Academic Education Publishing House
Industry Science and Engineering Vol. 2 No. 5, 2025

A Study of the Impact of Big Data on Transport

Shan Ge
AI Digital Media College, Liaoning Communication University, Shenyang, Liaoning, China

Abstract: This paper provides an in-depth discussion of the far-reaching impact of the development and application of big data technology on the field of transport. the definition of big data and its characteristics is introduced, and deep analysis is presented of the application of big data in the fields of intelligent transport system, traffic flow prediction, route optimization and traffic safety. In addition, this paper describes the difficulties and challenges faced in the application of big data in the field of transport and looks forward to the future development trend. the study shows that big data technology is profoundly changing all aspects of the transport field, providing strong support for building a more efficient, safe and sustainable transport system.

Keywords: Big Data; Intelligent Transport; Traffic Management; Traffic Optimization; Traffic Safety

1. Introduction

With the acceleration of China's urbanization, the mismatch between the speed of traffic development and the speed of urbanization development has become an unfavorable factor affecting urban development and the quality of life of the residents. Traffic congestion, frequent accidents, environmental pollution and other problems need to be solved urgently. Therefore, the extensive application of big data technology in the field of transport brings significant opportunities for change in transport planning and development. Big data technology can deal with massive traffic data, and it is not picky about the form of data, from which valuable information is extracted to provide a scientific basis for traffic management decisions.

The purpose of this paper is to analyse the impact of big data technology on the field of transportation comprehensively, explore its specific applications in traffic management and optimization, identify the current challenges, and look forward to the future development trend. By systematically sorting out the current status of the application of big data in the field of transport, it provides reference for relevant research and practice, and promotes the deep integration of big data technology and the field of transport.

2. Overview of Big Data Technology

Big data is a collection of data that is large in scale, diverse in type, fast in generation and requires special technology for processing and analysis. Big data has the "4V" characteristics: Volume (volume), Velocity (high speed), Variety (variety) and Veracity (authenticity). In the field of transport, Big Data mainly comes from traffic sensors, GPS devices, cameras, social media and other channels.

The data in the transport domain includes vehicle track data, traffic flow data, accident records, weather information and many other types. These data are characterized by high real-time, high spatial correlation, and obvious time series characteristics. Processing and analyzing these data require advanced technologies such as distributed computing, machine learning, data mining and so on. Through these technologies, valuable information and patterns can be extracted from massive traffic data to provide support for traffic management and decision-making.

3. Application Of Big Data in Intelligent Traffic System

Big data technology plays an important role in intelligent traffic signal control. Traditional traffic signal control systems often use a fixed-time scheme, which is difficult to adapt to real-time changes in traffic flow. Intelligent signal control systems based on big data can analyse traffic flow data from various sensors in real time, dynamically adjust signal timing, and significantly improve intersection traffic efficiency. For example, certain cities have reduced traffic delays by 20-30 per cent by deploying big data-based adaptive signal control systems.

In terms of public transport optimization, big data can optimize bus routes and schedules by aggregating information from all aspects and performing big data. By analysing bus card swipe data, GPS track data and passenger mobile phone data, passenger flow hotspots can be identified so that more efficient travel bus routes can be designed. Some cities have already achieved dynamic scheduling of public transport based on real-time data, which has significantly improved the service level of public transport.

4. Role Of Big Data in Traffic Flow Prediction

Traffic flow prediction is an important foundation for traffic management. Big data technology has greatly improved the accuracy of short-term and long-term traffic flow prediction. Machine learning algorithms can analyse historical traffic data, weather data, event data and many other factors to build complex prediction models. These models are able to capture the nonlinear characteristics and spatial and temporal correlations of traffic flow, providing more reliable predictions.

A real-time traffic monitoring system based on big data can detect traffic anomalies and congestion in a timely manner. By integrating data from multiple sources such as cameras, geomagnetic sensors, and floating vehicle GPS, the system is able to fully grasp the operational status of the road network and provide decision-making support to the traffic management department. When abnormal traffic conditions are detected, the system can automatically trigger emergency plans, such as adjusting signal timing and releasing traffic guidance information, to effectively ease traffic congestion.

5. Application Of Big Data in Route Optimization

Personalized navigation service is a typical application of big data in route optimization. Modern navigation systems not only consider the shortest path, but also integrate real-time traffic conditions, historical travel patterns, personal preferences and other factors to provide optimal personalized route suggestions for each user. By analyzing massive user trajectory data, navigation systems can continuously learn and optimize algorithms to improve the accuracy of route recommendations.

For the logistics and freight industry, big data-driven route planning can significantly reduce transport costs. By analysing multi-dimensional data such as cargo characteristics, vehicle status, road network conditions, weather conditions, etc., optimization algorithms are able to calculate the most economical transport routes and scheduling solutions at the moment. Some logistics companies have already implemented intelligent scheduling systems based on big data, effectively improving transport efficiency and reducing fuel consumption.

6. Impact Of Big Data on Traffic Safety

Big data analysis shows great potential in accident prediction and prevention. By mining historical accident data, traffic flow data, road design data, weather data, etc., it is possible to predict high-risk accident road sections and time periods and establish accident prediction models. These models can help traffic management departments deploy targeted safety measures, such as adding warning signs, improving road design, strengthening law enforcement, etc., to effectively prevent accidents.

In terms of driving behaviour analysis, in-vehicle sensors and smartphones can collect rich driving behaviour data, such as vehicle speed, acceleration and braking frequency. Through big data analysis, dangerous driving patterns can be identified and personalised feedback and safety advice can be provided to drivers.

7. Challenges And Future Prospects

Although the application of big data in the field of transport is promising, it still faces many challenges. On the technical level, how to efficiently process and analyse massive and heterogeneous traffic data is still a challenge. Data quality and consistency are also often problematic, and data from different sources may be conflicting or missing. Privacy protection is another important challenge. Traffic data often contains sensitive personal information, and how to protect user privacy while utilising the data requires special attention.

In the future, with the development of technologies such as 5G communications, IOT, and artificial intelligence, the application of big data in the transport sector will become more in-depth. Emerging technologies such as vehicle-road coordination systems and autonomous driving will rely on big data support. At the same time, cross-sector and cross-region traffic data sharing mechanisms will be gradually established to form a more comprehensive traffic data ecosystem. Big data technology will

continue to drive the transport system in the direction of smarter, more efficient and safer.

8. Conclusion

Big data technologies are profoundly changing all aspects of the transport sector, providing unprecedented possibilities for traffic management, planning and optimization. From intelligent signal control to public transport optimization, from traffic prediction to route planning, from accident prevention to driving behaviour analysis, big data applications have shown remarkable results. Despite technical, privacy and organizational challenges, with the advancement of related technologies and the accumulation of application experience, Big Data will certainly play an even more critical role in building future intelligent transport systems. Traffic management departments, enterprises and research institutes should strengthen cooperation and jointly promote the innovative application of big data technology in the field of transport to create a safer, more efficient and sustainable travelling environment for people.

References

[1] Zhao GuangHui. Research on the Application and Development of Big Data in Transportation, China Social Sciences Press, 2018-09.

[2] Yu Qing, Yuan Jian, Song Xuan. Detailed Explanation of Traffic Spatiotemporal Big Data, Tsinghua University Press, 2024-07.

[3] Li HongChang. Research on Spatiotemporal Economy of Traffic Big Data, Social Sciences Academic Press, 2024-12.

[4] Zhang JinLei, Yang LiXing Gao ZiYou. Practical Combat of Deep Learning and Traffic Big Data, Tsinghua University Press, 2022-07.

[5] He Cheng, Zhu YangYong. Urban Transportation Big Data (2nd Edition), Shanghai Science and Technology Press, 2022-08.