Research on Intelligent Parking Management System of Urban Roadside

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ABSTRACT

Static traffic, as supplementary dynamic traffic, plays an equally important role in the development of modern city transportation. Because the urban land resources are very limited, the parking problem has been the focus of the city management department, while the traditional off-road parking has been unable to meet the requirements of the development of the city parking. This paper will introduce a roadside parking way, the front end detection device to video as pile, combing the basic business processes of roadside parking, and build a complete cloud platform to deploy the network topology, and then realize the communication between front-end video detector and cloud platform according to the specific business needs, and ultimately to achieve the real unattended of parking, timing and charging.

INTRODUCTION

In recent years, with the rapid growth of urban car ownership, the proportion of parking space supply and demand is seriously imbalanced. According to the international urban construction experience, the number of parking spaces and the number of motor vehicles is more reasonable ratio of 1.2:1. According to the city statistics, in April 2013, the number of motor vehicles in main urban area of Hangzhou has exceeded 1 million, but the existing parking spaces are only about 400,000; In February 2012, the number of motor vehicles in Beijing more than 5
million, but more than 1.47 million parking spaces, there are more than 1 million parking spaces in the unmanaged state, the parking gap reached 2.5 million. As of March 2012, Tianjin motor vehicle ownership reached 2.665 million and motor vehicles on the growth of more than 30,000; the Tianjin Binhai District is about 600,000 vehicles a day and is growing at an annual rate of 15% a year[1]. Generally, the proportion of urban parking spaces and motor vehicles is about 10% ~ 20%. Even if the "advanced" cities are only 30% ~ 50%, which can not meet the requirements of the development of modern urban traffic. For the closed parking lot (mainly shopping malls, hospitals and other underground parking lot, and the off-road centralized parking lot) management, the current solutions have become more mature, but for outdoor roadside parking management is still a lack of effective solutions[2,4].

Compared to the dynamic traffic problem, the static traffic problem is not only a city traffic problem, but it is a problem of city land utilization rate. For the construction of modern cities, the land resources are very limited. It is impossible to build enough off-road parking lots to meet the needs of the static traffic. With the accelerated pace of people's life, roadside parking as the road side parking an auxiliary and supplement, more and more highlights the importance and necessity of its existence[4].

The urban roadside intelligent parking scheme was studied in this paper. It is based on the video intelligent identification technology and mobile Internet technology, the use of front-end video detection equipment to automatically obtain the parking spaces of the vehicle information, through the network and platform for communication, the system automatically time billing, the drivers use a smart phone terminals through the WeChat public number, the client side of the way to obtain parking information automatically and complete self-service payment model, in order to achieve roadside public parking automatic management[5,6].

ROAD PARKING SOLUTION STATUS QUO

Along with the advancement of the city roadside parking, there are a variety of solutions on the roadside parking. From the beginning of a single pure artificial custody berth mode, gradually derived by meter[3], magnetometer detector + POS terminal, and then the full use of video detector automatic data acquisition mode. The ideas of the various solutions have their advantages and disadvantages, and there are shown in TABLE I:

To sum up, in view of the current needs of the development of urban intelligent traffic management, the use of video mode is undoubtedly the best scheme to solve the problem of city static traffic roadside parking. The program adopts the popular video recognition image processing technology and mobile Internet technology to realize the collection and processing of vehicle information, record the original data of parking and the evidence of parking photography. So as to realize the intelligent mode of automation, unattended, traceable, open and transparent, completely cater
to the needs of the development of modern urban wisdom parking in order to solve the urban road traffic and to facilitate the travel of the owners to provide a good program reference\[2,6\].

<table>
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<th>Billing mode</th>
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<td>Advantages</td>
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<td>Disadvantages</td>
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<td>Manual model</td>
<td>The use of pure care of the berth and complete the time / time charges, each of the tolls can only manage about 30 parking spaces.</td>
<td>The System construction costs are low, just in the toll section of the berth, you can charge.</td>
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<td>The toll management of parking parking lot less, low efficiency, and the labor cost is higher; There are serious leaking phenomena in terms of costs; The original means of management is easy to cause the dispute.</td>
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<td>Meter mode</td>
<td>Domestic from Hong Kong, using a meter device management 1-2 parking spaces by the owner to complete the punch card billing. It has been piloted in Jinan, Zhengzhou, Tianjin, Changshu etc., but mostly failed in the end.</td>
<td>The manual management berth is omitted, and the magnetic card is unified by the owner, to improving the automation degree of the parking fee.</td>
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<td>Each meter equipment construction costs ranging from 1.5-2 million, the system construction costs are higher, the price is low; The car owners can only use the card payment, promotion difficulties, ease of use; It needs the maintenance personnel with relevant technical knowledge are required to maintain and increase the overall cost.</td>
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<td>Geomagnetic + POS terminal mode</td>
<td>Using the geomagnetic sensor as the vehicle detector, manual entry vehicle information generated parking orders, to record the vehicle into the platform, and leaving time and expenses according to the accounting rules, the owners pay parking fees by cash, App and other forms. It has been piloted in Taizhou, Xuzhou etc.</td>
<td>The whole business process requires the participation of the car owners and the managers, and the questions of owners can be resolved in a timely manner. It aims to enhance the trust of the owners, which is in line with the current requirements of the development of China's parking.</td>
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<td>Geomagnetic detector using battery power supply, the latter part of the maintenance costs are higher; In operation, it requires more on-site personnel, and comprehensive operating costs are higher; Moreover, there are many disturbances in the geomagnetic detector, such as false alarm and non-alarm etc., which leads to the management of the tollers.</td>
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A video inspection device is used to identify the license plate scheme, to identify each vehicle in the berth, and to record the time of the vehicle entering and leaving, and capture the evidence picture. Owners can complete the payment by smart phones, city cards and so on. It has been trial run and formally applied in Changshu, Zhengzhou and other places.

It can realize the personalized collection of vehicle information and obtain the unique ID of the vehicle through the license plate information. It can be identified a variety of non-standard parking behaviors; It is easy to connect with the Internet fee management system; The pictures can be used as evidence of illegal parking, which can be used to implement non-scene law enforcement and reduce human intervention.

The initial construction cost of the whole system is high, and it needs a trial operation for a period of time before it can complain about the market application. Moreover, it needs the long-term operation and maintenance staff to deal with the user's complaints or questions.

**BASIC BUSINESS PROCESS OF ROADSIDE PARKING**

Taking the basic business at this stage has been the end of the test run and formally put into use, Changshu roadside parking site in Jiangsu as an example to further illustrate the general process automatic processing of video mode: The two basic processes of parking are the stopping and leaving of vehicles; The basic operation of the platform is divided into whether the owner is a registered member and whether the vehicle has an order of historical arrears. The front-end video detector completes the collection of the parking berth information, and the platform performs the corresponding processing according to the data collected by the front end, and feedback the result to the front, so as to complete the information interaction and form a closed loop process.
Order Creation

According to the above Figure 1 analysis, the video equipment detected after a vehicle berth, then the vehicle information collection (including the license plate number, vehicle local pictures, etc.), after the information is collected, the system will gather up the heartbeat data upload to the cloud platform via network, and the cloud platform processing the information data according to the specific requirements. Such as: (1) Whether the owner is a registered member, if not, the platform will judge the results back to the front-end equipment, video piles can be displayed in the form of light control to the owner, to remind the owner need to...
register members, at the same time, it will generate the corresponding parking order time billing in the background database, if the user is a member, then the next judgment (if the detection is non-members, will also be the next step to judge); (2) Whether the vehicle has a history of unpaid orders, if not, the system generates a parking order for time billing, if present, then inform the video pile in the form of light to remind the owner to pay historical arrears, at the same time to generate parking orders for timekeeping fee.

The End of The Order

According to the above Figure 2 analysis: The video pile detected the berth has the vehicle to leave, and will leave the data to upload to the cloud platform by the network platform, and the cloud platform carries on the departure and charge according to the requirements of the business. If the owner is not a registered member, the parking order is completed directly, and the order shall be placed in arrears. When the vehicle parking again, the vehicle will enter the business judgement. If the owner is a registered member, the system will judge the membership account balance. If the balance is sufficient to pay for the parking fee, the system will automatically deduct the fee or prompt the user to pay the parking
fee; if the balance is not enough to pay the parking fee, the system also direct the order for the arrears state, member users can be through the client APP or WeChat public number and other means to pay the cost of the arrears order.

**Handling of Arrears Orders**

In particular, the handling of the arrears of the vehicle is the last step in achieving the closed loop of the parking order and is a more critical step. The effective handling of arrears orders can better ensure the integrity of the whole system, to avoid the phenomenon of owners using the system’s loopholes malicious arrears and intentional evasion. For the parking fees, the local government departments should be planed, approved and assigned to the operating companies to manage. Therefore, the management of the whole system can realize the linkage with the city public security system, which can guarantee the effective management of the orders for arrears to a large extent.

For non-members users existence of lack of order, when generated the parking order for the next time, according to the video pile lamp control tips, the user can download the APP, or concern about the WeChat public number, registered members and recharge, after check the arrears and make payment. In addition, the operating company should organize the background operation and maintenance personnel on a regular basis arrearage carding and statistics. If non-member users arrears orders up to a certain amount, we can coordinate with the city public security system implement the corresponding treatment measures for low credit users. For member users arrear exists, which itself can recharge the payment through the APP or WeChat public, and if the arrears reached a certain amount of unpaid, the background can remind users to pay arrears in a timely by sending SMS, APP or WeChat public number push message, but also in conjunction with the public security departments to implement the corresponding treatment. Therefore, for the city road charges, it is necessary to coordinate with the relevant departments of the government to ensure the long-term and benign operation of the whole model.

**CLOUD PLATFORM DEPLOYMENT TOPOLOGY**

The following Figure 3 is a set of relatively complete cloud platform deployment network topology diagram according to specific business development requirements and the overall parking process architecture. This system combines the front-end video information collection equipment, data transmission network (including Internet, 4G network, wireless WIFI and other forms), cloud platform services (covering database services, application and interface services, cache and storage services, WeChat public service, etc.), and APP, short message and WeChat client and other data display terminal, constitute a more complete system structure framework[8,9]. Specific deployment framework is shown in Figure 3:
Parking management cloud services platform deployment architecture plays a very important responsibility throughout the city roadside parking operation system, to provide services for each parking management party. Its effective make video detection front terminal together with the user group, on the one hand, it can ensure each parking berth field information to be process in real-time and rapid feedback; On the other hand, it also can guarantee for the owner's needs or request a timely and accurate processing, to provide friendly service. The main functions of the whole system are:
Automatic Video Detection

The method of video detection is used to detect the vehicle status of berth, which can automatically identify the vehicle's entering and drove away, and complete the recognition of the license plate. Using ultra-low illumination 1.3 million or 200 million pixel CMOS sensor, providing high-quality images, to adapt to a variety of complex monitoring environment. Finally it can achieve all-weather high-precision vehicle detection and identification. At the same time, it is highly integrated with the intelligent detection algorithms, video imaging units, and complementary optical units. Compared to the early meter equipment, this model has the advantage of high reliability and low cost. In addition, it also supports data uploads such as MQ message middleware, HTTP, FTP, etc., and its central system has flexible access to data and images such as license plates and models.

Processing of Parking Information

The rapid and accurate handling of berth data is one of its heavy tasks. For the whole system architecture, all the data of parking berths need a cloud platform to do the corresponding processing. For example, the real-time information of the berth sent by the video detection equipment needs the platform to carry out the processing of the business, after processing, and feedback to the equipment. The processing of the berth vehicle order, including the time stamp of the order and the information of the member user, etc.; the users can be triggered by the WeChat public number, APP, etc., registration, inquiries and payment, and so on. These are submitted to the platform through the Servlet to complete the processing and operation and feedback processing results, which not only requires the real-time processing of these data, but also ensures the accuracy of processing those results.

With the deepening of the Internet business, mobile payment has gradually become a mainstream consumer habit. Therefore, for the application of urban roadside intelligent berth, the client not only provides the function of inquiry the parking information, but also should realize the payment function of the parking fee. Owners do not need cash transactions, and they can directly through the way of the mobile APP or WeChat public number, to achieve Alipay, WeChat, UnionPay cards, membership accounts balance and other electronic means to pay the parking fee online. After the owners pay the cost, the system will send text messages for users. So as to enhance the turnover rate of berths, and avoid the low efficiency of the charges caused by parking access congestion, but also improve the owner of the payment of intelligent, without on-site charges of intervention, to a certain extent, there are saved labor costs[9].
THE ADVANTAGES OF THE SYSTEM

The system uses intelligent road management system based on front-end video detection technology, cloud platform data service, and information display terminal. At present, it has been put into use in Changshu, Jiangsu. It has analyzed the performance of the site in the last four months. Compared with other roadside management system, the system has the following advantages:

1. The front-end uses video detection equipment, integrated camera acquisition module, lamp control indicator module and night lighting module. It is a high degree of automation, eliminating the need for manual participation, effectively reducing the operating costs, to achieve a real unattended.

2. The system retains the owner’s parking data and the record of the image collected at the site for the late owners contribution or complaint handling credentials. In addition, the pictures can be used as evidence of illegal parking, for non-standard parking, malicious arrears and other acts to achieve off-site law enforcement and to reduce human intervention.

3. The management departments can obtain the charging data and various types of management information quickly through the platform. Provide a basis for the next parking planning, and we can expand the operation of the public security department in the future.

4. The owner can inquire about the vehicle parking and payment in real time through the smart phone terminal (APP, SMS, WeChat public number etc.), to realize the transparency of the information.

5. According to the analysis of the operation and maintenance personnel in Changshu, the number of video berths of the official fee operation has reached more than 600, the recognition rate of video detection is more than 99.05%, and the turnover rate of berth is increased to about 2.5 times, and the turnover is greatly enhance the speed, to some extent, which was accelerated the roadside promotion and application of video detection mode.

CONCLUSIONS

At present, the research on intelligent parking of urban modernization in our country is still in the stage of development. With the development of urban economy and the deepening of intelligent transportation, the study of intelligent road berth system on the road side of the city will provide a strong support for the rapid development of China's socialist economy and the development of urban integration.

Throughout the development of urban intelligent transportation in recent years, the development trend and prospect of urban intelligent parking management system are mainly in the following aspects:

1. The parking position induction and reverse vehicle search guidance are achieved, which reduce the time of searching a berth for the owner and ease the traffic congestion.
(2) Full realize the online electronic payment, and achieve complete berth unattended, automatic charging.
(3) Parking information of car owners to achieve data sharing and breaking the information island.
(4) In the future, it can be combined with the charging piles to provide charging services for electric vehicles.
(5) Through the intelligent parking, we have derived more secondary service products, to achieve industry exchanges and penetration.

REFERENCES