

Yunkong Bomi Intelligent Reverse Vehicle Finding System

Ge Jiaying, Xie Siyu, Peng Qihan, Qin Yuanyuan,

Fu Tingyue And Song Xinyue

SILC Business School, Shanghai University

Abstract

This paper focuses on the Yunkong Bomi intelligent reverse vehicle finding system. With the increasing gap between parking supply and demand, this system emerges as a solution. It encompasses a parking management software system with functions such as user management and authentication, parking lot search and selection, space reservation and management, parking guidance and visualization, reverse vehicle search, and vehicle monitoring and payment. The Internet operation platform offers resource integration, data sharing and collaboration, and intelligent scheduling. Intelligent hardware like electronic parking locks and IoT devices play a crucial role in space management and data transmission. The system is applied in commercial areas, hospitals, and office buildings, improving parking efficiency, providing diversified payment methods, and enabling unmanned operation. Overall, it brings significant benefits to both users and parking management.

Key Words: *Yunkong Bomi system; parking management; intelligent hardware; QR code navigation; real-time data interaction; parking efficiency*

Date of Submission: 13-01-2025

Date of Acceptance: 23-01-2025

I. Introduction

Recently, booming car ownership has led to a large gap between parking space supply and demand. The inconsistent supply in time and space also reduces utilization. Thus, parking is a headache for car owners. Plus, lacking guidance and navigation in lots, it's tough for drivers to find spaces and cars. To solve this, our team developed the Yunkong Bomi intelligent reverse vehicle finding system. Using QR code nav and intelligent locks with IoT, it has a user-friendly client and efficient subsystem. Users can reserve, get guided, find cars, book valet, and pay contactless. For managers, it makes space info transparent and automates management, boosting smart lot development. It'll surely benefit both owners and cities. This essay mainly focuses on the function introduction and practical application of this system, aiming to show clearly the efficiency and practicality of this product.

II. Parking Software System Functions

The parking management software system stands out for its comprehensive functionality, as it meticulously combines diverse features to address all key aspects of parking, from user onboarding and space reservation to vehicle guidance and payment settlement. In the context of modern urban transportation, intelligent parking management systems have drawn increasing attention. As stated by Xu (2024) which emphasizes the importance of integrating multiple functions to optimize parking efficiency, our proposed intelligent parking

software demonstrates remarkable comprehensive capabilities. This system, adopting a ¹service-oriented architecture (SOA) and applying the “layered concept” to divide functions, consists of three modules: entrance and exit control, app, and back-end management. It further encompasses five components in the software system: ²Hyper LPR application, web back end, server, database, and app application. The server and database are deployed on Alibaba Cloud servers, ensuring the stability and security of the system.

User Management & Authentication

Firstly, regarding user management and authentication, once users register and log in, they must complete real-name authentication and bind personal details (name, ID card number, bank card information, and mobile phone number) along with vehicle information. This not only lays a precise foundation for subsequent services but also guarantees the accurate matching of user information with vehicle usage records, enabling personalized services, a crucial aspect in enhancing user experience (Xu, 2024).

Parking Lot Search & Selection

Secondly, for parking lot search and selection, the homepage presents recommendations, while users can also conduct manual searches for parking lots near their destinations. By acquiring detailed information such as locations, remaining parking spaces, charging standards, and past reviews, they can make more than informed decisions, which aligns with the concept of informed decision-making in parking management discussed in the cited paper.

Space Reservation & Management

The parking space reservation and management feature is equally significant. After a user reserves a parking space, the Internet back-end server sends a request to the relevant parking as lot, triggering it to update the status. When the vehicle arrives at the entrance, the license plate detector (powered by the Hyper LPR application in part) automatically identifies it and assigns the management rights of the parking space. Once the vehicle reaches the reserved space, the software server commences charging, ensuring an automated and efficient process, which is in line with the automation trends highlighted in the paper.

Parking Guidance & Visualization

In terms of parking guidance and visualization, through the user interface of the mini-program and the display screens within the parking lot, real-time availability of parking spaces is shown. This visual guidance helps users quickly locate parking spaces, reducing vehicle wandering time and enhancing traffic flow within the parking lot, as corroborated by the traffic flow optimization theories in the cited paper.

Reverse Vehicle Search

The reverse vehicle search navigation utilizes QR code positioning and navigation technology. QR codes affixed to the concrete pillars and electronic parking space locks store positioning and mapping information. When users come to retrieve their vehicles, scanning the QR codes allows them to obtain location information

¹ SOA, or Service-Oriented Architecture, is a software design approach. It structures applications as services that can be combined and reused. In intelligent parking, it enables different system parts to interact flexibly, enhancing adaptability and scalability.

² Hyper LPR application: It applies computer vision and deep learning to recognize license plates. At parking entrances/exits, it captures plate images, gets numbers for management ops like matching reservers, recording entry, and triggering gate opening.

and plan their routes, effectively solving the problem of vehicle retrieval in large parking lots, a common issue addressed in the cited paper.

Vehicle Monitoring & Payment

Finally, vehicle identification and monitoring, along with automatic billing and payment, further enhance the system's functionality. The intelligent vehicle barrier can automatically recognize reserved vehicle information, record arrival time, monitor parking compliance, and issue warnings. Meanwhile, the system automatically calculates parking fees based on factors like parking duration, charging criterion, and user credit score, and supports multiple payment methods including WeChat, Alipay, UnionPay, etc., facilitating user payment and assisting avoiding exit congestion, all of which are integral parts of an efficient parking management system as advocated in the cited paper.

III. Internet Platform Advantages

The Internet operation platform has emerged as an absolutely essential component in modern intelligent parking management. In the current era, where the number of vehicles is skyrocketing and the demand for efficient parking solutions is more pressing than ever, the significance of such platforms cannot be overstated. As elaborately expounded in the research paper "Parking, Intelligent Yunkong Bomi system" authored by Jinhui Zhao, Qi Wu, Jie Chen, and Yang Huang, intelligent Yunkong Bomi systems that harness the power of UWB (Ultra-Wideband) positioning and navigation technology and deftly integrate a diverse array of functions hold the key to unlocking remarkable potential in revolutionizing the parking landscape.

Resource Integration

Our proposed Internet operation platform, in strict accordance with this innovative concept, showcases three highly crucial and interrelated strengths. Firstly, the aspect of parking resource integration represents a fundamental building block. By ingeniously interconnecting multiple parking lots to a unified platform, it ushers in a new era of centralized control. From this perspective, administrators are now endowed with the capability to monitor other critical parameters in real time. For example, they can easily measure the use of parking space and this is very important when predicting fluctuations of parking use during a day. Similarly, monitoring of equipment functionality helps to minimize the risk of parking lot equipment failure or its low efficiency in operating features such as entry barriers or lighting systems, as well as payment kiosks. In addition, the details on park income from parking fees, expenditure on maintaining cars, and operating costs that are derived from the financial plan are very useful in managerial decision-making. This is all aided by providing the managers with a unified interface for easy use and a range of tools for decision making to help manage multiple parking lots with incredible ease.

Data Sharing & Collaboration

Second, data sharing and collaborative management represent the core of platform mechanisms. The real-time and virtually autonomic communication between the parking lot platform and particular parking lot management systems ensures the data's integrated and up-to-date quality. Workers in the parking lot whose work involves daily interaction with customers will be able to access information in real time. It allows them to perform essential duties with a high level of effectiveness. In terms of parking space management, they provide the information concerning the existing occupancy in the car park to guide the arrival of the cars to the appropriate available space promptly. In regard to vehicle control and management, it can track the time of entry as well as the time of exit of vehicles, regulate and implement appropriate parking rules, and recognize any illicit or

prohibited operation instantly. On the other hand, platform operators enjoy the access to aggregated and analyzed data to design more general resource type operational strategies. They can discover patterns, e.g., when and where people like to park their car, which parking lots are hottest and when it is most dynamic, and apply that insight to better manage resources, personnel, and promotional campaigns for a general enhancement of the general performance of the whole parking system.

Intelligent Scheduling

Finally, the self-organized platform of intelligent schedules and optimal allocations works perfectly well especially when things get tough. Given that the availability of parking spaces by all parking lots, geographic locations of each parking facility in relation to a given population density, and the traffic flow dynamics of the surrounding eventualities are dynamic factors that are constantly changing, the platform is able to independently and shrewdly connect users to the lots that harbor the least traffic. This becomes very important during the busy periods of the day for instance during rush hour in the business area or before or after special occasions. Thus, optimizing the distribution of parking resources in this manner not only provides an efficient relief to the immediate concerns of congestion that could otherwise frustrate drivers looking for a parking lot to park their vehicles but also helps to achieve greater goals of minimizing unnecessary traffic jams and emissions caused by circular movements in search of parking lots.. In essence, our Internet operation platform, underpinned by advanced technologies and forward-thinking design, is set to redefine the future of intelligent parking management.

IV. Intelligent Hardware In Parking

In the current context of surging vehicle numbers, the parking crunch has become a severe issue, with demand far outstripping supply and existing spaces often underutilized. However, the advent of intelligent hardware, particularly ³IoT-enabled devices, offers a glimmer of hope. As expounded in relevant research, such as “Design of Intelligent Parking Lock for Road Parking Based on ⁴NB-IoT” by Lei Wang, Kunqin Li and “Smart Car Yunkong Bomi system in Smart Cities using IR” by Meenaloshini.M and others, these technologies can revolutionize parking management.

Electronic Lock Functions

Electronic parking locks play a crucial role in empowering parking management. They are designed to interface seamlessly with the cloud server, facilitating real-time communication. When a user reserves a parking space, the server instantaneously relays an instruction, causing the lock to lift and secure the spot. Upon the vehicle's departure, the lock detects the change and alerts the server, which then commands the lock to lower. This two-way communication not only streamlines the reservation process but also ensures optimal space management.

IoT in Parking Ecosystem

Moreover, equipped with photoelectric sensors, these locks can accurately sense vehicle presence. Once a vehicle is parked correctly, the sensor sends a confirmation signal to the server, registering the occupancy.

³ IoT, namely the Internet of Things, is a technology that combines various information sensing devices with the network through the Internet to achieve intelligent connection and interaction between things and between people and things.

⁴ NB-IoT, which stands for NarrowBand Internet of Things, is a low-power wide-area network (LPWAN) radio technology standard. It's designed specifically for the Internet of Things

Conversely, when the vehicle exits, the sensor promptly notifies the server to update the status, maintaining an accurate real-time record of parking availability.

To guarantee uninterrupted operation, electronic parking locks come with an inbuilt self-check mechanism. This continuously monitors crucial aspects like low battery power, abnormal communication, malfunction of the lock arm lifting, etc.) and will immediately send alarm information to the server so that maintenance personnel can handle it in a timely manner and ensure the normal operation of the parking lock.

IoT technology serves as the connective tissue unifying the entire parking ecosystem. The true power of IoT in Yunkong Bomi systems lies in its ability to interconnect multiple devices. In a typical parking lot setup, a plethora of IoT-enabled tools such as electronic parking locks, space sensors, and vehicle detectors are deployed. These communicate wirelessly with the cloud server, leveraging technologies like NB-IoT or LoRa WAN.

The electronic parking locks respond to server commands to control space access, while the space sensors vigilantly track vehicle presence on each spot and relay the data back. Vehicle detectors play their part by sensing vehicle ingress and egress, triggering associated system actions.

All the data amassed by these devices – from parking space occupancy and vehicle movement timings to device health metrics – are encrypted and efficiently transmitted to the cloud. As for here, the server keeps, analyzes, and integrates the information, which constitutes the foundation for real-time, complete, and accurate idea of the parking lot movement, which improves the overall parking lot experience.

V. Application Scenarios

The Yunkong Bomi intelligent reverse vehicle finding system mainly comprises the following components; a client application and an electronic parking lock subsystem. The client application provides such services as parking space booking, navigation, and reversing aid. By using it, users can get real-time information about the parking lots and perform some activities like reservation and payment. The Electronic parking lock subsystem is the pillar of parking space management, command received from server and plays the role of locking & unlocking of parking spaces.

Commercial Areas

In large supermarket and commercial plaza, which may take time to look for empty parking spaces before reaching, the system allows users to do this easily. The reservation function can save users from the inconvenience of driving around the destination area in search of parking space. Regarding the post-shopping, the reverse vehicle finding function allows users place the right position at their vehicle, enhance the shopping experience (Cheng et al.,2024, para 1). For instance, during rush time in a mall we find it difficult to locate a parking space; with the help of system, users will be directed to the nearest parking space that is available.

Hospitals

Hospitals are normally hungry for parking space and people movement normally is very heavy. Due to difficult parking experience, stress will be minimized through the use of the Yunkong Bomi system in patients and families. In an emergency, a rapid parking of vehicle and the quick search for the vehicle may also be useful to medical personnel. For example, if an ambulance is to discharge patients at the hospital the system will guarantee an available parking spot close to the area where the patients need to be discharged.

Office Buildings

Office workers can use the system to book spaces to park their cars in advance to avoid any hassles during their trip to and from their workplace. When newly arriving at the parking lot during peak working hours,

it can play a role in rationally distributing the parking resources and increasing the usage rate of parking spaces. In large office building and with large number of employees, it means that the system can control the parking demand of a specific department or an individual making the parking system more ordered.

VI. Application Technical Features

QR Code Navigation Technology

There are four unique components of the system: QR code positioning and navigation technology. QR codes are installed on the pillars and the applied electronic parking locks are located in the parking lot. Customers can get their location in the parking lot and the location of their automobiles by using their mobile phone to scan the QR codes. These vision-based technologies are easy to use and easy to implement, and its positioning strategy performs well under a low GPS signal environment, for example, underground parking lots (Jia et al., 2018, p1).

Real-time Data Interaction

It is able to detect the remaining parking space in real-time and provide updates of some information including parking lots charges and preferential measures. Other information that can be made available by the app to help the users include historical user ratings on the specific parking lot as well as the recommended distance. Such real-time data interaction makes users have the most up-to-date information to enhance the accuracy of planning of parking.

Intelligent Algorithms

The system offers several smart procedures as part of its design. The parking lot recommendation algorithm also takes into consideration price, distance and user ratings in order to offer the best parking lots to the user. The application algorithm of the judgment of the peak and off-peak periods will allow using experience to choose the most appropriate time for parking. According to time division and user credit system, the intelligent charging algorithm applies differential charging which charges more reasonable.

VII. Application Advantages

Improving Parking Efficiency

The task of offering appropriate parking space information and smooth navigation decreases the total time required by the users in searching parking areas or vehicles. This not only improves the efficiency of individual parking but also alleviates traffic congestion around the parking lot. According to the market analysis in the business plan, the application of the system can effectively solve the problem of low parking space utilization (Jiao et al., 2022, para2)

Diversified Payment Methods

It supports multiple payment channels such as WeChat, Alipay, and UnionPay, and also offers functions like in-field pre-payment and noninductive payment. This provides users with more convenient payment options and reduces the waiting time at the exit. In modern society where mobile payment is prevalent, this feature meets the needs of users and improves the overall operation efficiency of the parking lot.

Unmanned Operation of the Parking Lot

The system realizes the unmanned operation of the parking lot through functions such as vehicle detection, automatic billing, and remote communication. This reduces labor costs for parking lot management and improves management efficiency. At the same time, it also reduces the occurrence of errors and disputes in

the traditional management mode.

VIII. Detailed Application Effect

In the busy business district of the city, office worker Xiao Li is about to go shopping. He opens the "cloud-controlled parking" application, logs in and entered the vehicle management center to confirm the vehicle information. Then he can see the nearby parking lot and the remaining parking space on the home page. Find the parking lot near the destination mall by searching, click on it to view the vacant parking space, select the appropriate parking space and the arrival time to submit the order, and the parking block will be lifted immediately. After arriving at the parking lot, he can quickly park through the small program or display to understand the use of the parking space, the parking sensor recognition information, the rear stop device down, the system records the parking start time. After the shopping, Xiao Li scans the QR code, the system plans the route to find the car, he finds the vehicle, and when he leaves, the sensor recognizes the parking space, automatically calculates the parking time and the fee to complete the payment.

IX. Conclusion

In conclusion, the Yunkong Bomi intelligent reverse vehicle finding system ushers in a new era of parking management. Its multifaceted functions, from the software's comprehensive capabilities to the internet platform's advantages and intelligent hardware support, work in harmony to address the long-standing parking woes. In various scenarios like commercial areas, hospitals, and office buildings, it has proven its worth by enhancing efficiency, offering convenience, and reducing congestion. As urbanization progresses and the vehicle population continues to grow, such innovative systems are not only essential but also a harbinger of a more organized and efficient urban life. With continuous technological advancements and wider adoption, it is set to redefine the parking experience and contribute significantly to the sustainable development of urban transportation infrastructure.

References

- [1] Cheng, L. M., Zhang, S., & Wu, M. F. (2024). Lightweight And Convenient Parking Lot Reverse Search System Design. *Electronics World*, (01), 16-19. <https://doi.org/10.13612/Dzcs.2024-01-004>
- [2] Jiao, J., Yan, C. L., Gou, Q., Shi, W. F., He, B. N., & Shang, Z. C. (2022). "Internet + Wisdom Model" Reverse Car Finding System For Large And Medium-Sized Parking Lots. *China's New Technology And New Products*, (23), 1-2. <https://doi.org/10.13612/Cntp.2022.23.012>
- [3] Jia, X. T., Suo, T. T., & Huang, J. C. (2018). Discussion On The Technology Of Reverse Car Finding System. *Digital World*, (02), 247-248. <https://doi.org/10.13612/Sjism.2018-02-223>
- [4] Xu, H. H. (2020, December 30). Design And Implementation Of Intelligent Parking System Based On Android. Wan Fang Data. <https://d.wanfangdata.com.cn/thesis/D02120740>