

# A Study of Intelligent Parking Management in the Era of Big Data

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**Abstract**—With the improvement of economy and the acceleration of urbanization, the number of private cars is increasing rapidly, which makes road congestion and parking difficulty become very common phenomena under the limited road and land resources. This paper aims to alleviate the problem of parking difficulty in China. Therefore, this paper firstly finds out the problems existing in the current parking situation and analyzes the reasons. Secondly, this paper proposes the importance of developing intelligent parking management in the era of big data and analyzes the links involved. Thirdly, a kind of intelligent parking guidance system is put forward, and its technical composition and implementation process are described in detail, then the advantages and disadvantages of the system are analyzed. Finally, the development trend and prospect of intelligent parking management in the future are put forward in this paper.

**Keywords**—big data; parking management; an intelligent parking guidance system

## I. INTRODUCTION

With the continuous improvement of economy, the number of private cars is increasing rapidly, and the problem of "difficult parking" becomes increasingly prominent when parking resources are limited, which aggravates urban traffic congestion and restricts the improvement of living environment and sustainable development of the city. Therefore, scientific, reasonable and effective parking management becomes more important. Nowadays, the development of science and technology has a direct impact on the development of traffic towards informatization and intelligence. Therefore, the Internet and traffic big data can be fully utilized to reasonably alleviate the problem of parking difficulty.

Compared with foreign countries, intelligent parking management in China started to research and apply late. As early as 1971, Germany established the world's first parking guidance system, which set up photoelectric display parking guidance signs at the main intersections of parking lots. The signs were controlled remotely, which promoted the effective use of parking lots [1]. In 1973, Japan also established the parking guidance system, which can provide drivers with information such as the location, the total number and the use condition of parking spaces [2]. In 2001, the United States developed a parking guidance and search

system, which used ultrasonic detectors installed in each parking space to know whether it is empty, so as to guide the driver to stop [3]. In 2001, the first parking guidance system was applied in China [4]. Since then, China's intelligent parking system has made continuous development, and has been gradually applied and promoted in some big cities such as Beijing, Shanghai and Shenzhen.

## II. ANALYSIS OF THE CURRENT SITUATION AND CAUSES OF PARKING IN CHINA

### A. The Serious Insufficiency in Parking Spaces

With the rapid development of economy and the improvement of living standard, more and more people choose to buy their own private cars. According to the ministry of public security, China had 240 million cars by the end of 2018, up 10.51 percent from 2017. As shown in "Fig. 1" below, the number of private cars has been increasing steadily in the past five years, reaching 189 million by the end of 2018. This inevitably leads to the increasing demand for parking by private cars. According to the data released by the national development and reform commission, the average ratio of cars to parking spaces in China's big cities is about 1:0.8, and that in small and medium-sized cities is about 1:0.5. According to conservative estimation, parking space gap exceeds 50 million in China. Therefore, it can be seen from the above data that the construction speed of parking spaces and related supporting facilities is far behind the growth rate of private cars, which inevitably leads to the fact that the supply of parking spaces is far from meeting the demand for parking.

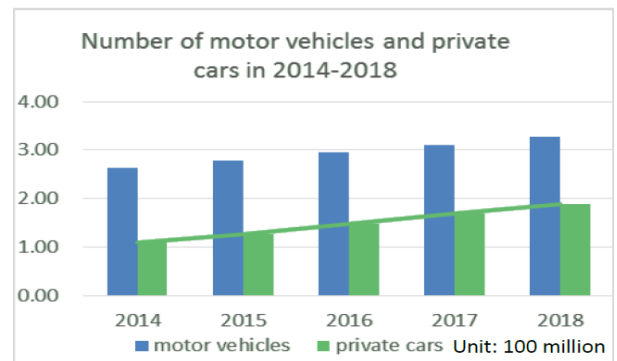


Fig. 1. Number of motor vehicles and private cars in China in 2014-2018.

### *B. The Confusion and Random of Parking*

Due to the shortage of parking spaces, the unreasonable setting and planning of parking lots and other reasons, it often happens that cars park randomly in public areas such as roads, green spaces and residential areas. This causes disorder of parking in public areas, interfering with the normal traffic rules and damaging the environment. In addition, especially in public areas with dense pedestrians, it will cause human-vehicle conflicts and affect safety of pedestrians.

### *C. Unreasonable Parking Charges*

Early in December 2015, the national development and reform commission on the motor vehicle parking fees policy guidance, put forward to improve the mechanism of motor vehicle parking fees, made full use of price leverage and promoted the construction of parking facilities, so as to improve the efficiency of parking resources configuration and create a good environment for the urban functions and people's convenient lives. Parking fee includes property parking fee, rental parking fee and temporary parking fee. All these charges may too high for drivers to cause no car parking, which naturally makes the parking space idle, forming a waste of resources.

### *D. Low Utilization of Parking Space*

Parking space utilization rate is low. One reason is that the disorder of parking lot management, which makes low service level and high operation cost. Another reason is that the relevant series of parking information failed to timely feedback to drivers and the parking management departments. This not only makes it impossible for drivers to know whether there are available parking spaces, but also makes it difficult for parking management departments to reasonably arrange parking spaces, resulting in low parking turnover rate.

There are different parking demands at different times of the day. For example, during the daytime, a large number of parking spaces in residential areas are idle, while parking spaces in business office areas, hospitals, schools, factories and so on are in short supply. At night, however, the condition is opposite. Therefore, parking spaces in different time and places may become idle, which cannot be shared in a timely manner. This also leads to low utilization rate of parking spaces.

## III. THE LINKS INVOLVED IN INTELLIGENT PARKING MANAGEMENT

### *A. Digital Connection of Parking Spaces*

The digital connection of parking resources is a key link to realize intelligent parking in the big data era. It is an important source for drivers to obtain relevant series of parking information. [5]

For parking resources, such as in-road and off-road parking spaces, digital connection can be realized by wireless communication technology, GPS position technology, geomagnetic induction coil, video camera and

other methods, which not only beneficial for real-time information interaction between parking lots and vehicles, but also feeding parking information back to the parking management department, so that parking resources can be deeply integrated and configured.

### *B. Collection of Refined Information in Parking Spaces*

Traditional information collection of parking lots is relatively simple, such as parking lot location, number of parking spaces, etc. Nowadays, in the era of big data, more detailed information can be obtained through video camera and other methods in the parking spaces, including the moment when a car enters or leaves a parking space, parking time, vehicle type, and parking behavior. The more refined the parking resource information collected, the more parking data can be mined and utilized, which is conducive to more targeted and personalized parking service.

### *C. The Improvement of Big Data Processing Platform and the Realization of Parking Data Sharing*

The big data processing platform should be improved to fully mine, utilize and integrate valuable information in urban traffic flow, bus, parking and other traffic big data, so as to share parking data, realize reasonable allocation of parking resources and improve parking efficiency. For example, the traffic big data is used to study drivers' parking choice behavior preference, so as to make a more reasonable and accurate prediction of drivers' parking demand, and realize the accurate and personalized parking service as far as possible.

## IV. AN INTELLIGENT PARKING GUIDANCE SYSTEM PROPOSED

Based on the current parking situation and problems, and in the era of big data, an intelligent parking guidance system is proposed in this paper. Based on the acquisition and collection of parking information, and with the cloud big data processing platform as the core, the intelligent parking guidance system provides parking guidance services for drivers, thus alleviating the difficulty of parking.

### *A. A Brief Introduction of the Intelligent Parking Guidance System*

The intelligent parking guidance system mainly provides drivers with the following parking guidance service information, including the qualified parking lot location, the total number of empty parking spaces, the driving path and estimated travel time to the parking lot, and the number of vehicles that may enter or leave the parking lot within the estimated travel time. This makes it easier for drivers to know relevant information of qualified parking lots in a short time, and make the corresponding parking decisions as accurately as possible, so as to reduce the driving time for finding available parking spaces on the road, which improves the parking efficiency.

It mainly includes the following modules: parking lot entrance and exit cameras, parking lot server, cloud big data processing platform, real-time road condition monitoring

module and parking guidance terminal. Entrance and exit cameras are installed in the parking lot (in-road and off-road) to collect video images of each car entering and leaving the parking lot. The parking lot server collects video images information of the parking lot and transmits it to the cloud big data processing platform through wireless communication technology. Real-time road condition monitoring module is used to collect and obtain massive urban dynamic traffic flow and other data, which are transmitted to the cloud big data processing platform through the Internet for analysis and processing. The internal modules of the cloud big data processing platform are as shown in “Fig. 2” below. It not only stores a large amount of data, but also needs to mine, analyze, process and manage these massive data to provide useful parking service information for drivers. The parking guidance terminal is installed on the vehicle. It receives and shows the parking information transmitted by the cloud big data processing platform. The detailed parking information on the display screen is shown in “Fig. 3” below.

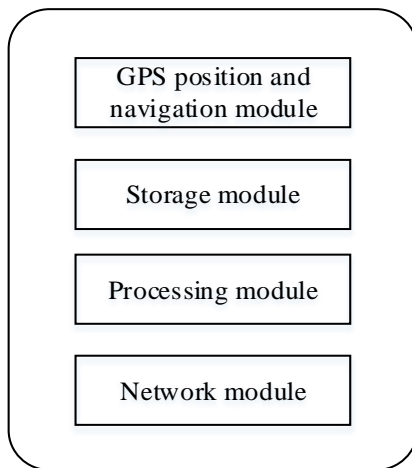


Fig. 2. The internal modules of the cloud big data processing platform.

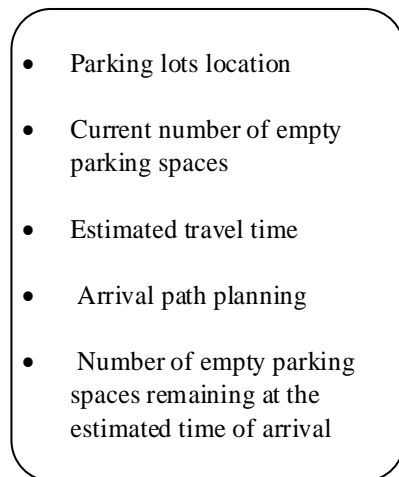


Fig. 3. Parking information displayed on the terminal display screen.

### B. Main Implementation Steps

“Fig. 4” is the technical implementation process of the intelligent parking guidance system. The specific implementation steps of this system are as follows:

Step 1: the driver issues a request to inquire parking information through parking guidance terminal. The parking guidance terminal sends the request to the cloud big data processing platform.

Step 2: the cloud big data processing platform accepts the request and automatically searches the qualified in-road or off-road parking lots in the cloud database based on the driver's vehicle location located by the parking guidance terminal. Send a request to the server of a qualified on-road or off-road parking lot.

Step 3: after receiving the request, the server of the qualified parking lot uploads the video images information of the camera installed in the parking lot to the cloud big data processing platform through the wireless network.

Step 4: real-time road condition monitoring module uploads road condition information to the cloud big data processing platform.

Step 5: the cloud big data processing platform receives the data information transmitted by the qualified parking lot server and the real-time road condition monitoring module for processing and analysis. The information after the processing, analysis and calculation is sent to the parking guidance terminal.

Step 6: the parking guidance terminal receives the parking information from the cloud big data processing platform and sends them to its display screen.

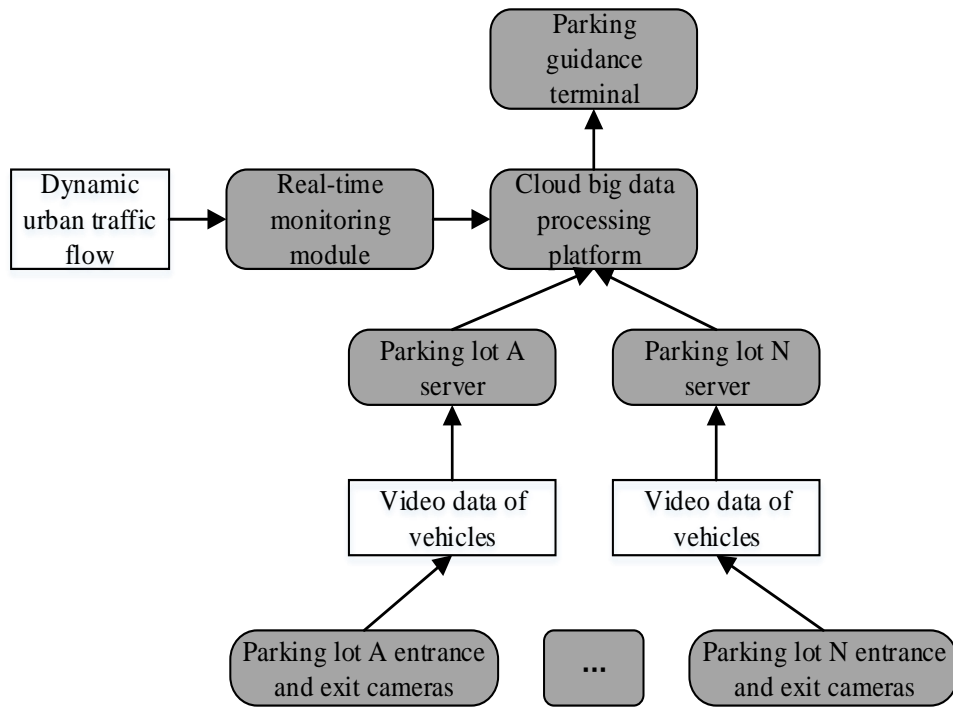


Fig. 4. The technical implementation process.

C. Analysis of Advantages and Disadvantages of the Proposed System

The advantage of the proposed intelligent parking guidance system is that it can predict the number of vehicles that may enter or leave the parking lot during the estimated travel time. It's helpful to guide drivers to make a more accurate parking decision and avoid the situation that although empty parking spaces in the parking lot are predicted in advance, there is no parking space when they arrive.

However, the accuracy of prediction depends on the consistency between the model put inside the cloud big data processing platform and the real situation, as well as its ability to mine, analyze and process massive traffic big data.

V. THE DEVELOPMENT TREND AND PROSPECT

In the future, the development of big data will deepen constantly and the information collection platform will be more perfect, which provides important data support for parking management. Drivers, parking facilities and information flow will fully communicate with each other under the support of a more intelligent parking guidance information system which based on big data [6]. On the one hand, it can improve the utilization rate of parking lot, improve service level, make management more scientific and effective, reduce operation cost and increase revenue. On the other hand, it also makes parking for drivers more convenient and more targeted.

VI. CONCLUSION

Nowadays, the problem of parking becomes more and more serious, and the traditional parking management has some limitations, which can't well meet the interactive needs of drivers, parking facilities and information flow. Therefore, in the big data era, intelligent parking management becomes more important. In particular, the advanced parking guidance system can effectively alleviate the problem of parking difficulty, promote the sustainable development of urban traffic, and make urban traffic safer and smoother.

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