Development Status and Problem of Intelligent Transportation System in China

Fuyou Zheng

Auburn University, Department of Civil Engineering, Auburn, USA

Fzz0017@auburn.edu

Abstract. With the rapid growth of China's population and urbanization, the need for urban transportation has surged. Effective technical support such as an intelligent transportation system (ITS) will be a traffic solution to avoid too much congestion. Effective ITS is supposed to provide protection for daily traffic operations, reduce traffic congestion, minimized environmental effects, energy conservation, and significantly improve the level of service. ITS is designed based on current traffic status to fit future urban development will be more and more important.

Keywords: Component, ITS, Transportation, Construction.

1. Introduction

China's accelerating urbanization since the last century has led to a continuously growing number of cars own. According to the Government of Chinese (GOC) website, up to now, the number of national motor vehicles reached 408 million. As a result, the huge number of vehicles are making congestion issue more and more serious which is hurting the economy a lot. According to data published by the China Intelligent Transportation System Association, the economic loss due to traffic congestion accounts for 20% of the disposable income of the urban population, which is equivalent to an annual loss of 5-8% of total gross domestic production (GDP), amounting to 250 billion RMB per year, and the daily treatment costs associated with traffic congestion nationwide amount to 1 billion RMB [1]. As matter of fact, the GOC started the ITS study in the last century. Over 40 years of development, Chinese researchers had started with almost zero builds to top lies of ITS development. Up to now, the Chinese government still attaches great importance to the development of ITS and has given strong policy support. In the future, ITS will have considerable development in China. The purpose of this paper is to discuss how China's ITS can have further development by pointing out the current development situation of ITS, analyzing ITS development history and existing problems, and putting forward the direction for solving them.

2. ITS overview

ITS combines advanced technologies such as computer programming, electronics technology, data transmission technology, traffic control, and sensor technology to collaborate and build the transportation network. ITS are operating with high efficiency and accuracy in our daily life. After World War two, the global economy and population boomed and continuously grew sharply. In the meantime, the number of vehicles and the transportation industry was developing rapidly as well. The United States, Japan, Europe, and other developed countries and regions from the 1950s and 1960s began to vigorously develop the automobile industry, road infrastructure, and roadway traffic mode, which is dominated by private cars [2]. By the 1970s, with the gradual exposure to the irrationality of this mode of transportation, developed countries began to vigorously develop public transportation, mainly urban public transportation. However, the problems of traffic accidents, traffic congestion, and traffic pollution were day by day prominent. Therefore, countries began to look for solutions in the 1960s and 1970s and finally reached a consensus that the trend of transportation development, namely intelligent transportation systems. At present, counties namely United States, Japan, Europe, Korea, and China are leading the ITS research.

3. History

The ITS study in China began in the 1970s. In the 1980s, Chinese researchers were making progress in this study and began to test some of the applications of automatic traffic signal control systems [3]. At the early stage of development, due to the immature technology, the control system was mainly introduced from foreign countries. Importing products including the British SCOOT system introduced by the city of Beijing and the SCATS system introduced by the city of Shanghai [2]. In the 1990s, the city traffic command center and control center were built in some of the cities, and the road traffic signal control system was advanced to the next level. Followed on this, a traffic information observatory and vehicle information management system were introduced. In 2008, China Intelligent Transportation Association was established. In 2019, the Central Committee of the Communist Party of China and the State Council officially issued the Outline for the construction of a strong transportation country, which pointed out the direction for the development of intelligent transportation vigorously develop intelligent transportation. Promote the deep integration of new technologies such as big data, the Internet, artificial intelligence, blockchain, and supercomputing with the transportation industry. In 2020, 'the Guidance on Promoting the Construction of New Infrastructure' was published. In 2035, the construction of new infrastructure in the transport sector has achieved significant results. Driven by active policies, the ITS national market size has been growing steadily. Figure 1 shows the market size of ITS for the past 5 years in China which was created according to data collected by China Intelligent Transportation Association. [4]

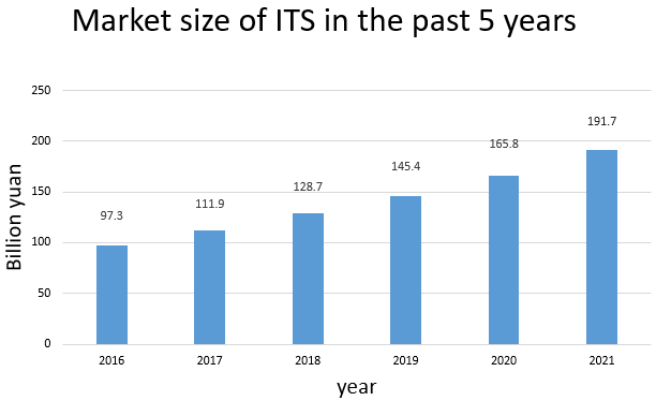

Figure 1. Market size of ITS in the past 5 years

In 2016, China's intelligent highway market size was 97.3 billion yuan. This figure has surprisingly increased in the past five years to 191.7 billion yuan in 2021. The doubling of the market size reflects the growth of China in ITS in recent years. In the near future, the Chinese government will continuously provide strong policy support and the development of ITS will go steady.

4. Application

Overall, the national current stage of ITS development is subjected to the constraints of many objective factors which results in its construction still being behind. However, thanks to strong policy support and the development of science and technology, the development of urban ITS has been promoted from far behind the world to the top tiers worldwide. Nowadays, China is one of the most ITS-developed countries. The following aspects of the development of urban ITS are from the following aspects of the current situation.

4.1. Smart parking

In the early stage of ITS development, smart parking was not the target outcome. As the urban expanded and increment of vehicles, limited urban spaces faced challenges. Smart parking contributed to increasing the vehicle capacity of parking lots, managing parking lots effectively, and reducing labor costs. At present, various smart technologies are widely used in parking lots

nationwide. Technologies applied included monitoring systems, automatic billing, mobile payment, vehicle identification, parking spot guidance, vehicle positioning, and other functions. For users, it promotes user experience. For owners, it enhances management efficiency and management while reducing labor costs. For example, in April 2020, Nanjing Railway Station Square built an all-channel ETC sensor that enables cell phone self-service payment, parking reservation, parking guidance, charging sharing, and other functions through the Ning Parking App. [3] The smart parking management platform can update the status of parking spaces in real-time. Stereo garage is another application of smart parking. Compared with the traditional parking method, a stereo garage has more vehicle capacity with the same amount of footprint. A stereo garage was considered as a solution to the limited peaking space. The nationwide low usage indicates that it won't be the right answer in near future. The applications of this type of parking are subject to many constraints, including the lack of reliable technology support, high construction cost and maintenance cost, and unfamiliarity from pubic [5].

4.2. Automated driving

China is a late starter in automotive production technology and autonomous driving technology. The world's first self-driving cars appeared in the United States in the 1980s, while the first in China appeared after 2010. However, after that, thanks to policy support, China's self-driving programming technology has developed rapidly. At present, some Chinese company like Baidu has become the companies leading the relevant research. The first automated driving car was developed by China's National University of Defense Technology in 2011, namely HQ3 under the Red Flag brand. In practice, this car drove from Changsha to Wuhan, with a total journey of 286 km, achieving 76 overtaking times independently and reaching an average speed of 85 kmh. The success of this driverless technology is a feat in the development of urban intelligent transportation systems so far. In 2018, the first commercial-grade driverless bus was in Pingtan, Fujian Province. In April 2020, Baidu's self-driving cab experience test ride service was opened to the public for free in Changsha City. In April 2020, Baidu's self-driving taxi service was opened to the public in Changsha for free [3]. Tesla, considered the leader in autonomous driving technology, has no doubt led over Chinese auto companies in this research area. In October 2019, Tesla's gigafactory located in Shanghai started operating. By August 2022. This gigafactory produced its millionth car. So far, autonomous driving technology is still an immature technology, which is the reason why self-driving cars are not yet wild produced and used. In recent years, China's leading companies have made great technological breakthroughs and brought affordable self-driving cars to real. For example, happened on July 21, during the 2022 Baidu World Congress, Baidu unveiled the steering wheel-less unmanned vehicle Apollo RT6, which costs 250,000 yuan and significantly reduces the cost of mass production to 110 of the industry [4].

4.3. Intelligent highway

China currently has the longest highway mileage in the world. How to manage such a long highway network efficiently has become one of the main concerns of the government. The path of ITS development in China in the 2000s', managed to form a national highway system; in the 2010s', completed the highway network digitalized; and in the 2020s', the goal is to further combine operations between humans, vehicles, and roadways. The achievements made by the government in highway network digitalize and intelligent management are performed as follows:

1) A dedicated network of highway communication transmission network has been established. All municipalities have built a dedicated communication transmission system highway, generally consisting of mobile communication equipment, digital program-controlled switching equipment, and emergency auxiliary equipment. Currently, municipalities are working on upgrading 5G (fifth-generation telecommunications technology) on highway transmission networks. The specific upgrade approach is connecting existing outfield video links to 5G networks, and finally improving video surveillance and voice communication quality. 5G networks can be used specifically applied at toll

stations, service areas, and management centers. In contrast to current communication networks, 5G networks have better transmission rates, security, reliability, and low latency.[6] On October 23, 2020, the Ministry of Transport released the Key Points of China Mobile Pilot Tasks for the Construction of a Strong Transportation Country, which proposes to accelerate the construction of 5G networks in highway networks. Now there are many 5G pilot areas nationwide such as the 5G automatic driving open test section carried out in Fangshan District, Beijing, and the Beijing-Taipei Expressway section of the reconstruction and expansion of the highway demonstration pilot [4].

2) A toll station system network has been established. The government has vigorously promoted the unify of toll stations nationwide. Previously, toll stations were built and operated by provinces. The new toll stations network is supported by the internet and manages to collect tolls from provinces and cities. Also, electronic toll collection (ETC) is applied nationwide. Upon toll stations, vehicles entering the expressway now can pay tolls with no stop. Until 2019, the total number of ETC users nationwide reached 2.5 billion which is the greatest ETC network in the world [7]. The national coverage rate of ETC has reached 90%. The unified toll station network and ETC significantly increase mobility and convenience on the roadway.

3) The establishment of an integrated safety monitoring and control system. The current highway operating companies have established a security monitoring network consisting of a large number of camera monitoring equipment on the road to achieving the monitoring of highway conditions, real-time control of highway vehicle operations, traffic flow, and lane usage, to provide control service information for highway traffic, especially for important highway bridges, tunnels and other sections of the implementation of monitoring, to further reduce the risk of vehicle operation risk.

5. Existing problems

The development of intelligent transportation has made remarkable progress in China, but it is facing more and more challenges. Figure 2 shows the trend of Chinese intelligent transportation industry-related enterprise registration numbers from the year 2012 to 2021 [4].

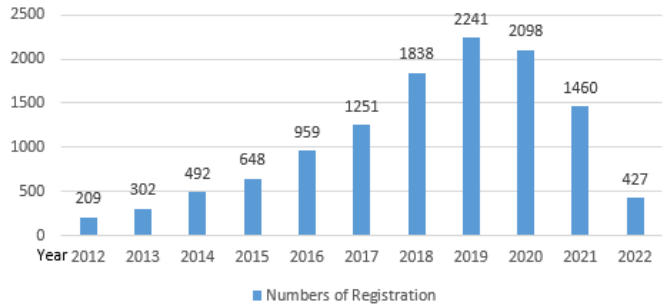

Figure 2. Chinese intelligent transportation industry-related enterprise registration number in the past 10 years

According to data released by online database company Qichacha, the trend of China's intelligent transportation industry-related enterprise registration goes down. From 2012 to 2019 the development of China's intelligent transportation industry grew rapidly. The number of new enterprise registrations in 2012 was 209, and this number doubled 10 times in 8 years and increased to 2241 in 2019. But since then, this number is going down to 1460 in the year 2021. The continuously declining number is not a sign of a growing trend. At present, the development of ITS has problems listed below:

5.1. Management ability

Managing the traffic system involved the Ministry of Public Security Traffic Management Bureau, the Ministry of Transport and the Ministry of Housing and Urban-Rural Development, and other departments and industries in collaboration. Due to the multiple departments involved, the development is lacking unified development goals and planning. The industry lacks unified policy and standards [8]. Those issue has led to high management costs and poor management effectiveness,

which is limiting the development of intelligent transportation. The current highway operation and maintenance activities need a national operation platform, which will provide efficient and automated management and services.

5.2. Data analysis

China is collecting huge amounts of data daily, but how they deal with those data is not doing enough. The majority of the collected data is from a single source, traffic cameras [9]. In current stage, companies concerned more on how to collect data and putting less effort on deep mining. Therefore, the '1 dimension' data is not proving enough information for deep analysis. There is the reason why the existing management system has poor prediction ability and cannot provide effective assistance for manual decision-making, which means the decision mainly depends on the experience of commanders in unexpected situations. Besides, due to the lack of 3-dimensional comprehensive data, the root cause of roadway incidents cannot be determined accurately which brings more challenges on roadway control.

5.3. Detection approach

The current traffic detection system has a high coverage across the country, but not intelligent enough. It is an outbreak period of the video surveillance market from 2019 to 2021. In 2019, due to the abolition of provincial boundary toll stations, a new surveillance model was introduced by order of the video cloud networking requirements issued by the Ministry of Transport [4]. The new surveillance model requires a large number of new advanced video surveillance equipment. After those updated projects, the desirable coverage and clarity of video camera deployment have been met. However, intelligent and digital technologies are mostly still in the pilot stage and not yet ready for practical use. Most existing technologies are focusing on a single circumstance and won't be able to handle comprehensive problems. Besides, the industry is still missing a unified standard specification or regulation which drawbacks the development. Some cities are running tests of video surveillance intelligent analysis technology, including AI traffic video analysis platforms, image analysis algorithms, and pedestrian movement trajectories [10]. However, the accuracy of the detection still does not fully meet the needs, and manual reviews are required.

6. Suggestions

6.1. Increase of reasearch investment and enourage innovation

The government is acquiring massive amounts of information, but the existing equipment has low information processing capabilities and still relies on manual decision-making. The department of transportation should increase investment in intelligent transportation research and pushes science and technology innovation. A lower cost will be the best catalyst that accelerate the development. The key feature that needs to be promoted include:

●Autonomous decision-making:

Able to use machine learning technology to autonomously learn from roadway anomalies. Capable of carrying out the real-time calculation on the abnormal situation of roadway operation. It can predict the trajectory and results of abnormal situations, quickly propose the optimal solution, and comprehensively improve the decision-making standards of roadway abnormal situations.

●Instantaneous response:

Capable of sensing the occurrence of emergency situations in real-time, quickly assessing the level of emergency situations, instantly generating detailed response plans, and quickly mobilizing emergency resources. Comprehensively improve the standards of a roadway emergency

●Precise control:

Able to comprehensively perceive the road and identify the abnormal operation of the roadway network. Capable of taking the initiative to carry out precise control at the section level, lane level,

and special vehicles, so as to comprehensively improve the standards of roadway management and ensure the safe, orderly and smooth operation of roadways.

6.2. Governance

ITS is considered a solution to traffic congestion, and the government should continue to support the development of strong policies supply. As an evolving technology, smart transportation does not yet have a unified national standard or regulation. There are many industries involved in the construction of smart transportation such as transportation infrastructure, equipment manufacturing, and internet companies. The government can better manage the standardization of technical standards and guide development by introducing unified regulations and technical standards. In addition, with the participation of multiple industries, the government should facilitate communication among enterprises, strengthen technical cooperation, and enhance information sharing. Better collaboration among enterprises can strengthen the processing and analysis of information, enhance vehicle road collaboration, and more accurate AI autonomous decision-making capabilities

6.3. Developing a nationa guideline based on roadway conditions

China was a late starter in ITS research, and the majority of the equipment and technologies were introduced from a foreign country in the early stage. However, traffic conditions are various from city to city, and country to country. China is one of the most densely populated countries and has the longest road mileage in the world. Even within China, roadway conditions, traffic density, and weather conditions are different in the eastern and western cities. Introducing equipment and experience directly from foreign countries may not fit the condition. Therefore, the government should learn from foreign development experience and establish a guideline for developing a management system that best fits China's traffic conditions. Each province and city could adjust development by following the national guidance.

7. Conclusion

The development and construction of intelligent transportation in China have begun to bear fruit. The level of intelligent infrastructure development and intelligent management methods has been significantly improved. It is a necessary way to relieve the traffic pressure, promote the intelligence of government and traffic information, and help the digital transformation and upgrading of cities. The paper provides a review and summary of China's intelligence. The purpose of this paper is to provide some suggestions for promoting the construction of intelligent transportation. The study will provide ideas of future ITS development in China.

References

[1] China Intelligent Transportation System Association, 2018. “Solution of traffic congestion”. http://www.its-china.org.cn/SvoteDao?CREMARKS=0&sid=1534493211#:~:text=%E4%BA%A4%E9%80%9A%E6%8B%A5%E5%A0%B5%E8%BF%99%E4%B8%AA%E2%80%9C%E5%9F%8E%E5%B8%82%E7%97%85,%E8%BE%BE10%E4%BA%BF%E5%85%83%E4%BA%BA%E6%B0%91%E5%B8%81%E3%80%82.

[2] Xiaojin Wang, “Review of Intelligent Transportation Development in China (The beginning of the development of Intelligent Transportation system)”, China ITS journal, vol. 225, pp 19-21, December 2018.

[3] Bingyu You, Jiayu Li and Yumei Xie, “Existing issue of Intelligent Transportation in China”, Municipal Technology, vol 40, May 2022.

[4] 2022, “China Intelligent Transportation Industry Current Situation Deep Analysis”. Insight and Info Consulting LTD, Beijing.

[5] Honglang Qin, “The Types and Development Status of Three-dimensional Garage in China,” Value Engineering, pp 227-229, 2019.

[6] Bingshan Yang, 5G applications in transportation system, Technology Forum, 2021.

[7] Xiaojin Wang, “Review of Intelligent Transportation Development in China (The development of electronic toll collection system)”, China ITS journal, vol. 249, pp 27-35, October 2020.

[8] Chunli Duan, intelligent transportation technology and application, Smart City, 2021.

[9] Jixiang Fei, promotion of intelligent highway, ICT insights (smart Transportation special), vol 30, April 2021.

[10] Xinbing Li, Yongping Xu and Li Huang, “Status and Countermeasures of Urban Intelligent Transportation Management in Big Data Era”, Hot Spotlight- Intelligent City, pp 10-13, 2020.