Design of Intelligent Parking Control System

Chunhong He¹, Hongchao Li¹, Bin Ren ²*

¹School of Computer and Information, Dongguan City University, Dongguan China 523000
²School of Electronic Engineering and Intelligence, Dongguan University of Technology, Dongguan China 523000
*Corresponding author’s e-mail: renbin@dgut.edu.cn

Abstract: Along with the historical process of the industrial revolution, the automobile has undoubtedly made life more convenient. But at the same time, various problems also come along: Traffic jams are becoming more and more serious, and problems such as parking are becoming urgent problems. This design uses STC89C52 microcontroller, through the infrared sensor module to detect the information of the garage, then the nRF24L01 wireless module is used to carry out the wireless transmission of master and slave information. Finally, the LCD1602 LCD screen is used to establish the human-computer interaction page, and an intelligent parking space management system is designed. The owners can easily check the parking lot to understand the flow of the parking lot through the system, and judge whether to enter the parking lot, saving time. At the same time, it is easier to integrate with other intelligent systems, which provides a foundation for more advanced management and is the premise for making the parking lot a highly intelligent product in the future.

1. Introduction

Time into the 21st century, as durable cars, undoubtedly greatly improve the quality of life of the people. Especially at present, the automobile industry around the world is in a period of rapid outbreak and promotion, China's car ownership is growing rapidly. Nowadays, people's habit of using new energy vehicles is becoming more and more common, and the automobile industry ushers in the second spring. At the same time, demand for parking spaces is also rising. Many parking lots still use traditional manual management, which wastes a lot of public and human resources[1-2]. Urban parking difficulties, a difficult, forced parking management system and intelligent technology iterative update. In the future, the user's experience should be the top priority of parking management, and intelligent guided parking is one of the main parts.

In this paper, the single chip microcomputer is used to design the intelligent parking control system, which can integrate and configure the resources of the parking system, and effectively improve the parking space problem of the traditional parking lot. Car ownership is growing, and the yard reform is on the string. I am convinced that the intelligent parking lot in each city after the realization of parking problems, to be solved.
2. System principle design

2.1. Functional Structure Design of Intelligent Parking Control System

Nowadays, when the owner enters the car park, due to the lack of effective guidance, parking spaces cannot be easily found in large-scale parking lots\(^3\). The purpose of this design is to complete the intelligent management of the parking lot, so that users can easily observe the situation in the parking lot. Through the cognition of traffic flow or parking space, users can intuitively understand the actual situation in the parking lot, so as to realize efficient parking and solve the parking dilemma in the city. In this way, the parking resources can be fully utilized, and the social operation is more efficient, so as to improve people’s happiness. Considering the feasibility, stability, ductility, economy and benefit of the design, Fig. 1 is the main function of the intelligent parking lot control system.

![Fig. 1 Function Diagram of Intelligent Parking Control System](image)

2.2. Design and Planning of Intelligent Parking Control System

This design uses STC89C52RC chip, set up a host and two slaves, respectively, to detect the parking space and traffic flow. The sub-modules include multiple system modules such as wireless, sensor, and display modules, which are connected and used to realize the designed functions. At the same time, in order to let users more intuitively feel the specific location of the parking space, in addition to the occupied parking space displayed on the host screen, LED lights are also added to represent the relative position of the parking space. In this design, three LED lights are used to represent three parking spaces for users to view.

When the car enters or leaves the parking lot, the sensor at the door of the parking lot records it, and the data is transmitted to the host computer by wireless, and added to the traffic. When the car enters the parking space in the garage, the corresponding parking space records have been occupied and transmitted to the host computer. At the same time, the LED lights corresponding to the parking space in the host are lit at the same time. Users can watch the specific parking space on the display screen to select whether to enter the parking lot. Fig. 2 is the design of the parking lot.
3. Hardware circuit design

3.1. Hardware Design of Intelligent Parking Control System
The software used in this design schematic is Altium Designer. The software has SOPC development, FPGA development and other functions, which is a development system for electronic product design[4]. In today’s society, has been widely used in integrated circuit development, chip development and other high-end sophisticated areas. As a hardware designer, mastering Altium Designer software is the basic requirement.

The hardware consists of the following components: STC89C52 microcontroller, LCD1602 LCD screen, NRF24L01 wireless module, TCRT5000 sensor, infrared sensor. Two 89C52 slaves represent parking space detection and traffic flow detection respectively. When the measured signal is effectively received by the sensor, the information from the sensor is received from the microcontroller. After the information is processed, the information is sent to the main controller through the wireless module, and then processed by the main controller to realize the corresponding function. The hardware design is shown in Fig. 3.

Fig. 2 Design of Intelligent Parking Control System
3.2. Single-chip microcomputer minimum system
The chip processor used in this design is STC89C52, which is widely used in the electronic field. It has 8-bit central processor (CPU) and 128Byte internal RAM\(^5\). The power consumption of 52 single chip microcomputer is very low, the price is close to the people, plus high performance processor, for many electronic fields such as embedded design provides a more flexible and economic solution\(^6\).

3.3. Design of Display Module
The LCD1602 LCD screen is used to design the display part, which improves the clarity of the display font. In daily use, most of them are used to display various words and numbers. The screen consists of 16 * 2 display intervals. Users can modify each interval to their own text by programming, which plays a very good role in project research. The working voltage of the chip is 4.5 V ~ 5.5 V, and the working current is 2.0 mA (5.0 V)\(^7\). There are 16 pins on the screen. Users can transfer data by operating data after enabling the screen. The main data port is D0-D7.

3.4. Wireless module design
Fig. 4 is the schematic diagram of NRF24L01 in this design, the wireless module is 2.4G ISM band. Based on the use of SPI interface, its stability is good, and the price is friendly to the people. It can be used in various scenarios. In this design, 24L01 is driven by a single chip microcomputer to carry out wireless communication between the master and slave computers.
3.5. Sensor module design

The infrared obstacle avoidance sensor with clean signal, good transmission and strong driving ability is used to detect the parking status and traffic flow, and collect the receiving and transmitting. In today’s development and design, it is commonly used as robot obstacle avoidance, intelligent car and other experimental projects.

4. Software design

The language used in this design is C language, and the software is Keil u Vision5. The software provides configuration optimization of many types and levels[8]. The program design flow chart is shown in Fig. 6.
4.1. Design of Sending Mode

When the parking space detection and traffic flow sensor receive the required detection signal, the low level is input to the slave microcontroller. After receiving the low level signal from the single chip computer, the wireless module is controlled to send data to the host. When you need to send data, the data in the array can be sent. In order to realize the wireless communication between master and slave computers, the process is actually controlled by manipulating the register address in NRF24L01\[9\].

It should be noted that when operating the NRF24L01 register, it needs to be executed in standby or disconnection. Therefore, the CE end should be pulled down at the beginning of the sending function. After the program is completed, the CE end is enabled. Writing the sending mode function, mainly has the following points:

1) Lower CE level. Write receive address enable instruction and write register instruction, and set the address width and receive address. Note whether the sending address and the receiving channel address are the same.

2) Write the data and then enable the receiving channel, where the receiving channel 0 is enabled. In order to ensure that the host receives the sent data completely, the design of automatic retransmission times is ten.

3) Finally, the RF channel, transmitting power, data transmission rate and low noise amplification gain are selected to make the CRC end enable and the CE level can be raised.

4.2. Design of receiving mode

The master-slave communication in this design is realized by operating the register address of the NRF24L01 module, and the wireless module setting of the receiving board is also different. To receive the signal from the host, you need to operate the wireless module register of the receiving board, set to receive mode. It should be noted that the standby mode or disconnection state is also needed in the operation, and the address configuration of the receiving channel should correspond to the sending address, so as to obtain the required data completely.

Similar to the sending mode, the setting steps of acceptance mode are as follows:

1) Draw down the CE level, set the address width and receive address, write the receive address...
enable instruction and write the register instruction, so that the address of the receiving channel is consistent with the sending address.

2) Enables the receiving channel, where the receiving channel 0 is enabled.

3) Finally, the RF channel, data transmission rate and low noise amplification gain are selected, and the effective data width of the receiving channel 0 is the same as that of the transmitting channel. Enable the CRC end, and then the CE level is elevated.

5. Analysis of effect

When the design of hardware and software is completed, it is first necessary to ensure that the connection of the hardware part is correct, and whether there is a mistake in the preparation of the software program, and then the program is burned into the microcontroller. Due to there are many master-slave machines, the battery is used to supply power to the master-slave machine. Press the key, master-slave system started, into the initial state. At this point, the traffic flow is 0, three parking spaces are empty, displayed as 'N', indicating that no car occupies the parking space.

At this time, if a vehicle passes through the gate of the parking lot, the slave machine that detects and measures the traffic flow will sense the vehicle, and the data will be transmitted to the host machine. The user can watch the traffic flow through the host machine to know the specific number of vehicles in the parking lot and determine whether to enter the parking lot. When a vehicle enters or leaves the garage, it is included in the traffic flow, and the traffic flow increases. At the same time, the staff can also reset the button to zero the traffic flow.

When the vehicle enters the parking space in the parking lot, the user wants to see the specific situation of the parking space, you can switch to the parking space detection mode by the key. When the parking space is occupied, if the detection distance is effective, the parking sensor indicates the light, indicating that the vehicle enters the effective detection range, the sensor works effectively, starts working, and transmits the information to the host. After the interactive host receives the information, the specific information of the occupied parking space is displayed on the screen. The parking space information is changed from 'N' to 'P', which means that the parking space has been
occupied, and the corresponding LED indicator lights are on. When there are multiple occupations, the principle is the same as shown in Fig. 10, screen information and the corresponding indicator lights will also change.

Fig. 9 Parking detection diagram

When the car leaves the parking space, the signal detected by the sensor disappears, and the information returned to the host disappears. The parking space in the host shows a recovery from the initial state, from 'P' to 'N', and the LED lights corresponding to the parking space are extinguished. Displays the same as the initial state.

Fig. 10 Parking control diagram

6. Conclusion
The concept of this design is born from the dilemma of urban parking difficulties in today’s society. In order to solve the problem that the majority of owners are hard to find, the backward management system in the parking lot is designed and improved. An intelligent parking control system is designed by combining single chip microcomputer technology, electronic technology, wireless communication technology and LCD display technology.

In order to make the design closer to reality, the master-slave computer abandons the past wired communication mode, the use of wireless module makes the master-slave computer wireless communication, availability has been strengthened. At the same time, the LCD screen is used for human-computer interaction, which greatly improves the quality of display. Users can intuitively understand the required information in the garage on the LCD screen, and the user experience is improved. In order to make the design more humanized and the effect more specific, LED lights are added to assist in the display of specific information. Parking information is no longer a simple character representation, but also becomes the actual specific orientation. Through the design of hardware and software, the detection of traffic flow and parking space is completed, and the use efficiency of the parking lot is improved.
Acknowledgments
The research is supported by the Key Project of Dongguan Science and Technology of Social Development Program under Grant No.20211800901261 and No.20211800902431, Guangdong Provincial Basic and Applied Basic Research Fund Regional Joint Fundt under Grant No. 2020B1515120095, Guangdong Provincial Enterprise Key Laboratory Project under Grant No. 2020B121202001, Guangdong Province Climbing plan project under Grant No.pdjh2020a0786.

References
[1] Yu Ping. The solution of the intelligent parking lot management system in the community [J]. Security Technology, 2003(02): 48-49.
[2] Chen Changzheng, Dou Baoru, Shi Liang. Design and implementation of intelligent parking lot management system based on STM32 single-chip microcomputer[J]. Journal of Xi’an Aeronautical University, 2020, 38(05): 60-64.
[3] Zhao Sheng. Research on the smart parking lot scheme of the super-large comprehensive transportation hub[J]. Railway Communication and Signal Engineering Technology, 2021, 18(04): 47-51.
[4] Wang Qiang. The application of Altium Designer in circuit design [J]. Information Recording Materials, 2020, 21(02): 118-120.
[5] Zhang Xuqiang, Han Jianjie, Sharp Kate Maimat, Maihe Muti Yiming. Design of Intelligent Watering System Based on AT89C51 Single-chip Microcomputer [J]. Industry and Technology Forum, 2019, 18(13): 44-45.
[6] Li Aobo. Design and innovative application based on minimizing single-chip microcomputer system[J]. Science and Technology Innovation, 2019(07): 26-27.
[7] Zhao Huafeng. Research on Chinese Character Display of LCD1602 Module[J]. Modern Information Technology, 2020, 4(17): 35-37.
[8] Yu Qiaoshu. Keil C51 universal accurate time-delay programming [J]. Science and Technology Wind, 2020(10): 24-25.
[9] Chen Cong. Design of embedded wireless download system based on nRF24L01[J]. Mechanical Engineering and Automation, 2021(01): 60-62.