Research and Design of Indoor Parking Guidance System for Urban Traffic

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Abstract: In view of the existing drawbacks of indoor parking guidance system in commercial areas, this paper designs an indoor parking guidance system suitable for urban traffic. The owner first selects the appropriate parking lot through the Mini Program, and reserves a detailed parking space on the Mini Program, and after arriving at the parking lot, the Mini Program performs optimal path planning according algorithm to guide the owner to find the parking space. After arriving at the reserved parking space according to the prompts, the smart parking lock is unlocked by "one-key unlock", and the video detection system observes the parking behavior in real time to avoid the occurrence of illegal parking. At the same time, voice assistants and blind spot guidance facilities are also provided during the induction process to optimize the urban parking guidance system.

Keywords: Urban Transportation; Parking Guidance; Functional Design; Indoor Parking

1. Introduction

In recent years, with the continuous improvement of people's living standards, the demand for motor vehicles in China has also continued to rise rapidly. The number of motor vehicles in various countries and regions has shown a rapid growth trend. The gradual increase in the number of cars has brought people convenience to travel on the one hand, and has also caused problems such as parking difficulties and traffic congestion on the other hand. However, in many urban indoor parking lots, drivers often consume a lot of time looking for parking spaces due to insufficient terrain and inaccurate parking space information.At present, the problems exposed by the indoor parking guidance system are as follows: First, the information collection of indoor parking lots, the release of vacant parking space information and the guidance of driving paths have not been uniformly managed. Due to the large number of indoor parking lots in the city center, car owners cannot find the parking lot that best suits their current situation for a while. At the same time, no parking software can link the owner's location with the parking space in real time and provide point-to-point path guidance. In addition, there are many blind spots in the parking lot, which is prone to traffic accidents. Illegal parking cannot be avoided.

2. Literature review

With the rapid development of digital intelligent transportation, artificial intelligence, big data combined with transportation will become a major theme of future transportation engineering. Luyang Gong and Zhijun Zou of Tongji University used ArcGIS development tools and Viusal Studio and SQL Server relational database to design an integrated multi-functional urban parking planning management system to further carry out parking demand forecasting, planning schemes and other functions[1].In his master's thesis at North China Electric Power University, Hongbo Zhou proposed a dual-band WIFI positioning algorithm based on threshold selection to distinguish the dual-band WIFI signal from the signal positioning in the underground parking lot, which greatly reduces the construction cost of the WIFI fingerprint database, thereby effectively improving the positioning technology in the parking lot[2]. Xue Wang, Xianqing Shen and Haibin Li of Heilongjiang University of Science and Technology proposed the research of intelligent parking guidance system based on Internet of Things technology, which combines the parking vehicle collection system and the parking guidance system according to certain logic, and then optimizes the urban parking guidance system and alleviates the parking pressure caused

by vehicles.[3] On the whole, the implementation of indoor parking guidance technology should rely on the design of smart parking lots, Ruifeng Ding once proposed the design and implementation of intelligent parking systems in his master's thesis of Zhengzhou University, including, parking space identification system, parking space status system, parking lot control terminal, cloud management, etc.The construction of intelligent parking lot is undoubtedly the best carrier structure of parking guidance system[4].

2. System design

The parking guidance system designed in this paper is divided into two parts: software design and intelligent facility design. The software part mainly relies on the form of mini programs, which is convenient and concise; The intelligent facilities part mainly includes intelligent parking space ground locks, blind spot indicator screens, etc. Through the network construction in the parking lot, the small program and intelligent facilities are reasonably combined, so that the entire parking guidance system system is more perfect.

2.1 Design of the Mini Program

The interface design of the mini program is beautiful and generous, the design ideas are clear and reasonable, and the combination of in-depth analysis and map of modern parking problems can help drivers find the nearest parking space in real time, query personal consumption, and find their specific parking location. On the one hand, it saves users the time of finding parking spaces, and on the other hand, it assists in strengthening the management of parking lots.The relationship between user and administrator is expressed through the software use case diagram, as shown in Fig.1.
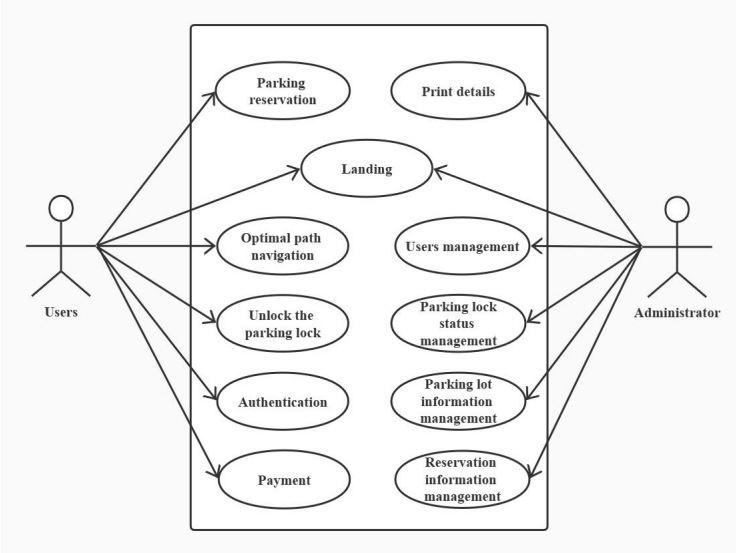

Fig.1 Use case diagram

The parking guidance applet should cooperate with the background management system for corresponding management, according to which the corresponding database E-R diagram is designed to determine the relationship between various entities，as shown in Fig.2.
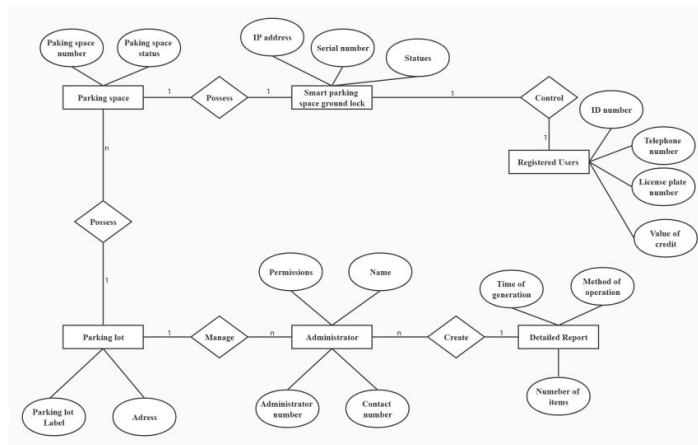
Fig.2 E-R diagram of the background management system

2.1.1 Main module design

Mini Program login module：The owner registers and binds through a mobile phone number or WeChat, and then uploads his driver's license and ID card on his personal homepage.

Parking space reservation module：After choosing the appropriate parking lot, the owner enters the parking space reservation module of the parking lot, and selects the parking space he wants to reserve by finding the parking lot distribution map, and the reserved parking space can be marked in red and the unreserved parking space can be marked in white in the distribution map for easy identification.

Voice navigation module: When the owner arrives at the parking lot, the voice navigation module can be used to navigate the owner in real time to facilitate the arrival of the reserved parking space, and the mini program also turns on the real scene navigation to display the route planned by the system using the optimization algorithm in real time.

Parking unlock module: When the owner arrives at the parking space according to the navigation instructions, he can press the function of one-key unlock of the mini program to unlock the intelligent parking lock of the reserved parking space, which comes from the concept of "sharing bicycles" unlocking, which can not only share the parking space, but also reduce the phenomenon of parking space preemption and incomplete parking information.

Charging and top-up modules：Car owners can recharge money in the wallet of the mini program, and when the parking space is used, they can automatically deduct fees in the background, and also check the balance in real time through the platform.

2.1.2 Parking guidance mini program structure design

The structure design of the indoor parking guidance applet is shown in Table 1

Table 1   Structure design of parking guidance applet

Feature page	Function key name	Description
Personal center management	Purse	Users can customize the denomination of recharge to the wallet, and at the same time can see how much change is left in the wallet.
	Real-name authentication	The owner needs to fill in personal information and upload a photo of the relevant document
Home	One-click unlock	The user can unlock the smart parking space lock by pressing the change button
	Voice navigation	The applet converts the planned route into a voice module and displays the optimal route at the same time.

	Information query	The owner can see the distance of the nearby parking lot and the remaining space of each parking lot
Parking reservations	Appointment selection	The user makes an appointment to select the appropriate parking lot and parking space

According to the above functional modules, the parking guidance system page of the indoor parking lot is planned and designed, with orange as the theme color, navigation buttons as the home page, parking space reservation page, and personal center page. The layout is simple and clear, which is convenient for users to operate.

2.2 Design of smart facilities

In the current parking guidance system, car owners always drive blindly into the parking lot when they do not know the parking space, which is easy to cause vehicle congestion in the parking lot. At the same time, it will also lead to the occurrence of uncivilized phenomena such as car snatching. In addition, because most of the indoor parking lots are built underground and the space is limited, the blind spots are inevitable, and the above situation needs to be alleviated through the establishment of certain facilities.

2.2.1 Smart parking space ground lock

The center of the smart parking lock presents a capital "G" letter, which means "guide - guide" in English, which is a detailed design that fits the core of the project. The smart parking lock adopts a wireless communication protocol to interact with the data in the background. Internet network access smart parking lock wireless communication network. Since the basis of the Internet is TCP/IP protocol, it is very important to use the gateway to realize the conversion of external TCP/IP protocol to intelligent parking lock wireless communication protocol, and the technical structure of intelligent parking lock is shown in Fig.3.

When not in use, "G" stands upright to lock the parking space. When the user unlocks through the mini program, "B" slowly descends, and the mini program displays that the parking space has been unlocked. If the parking space distribution map on the mini program will be displayed in white, it means that it can be reserved; If the parking space distribution map of the mini program is displayed in red, it means that the reservation cannot be   selected.
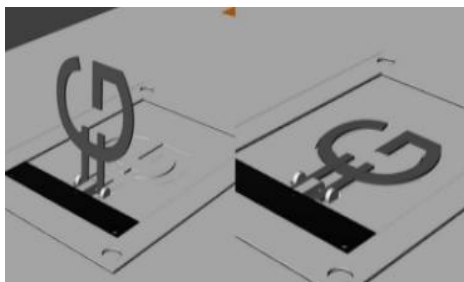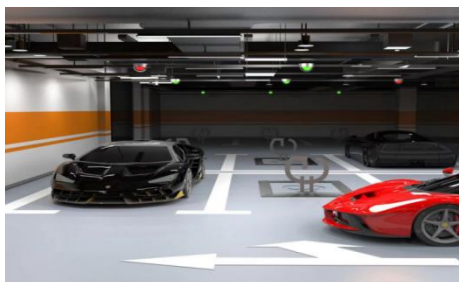

Fig.3 Smart parking space ground lock design

Fig.4 Scene application diagram

2.2.2 Blind zone induction structure

There are many blind areas in the parking lot, such as the double spiral entrance and exit of the underground parking lot is a blind area, when driving into the parking lot, the turn is not clear about the opposite lane, if the two drivers do not pay attention then it is easy to have a traffic accident.

In addition to the above-mentioned double helix blind zone, the wall structure of the parking lot is also a blind zone, and a device that combines radar detection sensors and guidance signs is designed to solve this problem. The vehicle's safety is ensured by radar that detects the distance of the vehicle in the blind lane and then displays the result through signs. Taking the wall blind zone of the parking lot as an example, the design decided to place the device above the corresponding blind zone in the parking lot to facilitate the driver's observation.The specific logic explanation is as shown in Figure 5: Take vehicle A as an example. Because of the barrier of the wall, it is impossible to observe the driving of vehicle B. If the driver is distracted, vehicle A and vehicle B may collide. However, if the radar is added to the graphic position to detect and display

the indicator screen, Car A can know the specific situation of the blind area in time, which greatly reduces the possibility of accidents. It ensures the safety of each car owner in parking guidance.
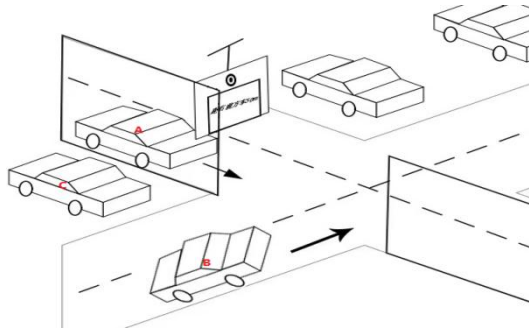

Fig.5 Scene application diagram   Fig.6 Scene application diagram

3. Conclusion

With the birth of the concept of "digital intelligent transportation", intelligent transportation mode will gradually replace the traditional transportation mode. In the future, the development of intelligent parking guidance system will be in-depth research from the perspectives of "intelligent optimization algorithm", "intelligent equipment development" and "cloud data sharing". At present, in order to alleviate traffic pressure, many cities in China have introduced policies to solve the problem of smart parking in urban commercial areas, with the promotion of policies, the field of smart parking will continue to expand, which is a key part of the intelligent development of cities in the future.

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Weiming Wu and Jiankun Li made the same contribution to the article, and both are first authors