Design of intelligent stereo garage system

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Abstract. With the rapid development of the city, the car has entered thousands of households, and the difficulty of parking in the city will bring inconvenience to the citizens. This paper takes a roadway-type stereoscopic garage (warehouse-type stereo garage) as the research object, with PLC and servo control technology as the core, supplemented by contactless card reader and mobile client technology, and develops design of Urban stereo garage system based on Internet+. Through the network communication between the stereo garage system and the mobile phone client, the remote garage information inquiry is realized, and the PLC is connected with the touch screen to perform, and data reading and writing data can be performed and the visual management of the stereo garage can be realized.

1. Introduction

With the rapid development of the city, thousands of households have access to the cars, Urban parking problems will put citizens to the traffic inconvenience. In this paper, a kind of three-dimensional garage similar to the roadway stacking (warehouse-type stereo garage) is taken as the research object. Taking PLC and servo control technology as the core, supplemented by non-contact reader and mobile client for the design of Urban Stereo Garage System which based on the Internet+ technology. Through the three-dimensional garage system and mobile client network communication, we can achieve remote garage information. Queries the connection of PLC and touch screen, data read and write the visual management of the stereo garage are implemented too.

2. The general system design

This system takes 4*3 rectangular array garage as an example. It is mainly composed of PLC, servo mechanism, touch screen, serial port module, RFID reader and mechanical parking space. The stereo garage contains 1 entrance and exit, 2 spare parking spaces and 9 parking spaces. The parking space is composed of the parking platform with cylinders to drive lifting and telescopic, and each action is equipped with a magnetic switch for feedback information. The movement of the loading platform is controlled by a 2-axis servo motor, which can accurately find the parking space address. In order to prevent dangers and ensure personal safety, detection devices are installed in the entrances and exits and parking spaces\cite{[1]}. The block diagram of the electrical composition of the system is shown in Figure 1. The main structure of the three-dimensional mechanical garage is shown in Figure2 and Figure3, respectively.
3. System software design

3.1 Vehicle access program design

3.1.1 Car storage process
As shown in Figure 4, the flow chart of the system is stored in the storage interface. The user holds the IC card prompt information to swipe the card. After the system feedback is compared the user confirms that the user selects the parking space number to confirm the parking. After the user confirms, the user enters the message and then enters the message. After the loading platform and the loading platform stop the user's vehicle to the designated position, the robot picks up the overloaded parking platform and automatically selects the selected parking space by the user selecting the designated parking space, and puts the vehicle into the garage, and the whole process is completed. The system will automatically remember the number of the vehicle parked by the user so that it can be called when the next time the vehicle is picked up[2-4].

3.1.2 Car removal process
In the existing vehicle in the garage, if a user has stored the vehicle, the relevant information will be prompted. After the user enters the pick-up interface, the card is first checked to determine whether the card is valid. If the vehicle is parked, the system automatically scans the pick-up information, calls the address when the vehicle is parked, the garage pick-up device starts working, and the vehicle is transported to the vehicle entrance and exit. At the point of arrival, the user can drive the vehicle away after arriving at the entrance. The pick-up process is shown in Figure 4.
3.2 Robot programming

The robot is used to transport the trolley. It is controlled by two solenoid valves and has lifting and telescopic functions. The program controls the robot's two sets of motion processes. The program—one process is extended, raised, retracted, and lowered. The second process of the program is ascending, extending, descending, and retracting. The two programs correspond to the process of taking out the loading platform and releasing the driving platform, and the ladder program is shown in Figure 5. The program uses M77 for transition control, which is also the starting state. When the robot is in the home position, that is, when it is lowered into position and retracted to the position, there will be a first action to set M80 to drive Y12 to extend the coil. When the extended limit is reached, the timer T0 starts to be charged for 500ms. When M81 is set to drive the Y11 rising coil, when it reaches the rising limit, it waits for 2S time, starts to reset the first coil M80 and then retracts to the position. After the condition is satisfied after 500ms, the reset M81 coil falls to the position, triggering the falling edge pulse M81, so that The counter is powered. Wait for the cylinder to retract slowly, and ensure that all the next reset functions are performed after the safety is in place. The reset is completed waiting for the next program call. Program 2 is also similar to program 1, except that the action flow is different, and the solenoid valves of the drive are shared.

![Figure 4. Storage & Extraction process](image-url)
3.3 IC card communication

3.3.1 Communication parameters
The IC-10MR inductive card reader is used in this design to support PLC and its self-supporting protocol supports MODBUS. It can be connected to the Mitsubishi communication module QJ71MB91 via RS232 or RS485. In the navigation bar of GX work2, pull down the intelligent function module, open the “00A0:QJ71MB91” switch setting, set CH1 to start with the user setting parameter, CH1 in the module is not used by RS232 protocol, then set CH2 interface, mode setting is The QJ71MB91 is the main station function, and the IC card reader functions as a slave. The baud rate communication speed is set to 19200 bps, the data bit is 8, no parity, and the frame mode is set to RTU mode, as shown in Figure 6. When setting the automatic communication parameters, only the data in the automatic communication parameter 1 needs to be set. First, enable the CH2 function, set the target station number to 2, and use it as a slave. The next request time of the timer is set to 0. If the setting time is too long, the module will report an error. The object MODBUS device type is specified as 0500H: The register is read. Finally, set the read setting, start buffer memory address 2000h, object MODBUS device start number is 0, access point number input 16, as shown in Figure7. In the auto refresh data, input the area to write the register number[5]. In this design, input the D1000 most device designation data, and the number of transfer words is set to 4096. After the parameter setting is completed, the communication setting is made. After RS485 is connected to the IC card reader, open the “Device Buffer Memory Batch Monitor” button in the software, input D1000 in the component name for monitoring, and use the IC card to swipe to view the changes in D1000. The data is shown in Figure 8.

3.3.2 Communication procedures
This design is equipped with 3 IC cards, 2 of which are for the user group, and one for the administrator to debug the card. When the PLC is powered on for the first time, the SM400 is a special auxiliary relay in the Q series PLC. It realizes storing the information of the three IC cards into the program and writing them into the constant K. After the device is powered on, it is transmitted to the D register by the MOV instruction, and the 32 bits are stored. The data requires two consecutive registers, D100 is the administrator card, D110 is the user A card, and D112 is the user B card. DMOV refers to a 32-bit data transfer on the rising edge. When the system is started, feedback back to the servo signal in the PLC is started, the administrator card program can only be valid when it is allowed to be on the main screen of the touch screen, and the data of the module address D1000 is compared with the data of D100, if it is equal to the circuit. Turn on the constant 2 to D10 data, D10 is the screen switching function defined by the touch screen, and set the M100 auxiliary relay to be used.
as a function switch. When the data of D10 is less than or equal to 1, the status of M100 is reset. The above is the administrator[6-8]. The flow of the program runs. Before the user swipes the card, the system needs to set back to zero. When the user returns to zero, M12 is in the state. The interface also can be swiped successfully on page 5. Similarly, the data D1000 of swiped card will compared D110 of user A with D112 of user B. The data is compared. If it is equal to the data, the M is set. The above is the program design completed by swiping, as shown in Figure 9.

**Figure 6.** Switch settings

**Figure 7.** Automatic communication parameters

**Figure 8.** Automatic communication buffer area

**Figure 9.** Communication ladder program

### 4. Human-computer interface design

This design uses Mitsubishi touch screen GS21 series products, with Ethernet communication function, USB communication function, RS232/RS485 communication function and memory card expansion function. Connect the two touch screen devices and the Ethernet socket of the CPU through the network cable for connection communication. The garage information display screen is the current state of the garage parking space, and the user can read the stored and remaining parking space information in real time. The main interface of user operation consists of date, time, save, pick up, reset, repair, language switch, etc[9-10].

### 5. Mobile Clinence Design

In the operating environment of Android 7.0 system, this paper makes a three-dimensional garage terminal inquiry system. Users can open the mobile phone software to check whether the parking device is fully loaded at any time and anywhere, whether parking operation can be performed, and the user can select the parking place in advance in order to save time[11]. The interface is designed to switch between 2 languages, it is more user-friendly for users of different languages. This document template and more information is available on .org:
6. Conclusion
The intelligent three-dimensional garage effectively utilizes urban space, solves the problem of nowhere to park urban vehicles and reduces parking costs. At the same time, the intelligent stereo garage adopts PLC as the control core, organically integrates non-contact IC card, touch screen, network communication, display screen, signal light and other equipment, and joins the mobile terminal query system to realize the automation of the access vehicle, so that the city garage gradually moves toward Intelligent, secure, efficient, and unmanned development. The system adopts the roadway stacking design, and the system experimental data are shown in Figure 10, the result shows that the stereo garage system has the characteristics of short access time and high efficiency.

![Figure 10 Garage access time trend chart](image)

7. References
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