Design of Intelligent Garage Control System Based on Internet of Things

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Abstract. According to comb tooth multi-layer parking equipment control problem, a control system based on Internet of things the garage is designed. The control system mainly includes two parts, which are the garage terminal and the mobile phone terminal. The garage terminal used arduino microcontroller as the controlling core, it used the Ethernet module to access the internet of things, it can collect parking information, park and fetch the car to the garage, etc. The mobile APP terminal completes human-computer interaction with users. After the design of the control system is completed, the function test is carried out. The test results show that the app to complete the garage booking, parking, pick-up and other functions. It can meet the requires of the intelligent garage, which has a certain reference value for the design of modern intelligent garage system.

1. Introduction

As the advancement of science and technology and comprehensive national strength, the number of automobiles has reached a new climax. With the rapid increases of car users, the problem of difficult parking and random parking has become one of the urgent problems to be solved. According to statistics, the parking spaces in cities are far from meeting the national demand. The gap of parking spaces in china is more than 50 million, and at least 1/6 of the residential areas have parking problems. Therefore, it is extremely urgent to solve the parking problem of the vehicles and random parking. The construction of intelligent, technological and convenient parking garage has become an indispensable convenience project for social development [1–4].

At present, the research focuses the connection of things and the planning of parking routes on the existing garage foundation. To achieve the short-distance internet of things control, the integration of RFID radio frequency technology and ZigBee is reported [5–6]. To combine user selection with intelligent recommendation of the system, RFID-based positioning technology and active induced intelligent parking mechanism were used [7]. Literature [8] designed an intelligent garage management system, which can publish real-time information through the server and other functions. Literature [9] proposed the parking guidance system on the basis of system management. Based on path planning and human-machine interface module, Massaki Wada proposed an intelligent garage control system model, which successfully realizing vehicle management in the garage [10]. To achieve low cost, less area, flexible layout, high parking rate, fully automated intelligent stereo garage become more and more popular. A comb-type multi-layer stereo parking garage is proposed in Literature [11]. To solve the the control problem of this garage, this paper proposes a control system for the garage. The control
system mainly includes two parts, which are the garage terminal and the mobile phone terminal. The garage terminal used arduino mega 2560 as the main controller, the garage is connected to internet of things through Ethernet module, and the mobile phone APP terminal is built with APP inventor. Through the information interconnection between the garage and the mobile APP, the functions of parking information inquiry, reservation, automatic parking and automatic car picking can be realized.

2. Overall scheme of control system
The overall scheme of the garage control system based on the internet of things is shown in Figure 1. It can be seen that the system includes two parts, which are the garage terminal and the mobile phone terminal. The communication between the terminals adopts Ethernet communication. The garage terminal is the server with its own fixed IP address, which can receive and parse the instruction information sent by the mobile terminal. For example, when receiving the instruction of picking up the car from the mobile terminal, the garage automatically controls the lifting and moving device to transport the car to the exit position. The mobile terminal is the client terminal. The mobile terminal can access the parking space, address and other information of the garage by accessing the IP address of the garage. At the same time, it can also send the information of picking up the car, parking and reservation to the garage terminal.

![Fig. 1 System design scheme](image)

3. Design of Garage Terminal
The hardware components of the garage mainly include arduino mega 2560, Ethernet communication module, motor drive module and sensor module of W5100. W5100 module receives user instructions, and send parking space information data to user. The motor drive module controls the positive and negative rotation of the motor, to make the lifting and translation of the carriage board, and complete the parking and the fetching of the car. The sensor module is used to detect the information of loading plate and stopping in place.

Garage software mainly includes three parts, which are Ethernet data receiving module, parking space information acquisition module and data processing module. The overall flow chart is shown in Figure 2. Firstly, internal and external resources are initialized and the device is started. Secondly, the system changed into the data monitoring mode, waiting for the command information from the mobile terminal. If there is no command information, it will continue to wait for it. If there is information, the system will changed to the information processing mode, and start to process the next step. Thirdly, the data information processing module will analyze the received data, and send the control signal to the garage end according to the analysis data. For example, if it receives the parking command, it will send the lifting and translation signal. Finally, the garage information will be packaged and sent to the user APP through Ethernet module, and return to continue to monitor the command of the mobile APP.
3.1. Design of Ethernet data receiving module
Ethernet data receiving module mainly realizes the function of receiving mobile terminal data, and sends back the relevant data from garage terminal. It is composed of three sub-modules, namely: network configuration sub-module, Ethernet initialization sub-module and network monitoring sub-module.

3.2. Data processing module
This module mainly completes the processing and feedback of the instructions from the client's mobile terminal. It is divided into three parts: the design of the sub-module of data instruction classification, the design of the sub-module of data instruction processing and the design of the sub-module of data instruction feedback.

3.3. Parking information acquisition module
According to the instructions of the customer's mobile terminal, the system obtains the parking information, including whether the parking space is available and whether the parking space is in the reserved state, etc. If the parking space is not empty or reserved, the feedback information is unavailable. If the parking space is empty and the parking space has not been reserved, the feedback information is available. It is determined by the high and low levels of an I/O pin of the arduino mega 2560. The high level means the car is in the warehouse and the low level means the car is not in the warehouse.

4. The design and implementation of Mobile APP terminal
The software architecture of the client mobile terminal includes the functions of user registration, user login, function menu, garage query and reservation, parking, order cancellation, problem feedback and suggestion, and APP control and reception of garage server data. This is shown in Figure 3.
4.1. User login and registration module
This module mainly includes screen initialization sub-module, network database design sub-module, registered user name design sub-module and login user name design sub-module. It is mainly to achieve the user account login and registration.

4.2. Garage address map module
This module mainly includes screen initialization sub-module, garage selection box design sub-module, position sensor setting sub-module, garage longitude and latitude definition sub-module, static map URL and search URL definition sub-module, sending request to URL sub-module and feedback data decoding and processing sub-module. It's main function is to realize the garage address on the map display.

4.3. Parking information query module
This module logic programming mainly includes three module design, respectively for the definition of garage URL writing sub-module, sending data request to the URL sub-module, feedback data decoding processing sub-module. The main realization of the user for the garage parking status query and reservation function.

4.4. Parking and picking up module design
This module mainly includes screen initialization sub-module, garage URL definition sub-module, sending data request to URL sub-module, feedback data decoding and processing sub-module, timer setting sub-module. It mainly realizes the timing and cancellation of the vehicle trip.

5. The system test
The system function test is carried by using the designed APP, which mainly includes function menu function test, parking action and parking queries function test, system function menu interface is shown in Figure 4. The role of the interface has a web site navigation, the user can according to your requirements into a different interface. For example, garage query and reservation interface, trip start and terminal interface, problem feedback and suggestions.

The system parking query interface is shown in Figure 5. It can be seen that, when clicking the parking query button, the garage terminal will return the feedback of 20 spare parking spaces to the APP. It can complete the parking query function. At the same time, the function of parking reservation can be carried out through the reservation button on the page. The interface of the system for parking and picking up cars is shown in Figure 6. When clicking the "Start" button, the system will turn on the
timing function and park the car on the reserved parking space. When clicking the "End" button on the page, the system will pick up the car from the parking space and increase the number of parking spaces by one.

Fig.4 APP menu interface      Fig.5 Spare parking spaces interface        Fig.6 Parking interface

6. Conclusion
To involve intelligent garage control problem, a garage control system based on internet of things is designed, which including the garage control design and mobile APP design. In the design of the garage terminal, it selected arduino mega 2560 as the main controller and Ethernet W5100 as the Ethernet module as the system communication module. The Ethernet processing module, data processing module and parking space information acquisition module, were written to accomplish the instructions from the mobile APP terminal. In the design of mobile APP, by using the APP inventor programmer, human-machine interface is designed. After the design of the control system is completed, the function test is carried out. The test results show that users can complete the garage reservation, parking, picking up and other functions through the mobile APP terminal, which can meet the needs of the intelligent garage and has a certain reference value for the design of modern intelligent garage system

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