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AI-powered transportation can make traffic better?

Changxi Ma[1], Jianjun Wu[2], Ciro Caliendo[3] and Xuecai Xu[4*]

[1] *School of Traffic and Transportation Engineering, Lanzhou Jiaotong University, Lanzhou 730070, China*
[2] *School of Economics and Management, Dalian University of Technology, Dalian 116024, China*
[3] *Dept. of Civil Engineering, University of Salerno, Salerno 84084, Italy*
[4] *School of Civil and Hydraulic Engineering, Huazhong University of Science and Technology, Wuhan 430074, China*
* Corresponding author, E-mail: xuecai_xu@hust.edu.cn

Abstract

Artificial intelligence (AI) technologies have brought tremendous progress in various fields, and AI-powered transportation has been given more attention in recent years. From this perspective, the advantages and challenges confronted by road transport systems, railway and subway systems, the aviation industry, and Europe, especially in Italy have been discussed, and the conclusion reached that AI-powered transportation can improve traffic and make life better in transportation.

Keywords: AI-powered transportation; Intelligent transportation systems; Connected and autonomous vehicles

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Artificial intelligence (AI) technologies are experiencing rapid development in a variety of fields around the world. In the transportation field, these technologies range from transport planning[1], public transport[2], heavy transport[3], road transport management systems[4], e-bikes[5], autonomous transport systems[6], to water transport[7] and air transportation management[8]. AI has been reshaping the way we travel, communicating with transportation systems, and redefining the frameworks, driven by the goals of convenience, efficiency, safety, and sustainability. However, can AI-powered transportation improve traffic?

In road transport systems, traffic congestion alleviation and real-time traffic flow optimization have been the target of intelligent transportation systems (ITS), and connected and autonomous vehicles (CAVs) are being considered as the main means as well as vehicle-roadway coordination systems. Currently, AI has brought significant benefits to road transport systems, for example, CAVs can monitor the surrounding real-time traffic, interact with traffic signals and adjacent vehicles (preceding/succeeding), and execute informed responses (such as keeping suitable headway, car following, lane changing, braking, obstacle avoidance, etc.), as well as predicting the crash risk; RobotTaxi has been operating to take the responsibility of taxi drivers efficiently, while autonomous buses are being tested to share the burden of bus drivers to improve travel experience.

Meanwhile, numerous emerging challenges have arisen. For instance, with the first accident occurrence in CAVs, safety concerns has been aroused, what's more, cybersecurity, and privacy issues regarding the Internet of Vehicles are confronted with hack threats. Another concern has been presented regarding the responsibility-liability-interests division among authority, manufacturers, operators, and owners. Ethical dilemmas and economic disruption brought about due to driver replacement still need solutions.

In railway and subway systems, the application of AI technologies has brought brand new opportunities and challenges to improve transport efficiency, guarantee operation safety, and enhance service quality. Based on big data and high-efficiency computation structure, by combining computer vision, natural language processing and machine learning technologies, AI-powered railway transportation facilities and devices reveal some smart behavior, such as learning, deduction, decision-making, etc., and the following areas have been applied: smart dispatching and operation management, facility fault detection and maintenance, security monitoring and warning, work zone management, smart passenger service, and passenger flow prediction and flowchart layout.

Some challenges remain in the railway transportation field. In subway systems, a large amount of passenger information and operation data are involved, and how to keep the data safe and private is an important challenge. Since in the subway system high reliability and steadiness are required, even minor malfunctions may cause serious influence on operation safety, so algorithm security and risk, hardware fault coordination risk, and cybersecurity threats are the main challenges. Another issue is the lack of talent in the railway transportation field. It is difficult to recruit professionals who grasp railway transportation engineering as well as AI technologies, which may not only influence the progress of smart railway transport operation, but bring potential hazards for safe and steady operation.

AI has also been used in the aviation industry for decades, improving various aspects of the business and operations. Advances in automation, machine learning, and data analytics are helping to manage increasing air traffic. AI applications like advanced business intelligence are revolutionizing airline operations, particularly in marketing, sales, pricing, distribution, and fleet management, while machine learning can turn historical and real-time customer data into immediate business adjustments, such as modifying website content. Future challenges in aviation, instead, might include more automation for improved air traffic management and better air-ground integration, by also relieving certain tasks to allow pilots and air traffic controllers to focus on safety critical responsibilities. Moreover, due to the safety and security importance of aviation, AI implementations must meet even stricter safety and security standards, including protecting personal data associated with automated aircraft.

In Europe, the integration of AI into transportation is driving transformative progress in urban mobility, sustainability, and safety. AI-based technologies, such as those for real-time traffic monitoring, and predictive maintenance, are improving road transportation

systems across European cities, reducing both vehicular congestion and polluting emissions, enhancing travel time accuracy, and improving traffic safety. In line with the European strategies, in Italy, several actions have been taken to enhance road infrastructure and traffic management through advanced technologies. These include the integration of artificial intelligence in traffic prediction, road safety enhancements, and the digital transformation of infrastructure via the Smart Road initiative.

The implementation of AI-powered road transportation in Europe and Italy faces challenges associated with privacy concerns, regulatory barriers, and infrastructure limitations. Strict EU regulations on data privacy and ethical use of AI pose impediments to its wide-scale diffusion since transportation systems rely heavily on real-time data collection, which often struggles with the rigorous guidelines of the General Data Protection Regulation.

In summary, AI technologies have been applied and implemented in a variety of transportation fields and different areas, such as roadway, railway, aviation, etc., which has brought transportation with a new vision, new perspectives, and a new outlook, meanwhile a series of challenges and opportunities accompany them, including subway system vulnerabilities requiring robust data security protocols (e.g., encryption and access control), talent development pipelines for AI-integrated railway operations, and uncertainties regarding the long-term economic viability of transportation AI, all of which make AI-powered transportation worthy of being expected and aspired to for better traffic and a better life.

Author contributions

The authors confirm their contributions to the paper as follows: conceptualization: Ma C, Xu X. All authors wrote, reviewed the results and approved the final version of the manuscript.

Data availability

No dataset is included in this article.

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Conflict of interest

The authors declare that they have no conflict of interest.

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