

# A review of research on intelligent parking lot management systems

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## Abstract

**Facing the increasing car ownership, the increasing lack of land resources in major cities, low parking turnover and parking difficulties, emerged. With the rapid development of the Internet of Things, big data, the mobile Internet and other technologies, the design and development of intelligent parking lot management system is gradually solving these problems. This paper summarizes the design of intelligent parking lot management system and the development situation of the actual application of intelligent parking lot, and summarizes the development trend of intelligent parking lot management system.**

## Keywords

**Intelligent parking lot, management system, the Internet of Things.**

## 1. Introduction

With the sustained upward growth of China's economy, the demand for motor vehicles and vehicles has also grown rapidly, and the construction of parking lots has gradually lagged behind, which has become the "bottleneck" of China's urban transportation development, how to park? How to manage the relationship between empty parking spaces and vehicles will eventually become the main contradiction of urban transportation in China, and parking industrialization and intelligence will become the main way to solve the contradiction [1]. The proposal of building a smart city and building a transportation power affirms that smart parking is an indispensable part, but it faces many practical problems, so it is urgent to study a set of management systems to solve the current situation of difficulty in finding cars, slow parking, and payment queues[2]. With the development of modern information technology, the combination of computer technology, communication technology, Internet of Things technology and parking lot management, the establishment of an intelligent parking management system is one of the effective ways to solve the user parking difficulties and improve the utilization rate of urban parking spaces.

Therefore, the intelligent parking management system is the direction of the future development of the parking lot, which will maximize the utilization rate of parking facilities resources, alleviate the problems of urban parking difficulties and "urban traffic diseases" to a certain extent, and will greatly promote the construction of smart cities and further improve the quality of cities and management service levels [3].

## 2. The development status of intelligent parking lot management system

Intelligent parking lot management system is a collective term for the automatic management of vehicle charging and equipment in modern parking lots. Integrating inductive smart card technology, computer network, video surveillance, image recognition and processing and automatic control technology, the vehicle in the parking lot is automatically managed, including vehicle identity judgment, access control, automatic identification of license plates, parking space retrieval, parking space guidance, car reminder, image display, model proofreading, time

calculation, fee collection and verification, voice intercom, automatic collection (receipt) card and other series of scientific and effective operation. High-tech mechatronic products that place the parking lot completely under the unified management of computers. It takes the induction card IC card or ID card (the latest technology has two cards compatible parking lot) as the carrier, through the intelligent device to record the vehicle and the cardholder's access to the relevant information, while its information is calculated, transmitted and converted into a signal that can be identified and judged by humans through the character display, voice broadcast and other human-machine interfaces, so as to effectively control the entry and exit of vehicles and personnel, record all details and automatically calculate the charging amount, and realize the safety management of vehicles and charges in the field [4].

### 2.1. Intelligent parking lot identification technology

Vehicle identification is an important part of entering the parking lot, the traditional manual registration is time-consuming and laborious, often causes the parking lot entrance and exit blockage, reduce the service level, and the automatic recognition function of the vehicle can greatly improve the work efficiency. At present, RFID-based radio frequency identification technology is the most novel and widely used, and the combination of RFID-based automatic identification technology with carriers, servers and other equipment is also a hot spot in current research.

W.H.Xu summarized the current intelligent parking lot vehicle identification technology based on LabVIEW and RFID technology, RFID technology as the rise of automatic identification technology in the new era, the current rapid development of application prospects, LabVIEW as a carrier can communicate well with the next computer, to achieve intelligent management of parking lots. An intelligent parking lot management system based on LabVIEW and RFID technology actually uses RFID readers and high-frequency electronic tags to manage the entry and exit of vehicles in the parking lot. Write with LabVIEW as host software [5]. Y.Y.Sun and F.Li designed a convenient and efficient parking lot access control automation management system based on RFID and BOA servers, which uses virtual machines under the Windows system for Linux C/C++ programming under the system to build the architecture of the program, the use of HTML to write front-end web code, the use of SQLite database to achieve the database addition, deletion, modification and other operations, the overall project is S5PV210 The chip-centric development board is done, combined with RFID radio frequency identification technology, while remotely accessing vehicle information through a BOA server. The test results show that the system can run stably, is easy to use, has high safety performance, and is very practical [6]. B.W.Zhu proposes the research and application of face recognition technology based on deep learning for the current intelligent parking lot charging system based on license plate recognition technology for unlicensed cars cannot be recognized, and deck cars evade fees, and effectively identifies vehicle identity information according to the face image characteristics, through the face detection algorithm and vehicle attribute analysis algorithm. The research of the face recognition algorithm and the research and development of the intelligent parking lot charging system, and then the design and implementation of the intelligent parking lot charging system, the system not only effectively solves the problems of unlicensed car recognition, deck car evasion and other issues, but also provides the "face payment" function, providing an example for innovative applications in the field of parking lot charging [7].

### 2.2. Intelligent parking lot parking space guidance technology

With the increasing number of cars, the size, management and intelligent requirements of the parking lot are getting higher and higher, the commercial area, residential area of the parking lot scale requirements are greater, the traditional navigation software can only help you find the location of the parking lot, and how to enter the parking lot after the nearby, convenient,

efficient to find the parking space, which requires the assistance of intelligent parking space guidance technology. Parking space guidance technology is generally based on parking space information collection of hardware devices and Internet-based software to connect with users. J.L.Yang in the Internet-based intelligent parking space guidance system research, developed a set of intelligent parking lot guidance system, the system first uses magnetic flux sensor to solve the problem of parking space information strategy, and then designed and implemented two key parking space information hubs with communication functions and parking space information set hardware equipment, and finally completed the submission software design of a single parking space information from the parking lot server to the cloud server. In the Internet-based environment, a communication channel between the cloud data submission software and the WEB server is established, which realizes the collection and submission of multiple parking space information hub data by the parking information collector and the data collection of multiple magnetoresistive sensors controlled by one parking space information hub [8]. However, in the design of the intelligent parking space guidance system, it is limited to "one in and one out", and for "more in and more out", it is necessary to add a license plate recognition device to plan a specific driving route for each vehicle according to the license plate number. G.H.Zou and Y.J.Geng summarized several techniques that use the indicator light as an indicator to indicate the driver's idle parking space, one is the ultrasonic parking space guidance system, which is mainly emitted by the ultrasonic detector from top to bottom, detects the parking space situation, and transmits it to the computer system of the management center, so as to display the remaining information of the parking space on the display screen and effectively guide the traffic flow. The second is the video parking space guidance system, which can use the camera to detect the parking space, above each parking space is equipped with a camera that can identify the license plate and determine whether the parking space is idle, the license plate number can correspond to the parking space, saving the marking time, enhancing the practicality of the system, and guiding the vehicle to quickly find the parking space by displaying the information of the vacant parking space displayed by the conspicuous red and green indicators and the display at the fork [9,10]. However, the way this kind of indicator indicates information is better for indoor parking lots, and for outdoor parking lots, the indicator lights are not easy to see when the sun shines, and the installation of ultrasonic detectors in indoor parking lots is more complicated, so the way the indicator lights indicate information has certain limitations and drawbacks. R.M.Huang in the parking lot intelligent parking guidance method and system research design proposed a parking guidance system based on license plate recognition and positioning, this design is generally used for indoor parking lot positioning and navigation, it is in the parking lot of each road node to arrange the license plate recognition camera, each camera has an ID number and the location coordinate information of the parking lot to establish an association relationship. When there is a vehicle passing, the camera will capture the license plate number and camera ID number information sent back to the system service end, the system server side of the license plate number information and camera number data processing, because the owner of the car in the registration of the APP account bound to the license plate number, so the license plate number information can be parsed as the corresponding APP account information, and the camera ID number information can be parsed as location positioning information, the server side after data processing will be pushed to the corresponding APP account. After obtaining the positioning information, the APP can implement the navigation function by calling the map service [11].

### **2.3. Intelligent parking lot reverse car search function technology**

For the interior of large parking lots in commercial areas, the design of parking spaces is often monotonous, and when returning to find their own vehicles, it is often easy to get lost and

unable to find their own vehicles, affecting the service level and parking turnover efficiency of the parking lot. The reverse car search function of the intelligent parking lot is of great significance to solve the problem of "slow car search" and promote the development of static traffic. In the implementation of the reverse car search design and management system of intelligent parking lot, H.R.Chu discussed the planning algorithm of the shortest path, studied the time-based Dijkstra optimal path planning algorithm, and modeled and simulated, according to the reverse car search process, the transplantation of the time-based path planning algorithm was realized on the WINCE system of ARM11, using the touch screen reverse path induction, so that the user can quickly find the vehicle location according to the display on the touch screen. According to the optimal path algorithm, the optimal path out of the parking lot is given [12]. Z.M.Yang, X.D.Wang, Z.H.Yang and others designed a kind of intelligent parking space guidance system based on STM32F103, this system in addition to proposing a parking space guidance system based on ultrasonic sensors, in the reverse car search, proposed to use a digital tube to display the parking space number, with a buzzer to remind the owner of the way, the owner remembers the number displayed on the digital tube after parking, and through the specific mobile phone APP for real-time positioning and route navigation and then quickly find their own vehicle, In addition, the system also has a search route function, the owner only needs to click on the start and end point on the mobile phone to come out and accurately navigate the route, which helps the owner to better familiarize himself with the parking lot [13].

#### **2.4. Intelligent parking lot management system based on the Internet of Things**

With the development of Internet of Things technology and people's pursuit of the Internet of Things, more convenient life needs, intelligent parking management system based on the Internet of Things is also a hot topic in recent research, the current more popular is based on the narrowband Internet of Things (NB-IoT) intelligent parking lot management system. NB-IoT has many advantages of low power consumption, wide coverage, large volume and low cost, it is combined with intelligent transportation and intelligent parking lot, can set parking guidance, parking management, vehicle identification, billing management, vehicle query five functional modules as one, convenient for users to park, car search and payment, help parking lot managers grasp the parking lot status, parking total cost, vehicle distribution in the jurisdiction area, etc., to help traffic management personnel understand the real-time traffic conditions of traffic roads, It is convenient for traffic management personnel to provide a basis for vehicle dispatch and dredging traffic roads [14].

Z.P. Wang, G.P. Xu, and Y.J. Hu designed an intelligent parking management system based on NB-IoT communication. The system obtains parking space status information through geomagnetic sensors, and transmits the status information to the cloud through the narrowband Internet of Things; users can view the platform overview and system details in the management interface, add or delete devices and view terminal device information, analyze the data uploaded by the equipment, and prompt the system users to process when there is an abnormality in the device [15]. F.Y.Tan, M.Y.Wang also proposed a smart parking management system based on NB-IoT technology. Through the ultrasonic sensor to perceive the parking information, and the information through the STM32 MCU control unit and NB-IoT module uploaded to the operator's IoT connection management platform, intelligent parking management system from the platform to obtain the parking space sensor reported data, and the use of SpringBoot technology to achieve the issuance of control information, according to the control of the ground lock and other parking control equipment. Users can obtain information about idle parking spaces through mobile devices to quickly find parking spaces, thereby reducing the time to find parking spaces, improving the utilization rate of idle parking spaces, and improving the efficiency of urban transportation [16]. S.X.Su and X.H.Ma also designed an intelligent parking management system based on the Internet of Things. The

system uses geomagnetic sensor technology to detect the status of parking spaces, through zigBee networking technology to send parking information data to the server, aggregating the parking space information of each parking lot in the city, users can view the parking space status of each parking lot in real time through the handheld terminal, and then through the map navigation, to achieve intelligent and efficient parking. And the verification results show that the system can reduce the user's choice of parking lot and parking time, improve the utilization rate of parking spaces, and reduce traffic congestion [17]. X.M.Bo designed a set of Internet of Things, big data and mobile Internet and other technologies as one of the intelligent parking monitoring system, the system can integrate cost and service life and other factors, the use of ultrasonic sensors and three-axis magnetic field sensors combined with the way of parking space data collection, the use of NB-IoT communication technology will send the return information to the monitoring system server, by the server information update, It is then sent to the user's mobile terminal through mobile Internet technology, and finally realizes the efficient management of parking spaces [18].

### 3. Intelligent parking lot management system development trend

In summary, the development of smart parking lots is an inevitable trend based on the background of transportation power and smart cities, and its development must inevitably combine emerging technologies such as big data, The Internet, and the Internet of Things to build intelligent, convenient and efficient new intelligent parking lots.

Among them, vehicle identification technology is currently mainly based on RFID automatic identification technology to identify vehicles, and based on video and video reading technology for license plate recognition and reading, writing, storage; parking lot parking space guidance technology currently mainly has the method of indicator lights and display screens in the parking lot to indicate idle parking spaces, but this method has certain limitations; reverse car search technology mainly has a marker digital tube and the use of touch display to help owners quickly find their own vehicles; the above several technologies are relatively single, For the overall intelligent parking lot management system, the overall service system for parking users is currently based on NB-IoT technology of intelligent parking lot management system, it is based on Internet of Things technology, can realize from the detection equipment to network information transmission, the center control computer information classification, processing, and finally the information is released to the user of a whole service, so that parking more efficient and convenient.

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