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Bin Lian, "Intelligent parking management system based on cloud platform," Proc. SPIE 12506, Third International Conference on Computer Science and Communication Technology (ICCSCT 2022), 125063Y (28 December 2022); doi: 10.1117/12.2661986

SPIE.

Event: International Conference on Computer Science and Communication Technology (ICCSCT 2022), 2022, Beijing, China

Intelligent parking management system based on cloud platform

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ABSTRACT

With the rapid development of economy, the number of vehicles has increased sharply, and the parking problem has become increasingly prominent. By building a parking sharing system, resources are integrated for rational use. Cloud technology, NB-iot communication technology and image recognition technology are used to realize the interconnection of vehicles, parking equipment and parking lots, and increase the functions of reservation and access vehicles, AGV parking guidance, mobile payment, parking information query and so on, so as to seek reasonable and efficient utilization of parking resources and alleviate the problem of difficult parking.

Keywords: Cloud platform, NB-iot, Earth's magnetic field, parking management

1. INTRODUCTION

In recent years, with the increasing number of cars, the problem of "difficult parking" is becoming more and more serious. This problem not only affects the daily life of citizens, but also becomes an important factor restricting the social and economic development of cities and regions. In commercial areas, cultural centers and other high-density activity areas¹, there are problems such as lack of supporting public parking lots, lack of parking Spaces, non-standard parking management, lack of three-dimensional parking facilities and insufficient space utilization². In addition, the timeliness of parking space status information is also extremely important. A parking space management platform with high resource integration, strong timeliness, simple operation and convenience can effectively improve the utilization rate of resources and alleviate the problems faced. This system through the magnetic device, locking devices, cameras garage facilities idle for parking lots, and the use of NB-iot communication technology to transmit data to the cloud server, through WeChat applet can view real-time parking information, and make an appointment to access, AGV car parking guidance, mobile payment, parking information query functions.

2. SYSTEM ARCHITECTURE

The system is mainly composed of the cloud, mesh side and gathering and three parts, the cloud is mainly composed of cloud platform management system, mobile terminal applications (WeChat applet), most of the data to support the service platform, including cloud platform management system which can realize the number of parking lot parking, vehicles and other content monitoring³, and car park management, mobile terminal operations. As the entrance for users to obtain parking resources, the mobile terminal application has the functions of parking space search, vehicle entry and exit management, vehicle reservation, immediate access, parking space navigation and so on, so that owners can quickly and real-time understand the relevant information of parking space, to meet the owners' convenient and fast parking needs. The data support service platform is mainly responsible for providing the required standard business data to the upper application and delivering the control instructions to the lower parking equipment to ensure the effective data flow of the whole system⁴⁻⁸.

The equipment is connected to the network using NB-iot technology, which designs PSM mode, DRX mode and eDRX mode to reduce power consumption and achieve long standby. The NB-iot network supports LTE networks, thereby reducing network infrastructure construction costs. NB-IoT uses time-domain retransmission technology to improve penetration and apply to a wider range of scenarios. In order to increase the number of connected devices, THE NB-iot adopts a subcarrier of 15kHz for transmission to improve resource utilization. Streamlining physical layer instructions; Power-saving mode reduces the frequency of the device occupying the base station. For the application environment of this system, NB-iot technology meets the application situation⁹⁻¹⁴.

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Through geomagnetic, parking lock and camera to monitor the parking space idle state. Ordinary parking Spaces can be monitored by geomagnetic and camera, and some special parking Spaces can be reserved by geomagnetic lock. Image recognition technology can realize license plate recognition, vehicle access monitoring and other functions. The details are shown in Figure 1.

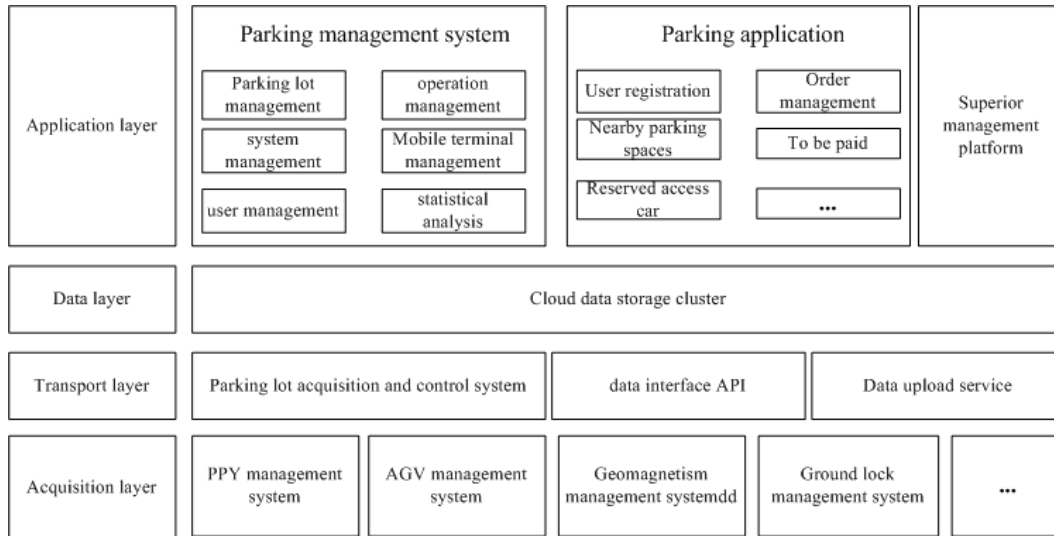


Figure 1. System architecture diagram.

2.1 System management platform

Most of the time in the parking process, from looking for the parking lot to entering the parking lot to find a free space, is spent looking. This system divides the area inside the parking lot and locates the parking space accurately through sensors. The user can be guided into the parking lot by map. The user can view the basic structure, area and idle state of parking Spaces in the parking lot, and guide parking Spaces through AGV induction system to help users quickly find parking Spaces. In order to improve user experience, the system has added many auxiliary functions to provide convenient digital parking services for the public¹⁵.

2.1.1 Parking Lot Management Function Module. Information query function: graphically display the total number of parking Spaces in the selected parking lot or corresponding parking area, real-time free parking Spaces, reserved parking Spaces, used parking Spaces, parking utilization rate, the number of orders on the day, the total number of orders, and the number of vehicles admitted on the day/month/year (Figure 2).

Vehicle information query function: According to the parking lot, license plate number and parking admission time range, the vehicle information of the current day will be displayed by default¹⁶⁻¹⁹.

Information maintenance function: parking lot basic information maintenance, mainly including: parking lot name, parking lot address, latitude and longitude, support models, contact numbers, parking lot introduction, parking lot charging standard configuration information.

Fault management: Queries fault information by device type, fault handling status (unhandled or handled), and fault occurrence time range.

Credit management function: according to the user's parking charge situation, the establishment of black and white list.

2.1.2 Operation Management Function Module. Order query function: Order information can be queried according to entry time range, departure time range, vehicle status, user type and mobile phone number.

Problem feedback function: check the feedback information of the parking lot submitted by users according to the submission time, status and type, and reply to the feeders.

Charging management function: users can choose charging per view, charging per hour and charging per segment according to their own usage.



Figure 2. Order statistical results.

2.2 Mobile terminal management platform

In order to facilitate the use of users, through the development of the corresponding Wechat small program, to achieve intelligent parking and improve the use of efficiency. Users can complete user membership registration by filling in relevant car owner information through mobile phone number or third-party account authorization; Search surrounding parking lots intelligently through mobile phone map, and make intelligent recommendation of target parking spaces according to constraints such as parking distance, parking type, charging ability and charging standard, and complete online navigation²⁰. To realize the parking space reservation in the parking lot, booking the car and vehicle application function; It can realize the path planning and navigation from the current vehicle location to the selected parking lot; Registered users can pay online parking fees through Wechat payment channels. View detailed historical parking and consumption records by day, month and year; Can remind and push the vehicle entry and exit, recharge consumption and other messages; View and modify user name, nickname, address and other personal information; Payment can be made through Wechat (Figure 3).

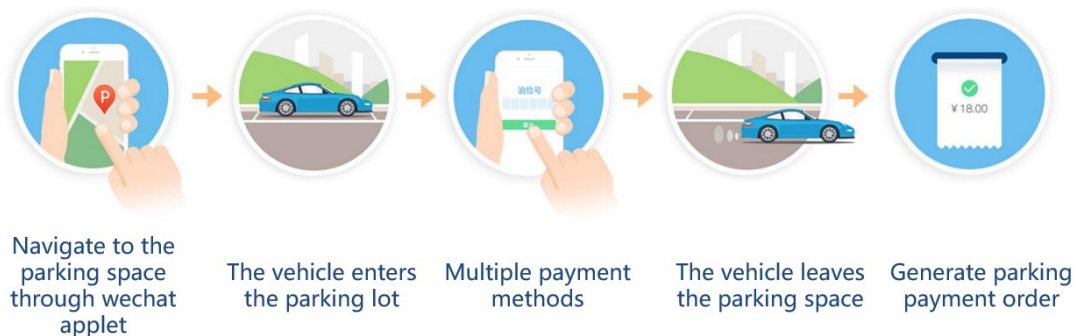


Figure 3. Flow chart of Wechat applet usage.

2.3 Data support platform

An integrated intelligent parking information system is built to integrate the real-time data of major parking lots. Through sustainable business service model, it provides remote monitoring, statistical analysis, data presentation and decision support services for parking managers. Realize cross-regional and multi-level centralized monitoring and management for all kinds of parking parks. Through the continuous expansion of parking applications, to promote the integration of parking information and information technology and intelligent development; Provide multi-layer mobile terminal applications for

the public, so that users can have convenient and comfortable parking experience, and improve the level of public parking information service; At the same time, data can be regularly reported to the superior government management platform to facilitate the construction of smart city and smart transportation, and promote the sustainable development of the parking industry.

2.4 Data transmission platform

At present, the mainstream wireless communication technology of the Internet of Things is mainly divided into short-range wireless communication and long-distance wireless communication. Short-range wireless communication is mainly represented by Wi-Fi, Bluetooth and ZigBee, while long-distance wireless communication is mainly represented by GPRS, NB-iot and LoRa. Wi-fi is deployed on a LAN without wires, reducing the cost of deployment and expansion. The communication distance is limited, the stability is poor, the power consumption is large, the networking ability is poor, its security is also questioned. Bluetooth has some problems, such as incompatibility between different versions, poor security (improved after 4.0), poor networking capability, and radio interference in 2.4GHz frequency. LoRa can be done using traditional cell towers, industrial base stations or even portable home gateways. Base stations and home gateways are cheap to build. But for NB-iot, upgrading existing 4GLTE base stations will be more expensive.

Communication module based on NB-iotas to provide connection management, equipment management, data management, open basic functions such as data, support magnetism, locks and other terminal parking equipment fast access, support customer focus on the application and business innovation, provide link awareness, diagnosis, connection control connection status query and management functions. At the same time, the NB-iot-based communication module also uses unified standards and protocols to connect to the application layer.

3. SYSTEM IMPLEMENTATION

3.1 Intelligent parking cloud platform development

3.1.1 Intelligent Parking Cloud Platform Hardware Environment Construction. Intelligent parking cloud platform hardware environment includes: system host, entrance and exit control equipment, self-service payment equipment, parking guidance equipment, remote monitoring equipment, etc., supporting mobile phones as mobile operating terminals. Figure 4 shows the topology of intelligent parking cloud platform system test platform²¹⁻²³.

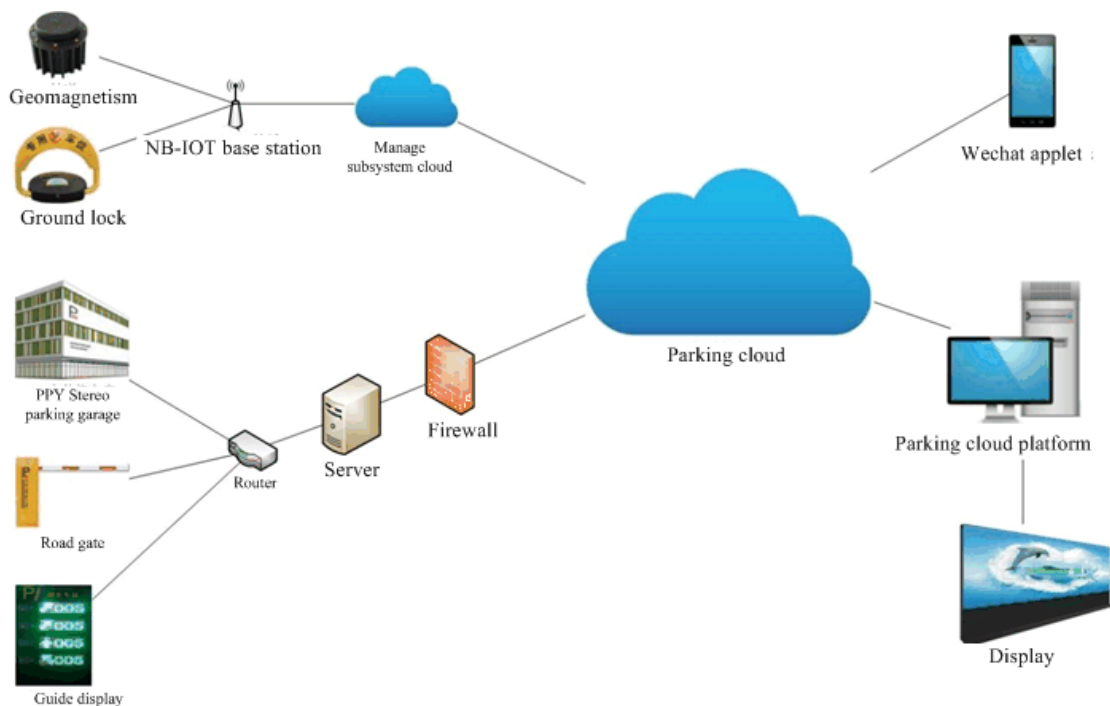


Figure 4. Topology of intelligent parking cloud platform system test platform.

Wisdom parking cloud platform via the Internet will all test equipment to connect, to collect all test equipment of the host data collect information to the cloud platform management system, through calculation analysis, through the cloud platform to realize the parking information release, berth query, induction, stop booking, booking car, mobile payment, such as function or service. At the same time, the status information of all test platforms will be displayed on the monitoring screen of the remote monitoring center.

3.1.2 Intelligent Parking Information System. Wisdom parking cloud platform is mainly composed of intelligent parking management system, intelligent parking mobile client applications (WeChat applet), most of the data to support the service platform, the intelligent parking management system can realize the number of parking lot parking, vehicles and other content monitoring, and operation, wisdom parking mobile application management. Smart Parking mobile terminal application, as the entrance for users to obtain parking resources, is equipped with parking space search, vehicle entry and exit management, vehicle reservation/immediate access, parking space navigation and other functions, so that owners can quickly and real-time understand the relevant information of parking Spaces, to meet the owners' convenient and fast parking needs. The data support service platform is mainly responsible for providing the required standard business data to the upper application and delivering the control instructions to the lower parking equipment to ensure the effective data flow of the whole system²⁴⁻²⁷.

The application layer of intelligent parking cloud platform adopts B/S structure and micro service architecture design, which divides the background applications supporting small program services into multiple services, so that each service can be independently expanded and deployed according to the application scale of each service in the later operation process. And each module is maintained separately, and each service defines the boundary through API to reserve space for future system expansion and maintenance.

The underlying data transmission service is established to realize the interface data standardization between the smart cloud platform and the data support service. For the heterogeneous data of the underlying control system, data conversion is carried out to realize the data synchronization between the intelligent cloud platform and intelligent geomagnetic, intelligent ground lock and planar mobile intelligent stereo garage. With this structure design, the intelligent parking cloud platform of different parking devices in different parking parks can be accessed only by changing the corresponding interface of data support service.

3.2 Realization of NB-iot communication function

3.2.1 Hardware Design. NB-iot technology is a 5G-oriented wide-area cellular narrowband Internet of Things technical standard led by Huawei. It is an emerging technical standard approved by the international organization 3GPP in June 2016. NB-iot focuses on the low-power and wide-coverage Internet of Things market, featuring wide coverage, multiple connections, fast speed, low cost, low power consumption and excellent architecture, and has become an important strategic direction for relevant operators, technology enterprises and industrial alliances to actively layout²⁸.

The COMMUNICATION module based on NB-iot adopts ST series industrial grade 32-bit communication processor, which can meet the requirements of high performance and low power consumption.

The power supply circuit is composed of voltage regulator chip, LDO chip, voltage detection circuit, protection circuit and EMC circuit, which can meet the requirements of safe and stable power supply.

The watchdog circuit adopts hardware watchdog and software watchdog double watchdog design, when the crash, program run away, the program has bugs appear uncontrolled, the watchdog circuit will be forced to reset, so that the program is re-controlled.

The NB-iot module adopts THE B35 full netpass module of Shanghai China Mobile Communication Company (Figure 5).

The NB-iot communication module mainly includes BC28 communication module, power management module, rf circuit and so on.

The power supply design of a module is critical to its performance. The BC28 communication module has two VBAT pins for connecting to external power supplies. The following table describes module VBAT pins and ground pins. When LDO is used as the power supply, low static current should be selected, and the output current capacity can reach 0.5A. At the same time, the module can support lithium battery power supply. The VBAT voltage of the power supply ranges from 3.1V to 4.2V. When the module is working in data transmission, ensure that the power drop is not lower than the lowest working voltage of the module 3.1V. To ensure better power supply performance, a 100uF tantalum capacitor with low ESR (ESR=0.7 ω) and filter capacitors of 100nF, 100pF (0402 package) and 22pF (0402 package) are connected in parallel near

the VBAT input of the module. At the same time, a TVS tube was added near the VBAT input terminal to improve the surge voltage withstand capacity of the module. In principle, the longer the VBAT cable is, the wider the cable width is. The design circuit of VBAT input terminal is shown in Figure 6.

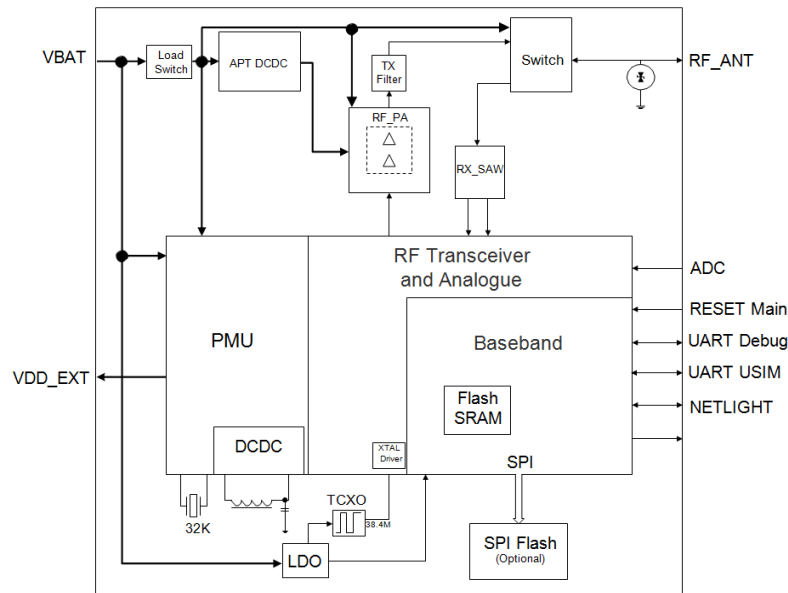


Figure 5. BC28 communication module frame diagram.

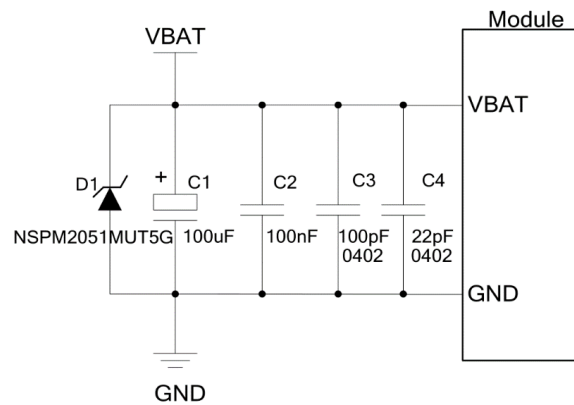


Figure 6. VBAT input circuit schematic diagram.

According to the reference of RADIO frequency part given by BC28 communication module, the design of radio frequency antenna part needs to pay attention to impedance matching (Figure 7).

3.2.2 Software Design. Through the software design, the module can realize two UDP transmission. Before transmitting data, the module can establish two socket connections at the same time and configure two server parameters respectively to realize the function of sending data to two servers at the same time. At the same time, the module can support CoAP mode transmission, bind the device to CoAP platform and realize bidirectional transmission between the device and the server through parameter configuration.

By using timer, timer in the serial port receiving interrupt service function overloading, marks the receiving completion status symbol in the timer interrupt, before the end of the byte transmission no timer will keep overloading, transmission timer to overflow value, after entering the timer interrupt service function and will receive the highest mark position 1, Data transmitted through this mechanism can be of variable length and can contain a maximum of 1024 bytes for uplink and

512 bytes for downlink.

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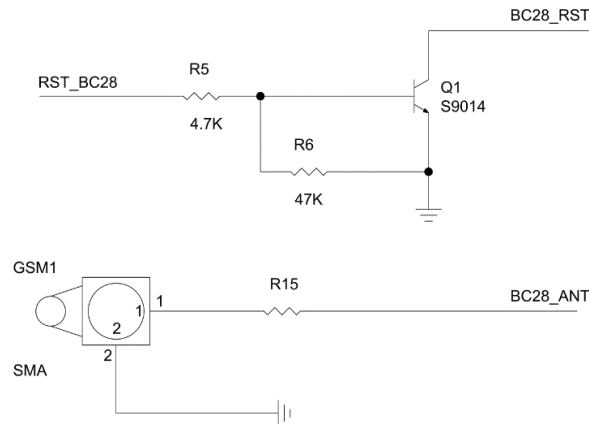


Figure 7. Schematic diagram of rf part circuit.

NB-iot communication module, such as transistors BC28 communication module start loop net until injection net success, if after read parameters for data transmission can be directly, if for the first time use no read or need to modify the parameters, the configuration parameters to enter configuration mode, after the success of the configuration again for data transmission, data interaction after a successful judgment whether to enter the sleep mode. The module can be put into hibernation mode by AT instruction if necessary.

4. TEST PLATFORM CONSTRUCTION

The overall layout of the test platform is shown in Figure 8. A total of 4 test platforms are set, namely, the flat mobile stereo garage test platform, the guide screen test platform, the test platform with intelligent parking lock, and the ground parking space test platform with intelligent geomagnetic.

The flat mobile stereo garage test platform can complete the normal access of vehicles through the local operation of man-machine operation terminal, and can also complete the access function of vehicles through wechat small program, with automatic allocation of parking space, garage internal state monitoring and remote fault detection and other functions. The management system of planar mobile garage is written by Kingview 7.0, and the database is SQL data server.

At present, WebService connects garage management system and intelligent parking cloud platform to realize real-time communication and data interaction between them. Through data exchange, the parking system of planar mobile stereo garage can realize real-time release of parking information, parking space query, remote monitoring, mobile phone payment and other functions.

Intelligent parking lock supports NB-iot communication. The parking system in this area connects with the cloud platform management system through NB-iot communication to achieve the following functions:

- a) Parking space detection function: Through the sensor, understand the parking space occupation situation, to provide a basis for the execution of parking space lock and drop command.
- b) Remote monitoring of parking space status: convenient for administrator management.
- c) Detection function: provide anti-crash protection, signal calibration and blocking detection of the blocking arm.

Intelligent geomagnetism is to establish the background magnetic field of the parking space. When the car parks in the parking space, the change of the background magnetic field and the current magnetic field intensity is used to monitor the occupied parking space. When the car leaves the parking space, the change of the background magnetic field and the current magnetic field intensity is compared to monitor the vacant parking space. Intelligent magnetic through magnetic detection technology, combined with the complex algorithm, can be high accuracy detection on the berth on cars or idle,

and transmits the cloud center through the Internet, through the multi-dimensional data comparison and calculation, further improve the accuracy of vehicle detection, will eventually parking space occupancy information sent to the service and management center.

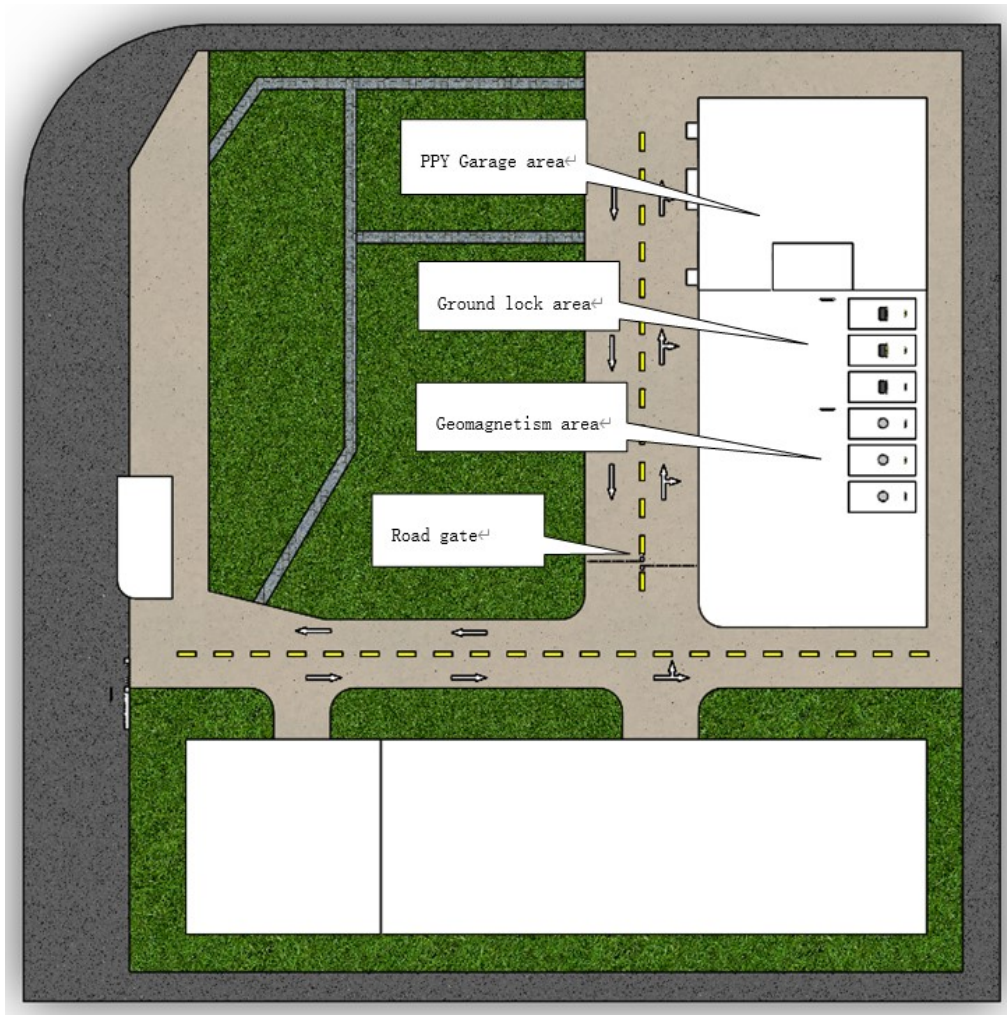


Figure 8. Schematic diagram of parking lot park construction.

Intelligent geomagnetic is based on the current situation of parking Spaces as a starting point, make full use of the Internet of things technology, combined with geomagnetic sensors, to develop a unique parking space detection system.

Intelligent geomagnetic built-in geomagnetic module, and built-in communication module, the parking space status information, through the network transmission and reporting platform, NB-iot geomagnetic directly to the cloud signal, save the relay and concentrator, lower cost, more stable network.

The geomagnetic sensor is used to sense whether the vehicle leaves or enters the corresponding parking space. Once the vehicle leaves or enters the parking space, it will immediately report to the platform to realize intelligent supervision.

Intelligent gate uses high-definition integrated network camera, camera has its own recognition algorithm, built-in multi-core CPU chip, high recognition rate, recognition speed, and stable performance. Strong light suppression, brightness compensation and so on can ensure that the equipment can better adapt to different locations. The split-type high brightness controllable LED complementary light can greatly improve the rate of license plate recognition. The system can be compatible with touch and video stream trigger two working modes, a wide range of applications, automatic license plate recognition of temporary vehicles, charging according to the time of entry and exit, no need to take the card, the vehicle

can access the parking lot without any trouble, providing users with a new service mode. The system can download the blacklist and whitelist to the camera, even if the computer is offline, the camera can also be based on the blacklist and whitelist fixed vehicle license plate recognition and give clearance.

Automatic recognition system into the vehicle number and license plate character, verify the user's legal status, automatically compare blacklist library, automatic alarm, and to monitor the parking situation and management, including entrance management, internal management, data acquisition, storage, and system working state, so that the administrator monitoring, maintenance, statistics, inquiry and print statements, etc. Vehicle access to the parking lot is completely under the system monitoring, so that the access of vehicles, charges, theft, parking space management is completely intelligent, automatic and has the advantages of convenient, fast, safe and reliable.

5. CONCLUSION

Through the introduction of geomagnetic, intelligent parking lock, intelligent lane gate, NB-iot technology, cloud platform and other technologies, to achieve fine management of parking lots and parking space resources sharing, make full use of parking resources, effectively solve the problem of difficult parking. Internet technologies such as cloud platform and Wechat mini program are used to transform the offline management of traditional property management or parking offices into online management, which improves the management efficiency and effectively avoids the phenomenon of arbitrary charging by toll collectors. The system plays a significant role in improving the efficiency of parking lot management and solving the problem of parking difficulty, which can be applied and popularized in the actual management of parking lot.

According to the development trend of the intelligent stereo garage market, the core technology of the market is quickly positioned, the intelligent garage cloud processing cloud computing and remote mobile terminal operation ability is designed and developed, and the core technology of the development of the intelligent stereo garage can meet the development requirements of the intelligent parking industry.

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