin large model, applications such as Baidu Maps are able to offer users more personalized and precise services. For instance, they can recommend optimal travel routes and transportation modes based on users' commuting habits and needs.

Enhanced Interactive Experience. The introduction of the digital avatar Jian Lulu exemplifies the potential of AIGC technology in elevating user interactive experiences. Through natural language processing and understanding technologies, digital avatars are capable of engaging in natural and smooth interactions with users, delivering more convenient and efficient services.

As evident from the aforementioned case, the application of AIGC technology in the field of urban intelligent traffic management holds vast prospects and tremendous potential. Through the following strategies, we can propel the development of intelligent traffic management towards a more efficient and intelligent direction: (1) Technological Integration and Innovation: The integration and innovation of AIGC technology with intelligent traffic management is crucial for the advancement of the industry. By integrating technological advantages from diverse domains, we can achieve more efficient and intelligent traffic management. (2) Data-Driven Decision-Making: The application of large-scale transportation models underscores the importance of data-driven decision-making. Through real-time perception and prediction of traffic conditions, we can provide precise and reliable decision

support for traffic management. (3) User-Oriented Philosophy: In intelligent traffic management, we should uphold a user-oriented philosophy. This implies that when designing and implementing intelligent traffic solutions, we should fully consider users' needs and experiences, ensuring that the solutions truly bring convenience and value to users. Additionally, this philosophy demands that we maintain continuous attention and respect for users throughout the process of technological innovation and optimization.

4.3 Challenges and Opportunities of AIGC in Intelligent Traffic

AIGC technology has demonstrated its immense potential and value in multiple fields. In the field of urban intelligent traffic management, the application of AIGC technology has brought revolutionary changes to traffic management, while also facing numerous challenges.

Complexity of Data Integration and Processing. The intelligent traffic system requires integrating various data sources and types, including video surveillance, sensor data, weather information, vehicle GPS trajectories, etc. The fusion and processing of such multimodal data serve as the foundation for AIGC applications, but it is also a significant challenge. Firstly, there are differences in data formats, sampling frequencies, and accuracy among different data sources, requiring data preprocessing and standardization. Secondly, the correlation between multimodal data is more complex than that of single-modal data, necessitating advanced algorithms to extract and fuse useful information from multimodal data. Additionally, the acquisition and processing of real-time data pose higher demands on AIGC systems.

Potential Risks of Adversarial Attacks. The widespread application of AIGC technology also brings new security risks, especially those related to adversarial attacks. In the intelligent transportation system, malicious actors may exploit vulnerabilities in AIGC technology by injecting harmful data or tampering with model parameters to conduct backdoor attacks on the transportation system, leading to misjudgment or incorrect decisions. Such attacks can trigger a chain reaction of traffic accidents or congestion, having a severe impact on urban traffic operations. Therefore, ensuring the security and reliability of AIGC systems is an urgent issue in the field of intelligent traffic.

Challenges of Model Interpretability. In the intelligent traffic system, the interpretability of models is crucial for ensuring the rationality and acceptability of system decisions. However, AIGC models often possess high complexity and nonlinear characteristics, making their decision-making process difficult for humans to understand and interpret. This "black box" characteristic not only increases the uncertainty and risk of the system but also reduces public

trust in system decisions. Therefore, designing interpretable AIGC models that can clearly demonstrate the decision-making process and reasoning basis is an important issue that needs to be addressed in the field of intelligent traffic.

Challenges of Real-time Response Capability. The intelligent traffic system needs to respond quickly to changes in traffic environments and unexpected events to ensure traffic safety and smoothness. However, AIGC models face some challenges in real-time applications. Firstly, the acquisition and processing of real-time data require speed and accuracy, posing high demands on the real-time response capability of AIGC systems. Secondly, some AIGC methods may be complex and require more time for reasoning and calculation, which may affect the real-time performance of the system. Additionally, real-time applications need to have the ability to handle abnormal situations, such as sensor failures or emergencies. Therefore, how to improve the real-time response capability of AIGC systems while ensuring their accuracy and reliability is a key issue that needs to be focused on in the field of intelligent traffic.

Ethical and Moral Challenges. In intelligent traffic systems, vast amounts of personal and transportation data will be collected and processed by AIGC models. This data may include sensitive information such as users' travel habits, location information, and vehicle details. Ensuring the security and privacy of these data, as well as preventing data breaches and misuse, poses a significant ethical and moral challenge. Furthermore, in the event of traffic accidents or violations involving AIGC technology in intelligent traffic systems, determining the attribution of responsibility will also be a complex issue.

The rapid development of AIGC technology also provides important opportunities to address challenges related to intelligent traffic:

Opportunities for multimodal data integration. Traffic data comes from a wide range of sources, including video images, GPS trajectories, etc. These multimodal data provide rich information for traffic management. AIGC technology can effectively integrate these multimodal data through methods such as deep learning, providing a comprehensive and in-depth perspective for traffic condition analysis. By designing appropriate mapping methods to unify the representation of different data modalities, further exploration of the spatiotemporal dependencies between data can be achieved, providing a solid foundation for traffic model training.

Opportunities for efficient model design. Traditional traffic models have issues with insufficient generalization ability and scalability. However, large-scale traffic models based on AIGC technology have higher generalization ability and potential for cross-task transfer learning. By designing model structures with shared features and combining the uniqueness of each task, multi-task collaborative processing can be achieved, improving overall performance. Additionally, combining the diversity of traffic data and the reliability of traffic physics knowledge, developing large-scale traffic models driven by both data and knowledge will provide more effective ways for traffic pattern simulation.

Opportunities for real-time traffic planning and decision-making. Traffic planning and decision-making are core tasks in intelligent traffic. AIGC technology, combined with real-time traffic perception capabilities and reinforcement learning decision-making abilities, provides new solutions for real-time traffic planning and decision-making. This approach can handle the complexity and uncertainty in traffic management, generating more efficient and flexible solutions. Particularly in the field of autonomous driving, large-scale language models with powerful knowledge reasoning and generation capabilities are expected to achieve accurate driving decisions in complex traffic environments.

4.4 Suggestions for Applying AIGC in Intelligent Traffic Management

With the rapid development of AIGC technology, its application prospects in the field of urban intelligent traffic management are increasingly broad. However, to fully realize the potential of AIGC technology in intelligent traffic management, comprehensive consideration and planning must be undertaken from various aspects, including technological research and development, data security, and regulatory policies. The following are specific suggestions for applying AIGC in intelligent traffic management.

(1) Enhance AIGC Technological Research and Development and Innovation

Deepen Algorithm Research. Focusing on the complexity and uniqueness of urban traffic management, strengthen the research on AIGC algorithms, optimize algorithm models, and improve their accuracy and efficiency in traffic flow prediction, signal control, and other aspects. Simultaneously, explore the application of AIGC in more areas such as traffic monitoring and emergency response to fully realize its potential.

Integrate Multi-source Data. Urban traffic management involves diverse data sources, including traffic flow, weather, road conditions, and other information. The application of AIGC technology requires the integration of these multi-source data, comprehensive analysis

through deep learning and other techniques, and providing more comprehensive and accurate data support for traffic management.

Strengthen Hardware and Software Support. The application of AIGC technology requires powerful hardware and software support. Therefore, increase the research and development efforts of related hardware devices to improve their performance and stability. At the same time, enhance the development of software platforms to provide more convenient and efficient data processing and analysis tools.

(2) Improve Data Security Mechanisms

Strengthen Data Protection. In intelligent traffic management, the security of traffic data is crucial. Establish a comprehensive data protection mechanism to ensure the integrity and security of traffic data. This includes adopting advanced encryption techniques, setting access permissions, and other measures to prevent data leakage and unauthorized access.

Monitor Data Usage. Conduct real-time monitoring of the application of AIGC technology in intelligent traffic management to ensure the legitimacy and compliance of data usage. Investigate and punish any illegal use of data in accordance with the law to safeguard data security and public interests.

Establish Data Backup and Recovery Mechanisms. To prevent data loss or damage, establish data backup and recovery mechanisms. Regularly backup important data and conduct recovery tests to ensure rapid data recovery in case of unexpected situations.

(3) Formulate Clear Regulatory Policies

Improve Laws and Regulations. Formulate comprehensive laws and regulations for the application of AIGC technology in intelligent traffic management, clarifying the rights and obligations of all parties and regulating the use and management of data. At the same time, strengthen law enforcement and severely punish illegal activities.

Develop Industry Standards. To promote the healthy development of AIGC technology in the field of intelligent traffic management, formulate relevant industry standards. These standards should cover various aspects such as technological research and development, data security, and application effects, providing clear guidance and norms for all parties.

Strengthen International Cooperation. Intelligent traffic management is a global issue, requiring strengthened international cooperation and exchange. When formulating regulatory policies, fully consider international standards and practices, promote international

cooperation and mutual recognition. At the same time, strengthen cooperation with international advanced technologies to promote the continuous development and improvement of AIGC technology in intelligent traffic management.

5 Conclusion and Prospects

In this article, we have delved into the application of generative artificial intelligence (AIGC) technology in the field of urban intelligent transportation management. AIGC technology, with its unique advantages, has provided powerful technical support for intelligent transportation management, not only improving the level of intelligentization in traffic management but also playing a significant role in optimizing traffic decision-making and ensuring traffic safety.

However, the application of AIGC in intelligent transportation management still faces a series of challenges, including the complexity of data integration and processing, the potential risk of adversarial attacks, challenges in model interpretability, and the challenge of real-time response capabilities. Facing these challenges, we need to continuously strengthen technological research and development and innovation, improve the safety and stability of AIGC technology, enhance the interpretability of models, and optimize the real-time performance of the system.

Looking ahead, with the continuous development and maturation of AIGC technology, its application in the field of urban intelligent transportation management will become more extensive and profound. We can expect AIGC technology to play a greater role in the following areas:

First, AIGC technology will further optimize in-vehicle intelligent systems, providing drivers with more accurate and timely navigation and traffic information through real-time data analysis and prediction, thereby enhancing the driving experience and safety.

Second, AIGC technology will play a greater role in intelligent decision-making systems, providing traffic management departments with more scientific and reasonable decision-making bases through deep learning and analysis of massive traffic data, thereby optimizing the allocation of traffic resources and improving traffic operation efficiency.

In addition, AIGC technology will further promote the intelligent development of traffic management and scheduling systems, achieving dynamic scheduling and optimization of

traffic flow through real-time traffic monitoring and prediction, effectively alleviating traffic congestion issues.

At the same time, we also need to pay attention to the ethical and privacy issues brought by AIGC technology in intelligent transportation management, strengthen the formulation and implementation of relevant laws and regulations, and ensure the healthy development of technology and social stability. In addition, we also need to focus on cross-industry and cross-field cooperation and integration to jointly promote the application and development of AIGC technology in the field of intelligent transportation management.

In summary, the application of AIGC technology in the field of urban intelligent transportation management has broad development prospects and tremendous potential. With the continuous progress of technology and the continuous expansion of application scenarios, we have reason to believe that AIGC technology will bring a better future to urban traffic management.

References:

[1] Anthopoulos L , Fitsilis P .From Online to Ubiquitous Cities: The Technical Transformation of Virtual Communities[J].DBLP, 2009.DOI:10.1007/978-3-642-11631-5_33.

[2] Drane C R , Rizos C .Positioning Systems in Intelligent Transportation Systems[M].IGI Global,1998.

[3] Farooq U , Siddiqui M A , Gao L ,et al. Intelligent transportation systems: an impact analysis for Michigan[J].Journal of Advanced Transportation, 2012, 46(1):12-25.DOI:10.1002/atr.138.

[4] Figueiredo L , Jesus I , Machado J A T ,et al. Towards the development of intelligent transportation systems[C]//Intelligent Transportation Systems. IEEE, 2001.DOI:10.1109/ITSC.2001.948835.

[5] Goodfellow Ian, Pouget-Abadie Jean, Mirza Mehdi, et al. Generative adversarial networks[J]. Communications of the ACM, 2020.DOI:10.1007/978-3-030-50017-7_16.

[6] Ho J , Jain A , Abbeel P .Denoising Diffusion Probabilistic Models[J]. 2020.DOI:10.48550/arXiv.2006.11239.

[7] Prabhu S R B , Balakumar N , Antony A J .A Research on Smart Transportation Using Sensors and Embedded Systems[J].Social Science Electronic Publishing[2024-05-13].DOI:10.21276/ijircst.2017.5.1.5.

[8] Radford A , Kim J W , Hallacy C ,et al. Learning Transferable Visual Models From Natural Language Supervision[J]. 2021.DOI:10.48550/arXiv.2103.00020.

[9] Wright S , Steventon A .Intelligent Spaces — The Vision, the Opportunities, and the Barriers[J].Bt Technology Journal, 2004, 22(3):15-26.DOI:10.1023/B:BTTJ.0000047116.13540.e0.

[10] Yovanof G S , Hazapis G N .An Architectural Framework and Enabling Wireless Technologies for Digital Cities & Intelligent Urban Environments[J].Wireless Personal Communications, 2009, 49(3):445-463.DOI:10.1007/s11277-009-9693-4.

[11] Zhang J , Wang F Y , Wang K ,et al. Data-Driven Intelligent Transportation Systems: A Survey[J].IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, 2011, 12(4):1624-1639.DOI:10.1109/TITS.2011.2158001.