Design of an intelligent underground parking guided and charging system based on WiFi

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Abstract. With the development of the society, the improvement of people's living standards, countless underground parking lots seem to be difficult to park and find cars. Underground parking lot was built under the thick concrete. Because the underground parking lot is built under the thick steel and cement, the GPS satellite signal can not penetrate the thick bunker, which leads to the problem that the navigation accuracy in the building is too low to be able to locate accurately. In order to solve this problem which is put forward an intelligent underground parking guidance system based on the wifi, the system install wifi routers on the underground parking lot, and mobile phones own wifi module scan wifi hotspots around the information, and then match the cloud database tagged wifi hotspots information, and get wifi hot spot on the map coordinate information. According to the mobile phone access to the location of the WIFI hotspot intensity information, the system gets to the phone's current location information, and the coordinates of the map is updated. Finally, according to the system for the whole test, the test results show that the system has achieve the expected goals, and the operation is convenient, has certain market practical value.

1. Introduction
At present, there is no mature solution for the realization of underground parking navigation in China. Most navigation software is designed based on GPS navigation system. However, the GPS satellite signal cannot penetrate the over-thick bunker, which leads to the problem that the navigation accuracy in the building is too low to accurately position [1]. However, at present, there are many underground parking lots in China, and with the development of society and the improvement of people's living standards, the number of underground parking lots is increasing year by year [2], so it is difficult to park and find a car, and so on. Because the underground parking lot is built under the thick steel and cement, the original external signal attenuation is serious, the environment is very bad. In order to solve this practical problem, this design decided to take the indoor positioning technology based on WiFi to provide vehicles and pedestrians with indoor parking, car search navigation and other functions. Firstly, by installing WIFI wireless router for underground parking lot, the problem of weak network signal of underground parking lot can be solved, so that users can quickly obtain positioning information from the server. Secondly, now smart phones are generally equipped with WiFi function, which can realize navigation function directly with the help of the phone's own hardware, without installing other hardware, so as to reduce user costs.
2. Overall scheme design of the system

2.1. Design of positioning and navigation algorithm
Parking guidance is divided into three parts: parking guidance, car search guidance and driving guidance. Parking guidance will draw the route from the entrance of the parking lot to the nearest parking space. Car search guides draw the route from the user's current position to the parked position of the vehicle. Drive out to guide drawing the route from the parking location to the exit of the parking lot. The three modes can be switched freely by the user according to the current situation. The current position of the user is compared by indoor WiFi location algorithm according to the MAC address of the WiFi hotspot information around the user's mobile phone and the MAC address of the WiFi hotspot information stored in the database. The coordinate information of the hotspot information in the database is obtained, and then the current position of the user is calculated according to the signal strength of the WiFi hotspot. When the user connects to the WiFi hotspot with coordinate information in the database, the accuracy of the current indoor positioning and the refresh rate can be increased. The implementation of WIFI indoor positioning algorithm is mainly based on the strength information of the three WIFI hotspots with coordinate information scanned by the mobile phone to calculate the location of the mobile phone. The positioning algorithm first transforms the WIFI signal strength into distance. According to the actual simulation, the distance drawn on the map is roughly equal to the value obtained by multiplying the WIFI intensity by 25 and dividing by 2.755.

After the distance between the phone and each WiFi is obtained, the location can be processed according to the WiFi hotspot coordinate information queried in the database. The location processing algorithm takes the coordinates of three WiFi hotspots as the center of the circle and the distance from the WiFi hotspots as the radius to draw a circle, and then takes the midpoint of the intersection part of the three circles to be the location located by the positioning algorithm. Then the bubble sort algorithm is used to take the intersection part in the middle of two WiFi signal ranges three times, and finally the intersection part in the center is obtained. The median value is the positioning coordinate.

Once the anchor point coordinates are obtained, the route is drawn. Canvas. DrawPath (Path, Paint) is used to draw the route. The Path parameter is the definition Path object, and the Paint parameter is the brush object. The starting point of the parking guidance route is the entrance, and then the route is drawn along the main road to the vacant parking space nearest the entrance. The drawing of the exiting guidance route starts from the current parking space of the vehicle, and is drawn along the main road to the exit of the parking lot.

2.2. Overall scheme design of the system
When the user enters the parking lot, the RFID reader reads the IC card information and sends the information to the ZigBee terminal through the serial port. After receiving the serial port data, the ZigBee terminal wirelessly transmits the data to the ZigBee coordinator through the ZigBee ad-hoc network. The ZigBee coordinator receives the information from the terminal, parses it, extracts the card number and sends it to the server via the serial port. When the server receives the card number data information, it first checks whether it has been registered in the vehicle information table of the database. If not registered, it needs to click the registration button to register the vehicle information. If it has been registered, query whether the vehicle is in the garage in the database garage information table, execute the warehousing operation, write the vehicle information and the current time of the system into the garage information table, view the vehicle historical parking data and parking guidance and other functions; When leaving, it will automatically recognize whether it is in the garage, perform the operation of out of the garage, calculate the parking time and amount, delete the vehicle data in the garage information table, and realize the payment by mobile phone.
Mobile client data mainly through the Internet TCP/IP protocol for data transmission, all network data transmission by the cloud server in the middle of the handler for data processing and forwarding, forward again in the middle of the cloud server running on the data processing program, the mobile phone Android client and server computer data transmission, can not only realize data between the server and the mobile phone Android client interaction, so as to realize the remote view parking information and guidance function. The overall design of the system is shown in Figure 1.

![Figure 1. Overall scheme design of the system](image)

3. System hardware design
The hardware of the system is mainly composed of RFID card reader, ZigBee terminal node and ZigBee coordinator node. RFID card reader is mainly a fixed card reader. When the card is swiped, the card is close to the RFID reader module[3]. The light of the RFID module is on, indicating that the card is swiped successfully. Zigbee module mainly USES is CC2530 chip[4], RFID module and Zigbee terminal via a serial port for data transfer, serial port for the connection of two root, two power cord, two CC2530 development board can implement Zigbee wireless ad-hoc network, through the terminal obtain RFID module data is passed to the coordinator, the coordinator will then via a serial port to send data to the PC.

The vehicle card swipe information is mainly transmitted by ZigBee, so there are multiple coordinators and a terminal device[5]. The coordinator device is connected to the RFID module, and the terminal device is connected to the upper computer. When the coordinator receives the card swiping information of the RFID module, it sends the card IC number information to the terminal device and displays it on the OLED small screen. After the terminal device receives the message sent by the coordinator, the serial port forwards it to the upper computer for processing.
4. System software design
This system mainly includes three parts: the server system of the upper computer, the cloud server system and the mobile APP. The server of the upper computer is mainly completed by VC++ development environment, which mainly provides a visual interface for parking management of vehicles in and out of the parking lot and data transmission with the cloud server. Cloud server program is developed with the Visual Studio 2017 software, main is to store data, provide the PC server and data communication bridge between the client APP, mobile phone APP client user login, user registration, MAC address and WIFI nodes coordinates and other information are stored in the cloud[5], convenience for the user. The APP end of the mobile phone is developed by using Android Studio development software. The Android client is mainly provided for parking users to download and use, and supports multiple users to query and navigate parking information at the same time. In addition, it also includes user login, user registration, historical information query, parking payment, remaining parking space display and other functions.

4.1. Overall scheme design of the system
Server-side software mainly receives vehicle information from ZigBee terminal serial port data transmission, and stores the information in the local database. First of all, the need for database connection and serial communication function, followed by login, vehicle information registration, historical information query, parking vehicles in and out of the warehouse fee management, garage residual parking space display, automatic allocation of parking nearby parking space and other functions.

4.2. Cloud server software design
The main function of the cloud server is to connect the bridge between the server of the upper computer and the APP client of the mobile phone, and store the user login, user registration, WiFi node MAC address and coordinate location and other data information of the client. The cloud server is open to four ports, three TCP ports and one UDP port[6][7]. The three TCP ports are respectively the server connection port of the upper computer, the login and registration port of the mobile client, and the parking information acquisition port of the mobile client. UDP port is the port to obtain all the information on the parking navigation page of the mobile client.

By querying the WIFI information table in the MySql database, the database of WIFIMAC address, map coordinates information such as packaged into Json data sent to request mobile client, then via TCP communications forwarding the information to the PC server, PC server according to the query information returned to the parking lot parking data returned Json data to the server, the server forwarding to the mobile client for data processing, In this way, real-time parking information and WiFi hotspot navigation information can be displayed on the map.

4.3. Design of mobile APP software
User login and user registration functions of mobile APP are realized through TCP connection to the cloud server, such as user login and registration, machine parking navigation. In the login interface, the function of saving the account and password of the login user is realized by saving the account password in the local text file of the mobile phone. In the indoor parking navigation interface, the WIFI module of the mobile phone is used to scan the intensity of the surrounding WIFI signal every once in a while. According to the location WIFI hot spot information in the database, the location is calculated to obtain the current location, and the location is displayed on the mobile phone interface to realize the indoor navigation function.

5. Conclusion
This topic mainly uses the algorithm based on WiFi location to complete the underground parking navigation and charging function. The system is mainly composed of parking lot management end and user end. The management end provides vehicle parking management and background data management, and the user end provides users with parking guidance function. Management mainly adopted RFID
radio frequency identification technology and ZigBee wireless transmission technology to read the ID card and read data transmission operation, client PC server, cloud server, mobile phone APP to complete, support multiple users simultaneously vehicle parking information query and navigation, and contains the user login, user registration, historical information query, stop pay cost, remaining parking space display, and other functions, tested the overall system, and the operation is convenient, has certain market practical value.

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