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Original Research Article

AI empowering smart city transportation systems: Path research from traffic prediction to improvement of social operation efficiency

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Abstract: This paper dives into how artificial intelligence (AI) is actually being used in smart city transportation systems and breaks down the step-by-step ways it goes from predicting traffic flow to boosting the efficiency of real-world social operations. It analyzes the principles and advantages of AI technology in traffic flow prediction and elaborates on how AI enhances social operation efficiency through optmizing traffic management, improving travel experiences, and promoting resource allocation. Research shows that AI empowering smart city transportation systems has significant practical significance and broad development prospects, but it also faces challenges such as data security, technical standards, and talent shortages. This paper proposes countermeasures including strengthening data protection, formulating unified standards, and cultivating interdisciplinary talents, providing references for promoting the application of AI in smart city transportation.
Keywords: artificial intelligence; smart city transportation system; traffic flow prediction; social operation efficiency

1. Introduction

With more and more people moving to cities—Global urbanization rate jumped from 30% in 1950 to 58% in 2023—And China's cars hitting 430 million in 2023, urban traffic jams have gotten way worse. In Beijing, for example, the morning peak stretches from 7 a.m. to 10 a.m., with drivers stuck in gridlock for hours just to go a few miles.According to the 2023 Analysis Report on Traffic in Major Chinese Cities, the average speed during peak hours in first-tier cities like Beijing and Shanghai is less than 25 km/h, and economic losses caused by traffic congestion account for 5%–8% of GDP. As an important solution to urban traffic problems, smart city transportation systems have received widespread attention in recent years. The rapid development of AI technologies (such as machine learning, deep learning, and computer vision) provides new opportunities for upgrading smart city transportation systems—Through precise traffic flow prediction and intelligent traffic management, optimal allocation of traffic resources can be achieved, ultimately enhancing social operation efficiency.

2. Application of AI in traffic flow prediction

2.1. Importance of traffic flow prediction

Traffic flow prediction is super important for smart cities because it lets them manage traffic proactively instead of just reacting. For instance, Shenzhen's AI systems cut peak congestion by 15%—That means less time stuck in traffic for commuters—While Hangzhou's "City Brain"made intersections 20% more efficient, so cars get through faster without endless waiting.

2.2. Principles of AI for traffic flow prediction

Our team collected traffic flow data from 50 sensors in Beijing's Zhongguancun (January–June 2023) and applied an LSTM model with a 128-unit hidden layer. After removing outliers and normalizing the data to a 0-1 scale, the model achieved 92% accuracy in predicting 15-minute traffic flow—This is 18% higher than the ARIMA model we tested (74% accuracy). However, during a sudden thunderstorm on May 12, 2023, the model's accuracy dropped to 65% due to lack of historical thunderstorm data [1].

2.3. Advantages of AI in traffic flow prediction

Our study finds that AI outperforms traditional models in traffic flow prediction—Its higher accuracy stems from nonlinear deep learning , and its dynamic adaptation allows it to update predictions in real time. However, we argue that AI's ‘comprehensive traffic modeling' is overstated—Fusing multi-source data often leads to data overload, reducing prediction speed by 20% in our experiments.

3. Pathways for AI to empower smart city transportation systems to enhance social operation efficiency

AI extends from the basic link of traffic flow prediction to multiple fields such as traffic management, travel services, and resource allocation, ultimately enhancing social operation efficiency. The specific pathways are as follows:

3.1. Optimizing traffic management: From "Passive response" to "Proactive prevention”

Using traffic flow predictions, AI helps make traffic management smarter—Like adjusting traffic signals in real time, spotting accidents quickly, and coordinating traffic across a whole area. For example, models based on LSTM (a type of deep learning) tweak signal timings, making intersections 25% more efficient—So you don't have to wait ages at red lights [2].

3.2. Improving Travel Experience: From "Information asymmetry"to "Personalized services”

AI reduces "invalid time"in travel by providing real-time and precise information services to travelers. For example:

Intelligent Route Planning: Machine learning models pull together real-time traffic, weather, and road data to tweak routes—And this cuts average travel time by 12% because it helps drivers avoid congestion spots that traditional GPS might not catch until it's too late. But don't get me wrong—This isn't perfect: if the data is delayed by even 2 minutes, the route recommendation becomes useless.

Intelligent Parking Management: AI predicts parking availability via sensors and models, guiding users through apps; Beijing's system cut search time by 50%

Personalized Travel Recommendations: Based on users' historical travel data (such as commuting routes and travel times), it uses recommendation algorithms (such as collaborative filtering) to provide personalized services (such as "Tomorrow morning peak suggests taking Metro Line 4, which saves 20 minutes compared to driving”).

3.3. Promoting rational allocation of traffic resources: From "Supply-demand imbalance"to "Dynamic matching”

After analyzing all the data, AI can allocate traffic resources more reasonably—Like adjusting the departure

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interval based on how many passengers are at the bus stop, so people don't have to wait too long. For example:AI optimizes transit via demand prediction: adjusts bus frequencies, plans infrastructure, and rebalances shared vehicles, enhancing service efficiency and coverage in urban transport networks.

4. Challenges faced by AI empowering smart city transportation systems

4.1. Data security and privacy issues

Using AI in smart city transportation means collecting a ton of data from different places—like GPS data from phones, mobile phone signals, and video from traffic cameras. But this data includes personal stuff, like where people live or work, which raises big privacy concerns—no one wants their daily commute tracked without permission [3].

4.2. Lack of unified technical standards and norms

Currently, the application of AI in the transportation field lacks unified technical standards. Different enterprises (such as Alibaba and Tencent) use different technical architectures for their "city brain"systems (such as Alibaba's "City Brain"using a cloud computing architecture and Huawei's "Intelligent Transportation System"using an edge computing architecture), resulting in inability to achieve data sharing and interoperability between systems (such as Shenzhen's "City Brain"cannot share traffic data with Guangzhou's "Traffic Brain”). the lack of technical standards will lead to the problem of "information silos,"hindering the large-scale application of AI in transportation [4].

4.3. Shortage of interdisciplinary talents

AI is an interdisciplinary subject (involving computer science, transportation engineering, data science), requiring talents who understand both transportation and AI. According to the 2023 China AI Talent Report, China's AI talent gap reaches 5 million, of which the gap in interdisciplinary talents in the transportation field accounts for 15%. For example, a city's traffic management department needs to develop a traffic flow prediction system but lacks talents who understand both LSTM models and transportation engineering, resulting in a 6-month project delay. The shortage of interdisciplinary talents is a key factor restricting the application of AI in transportation [5].

5. Countermeasures and suggestions

5.1. Strengthen data security and privacy protection

Strengthen data security via institutional, technical, and supervisory measures: enact smart city transportation data regulations (e.g., 6-month storage limit), apply advanced encryption, and establish a real-time monitoring platform to detect unauthorized access and ensure compliance.

5.2. Formulate unified technical standards and norms

Under government leadership by the NDRC and Ministry of Transport, unified technical standards—Such as AI traffic prediction performance indicators and intelligent signal control interfaces—Are developed jointly with enterprises and academia. Industry participation from firms like Alibaba and Tencent ensures practicality, including integration of proven technologies like "City Brain."Standards align with international benchmarks,

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including ISO/IEC 27001 and IEEE 1613, fostering global interoperability and technological consistency in smart transportation systems.

5.3. Strengthen the cultivation of interdisciplinary talents

Universities offer interdisciplinary programs like AI + Transportation Engineering, integrating machine learning and traffic planning. Enterprises collaborate with academia on "order-based"training to enhance technical competencies. International exchanges with experts from institutions such as MIT promote adoption of advanced global technologies in intelligent transportation.

6. Conclusion

Using AI to make smart city transportation systems better is a great way to help solve urban traffic problems and boost the efficiency of daily life—Like less time stuck in traffic and more reliable public transport. Through accurate traffic flow prediction, AI can optimize traffic management, improve travel expeiences, and promote resource allocation, ultimately enhancing social operation efficiency (such as reducing congestion time and improving public transportation utilization). However, AI also faces challenges such as data security, technical standards, and talent shortages in its application. In the future, the government, enterprises, and universities need to work together to strengthen data protection, formulate unified standards, and cultivate interdisciplinary talents to promote the wide application of AI in smart city transportation.

With the continuous development of AI technologies (such as generative AI and quantum computing), smart city transportation systems will move towards an intelligent direction of "full scenarios , full time periods, and full elements,"and future travel will be more convenient, efficient, and green.

About the author

Wenting Ding (1987 -), Han ethnicity, female, from Yixing City, Wuxi City, Jiangsu Province. She is a lecturer/engineer with a master's degree. Her main research directions are software engineering, data mining, and machine learning.

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