

# Core Technology Analysis of Intelligent Takeaway Cabinet System

Guixian Lin, Lu Zhang\*

College of Electrical and Information Engineering, Quzhou University, Quzhou, Zhejiang,  
324000, China

## Abstract

The intelligent takeaway cabinet system combines big data, cloud computing, the use of GSM mobile communication module, Internet of Things and other technologies to achieve the management of takeaway delivery, alleviate various contradictions in the process of takeaway delivery and meal picking, and facilitate everyone's life. The technology required by the system mainly includes four modules: intelligent access to meal technology, temperature control technology, human-computer interaction technology and fault alarm technology, so as to fully realize the function of the intelligent takeaway cabinet. This article is mainly based on the various functions of the "smart takeaway cabinet system", and briefly introduces and analyzes the required technical modules.

## Keywords

Smart takeaway; Human-computer interaction; OpenWRT; temperature control; Fault alarm.

## 1. Introduction

According to the delivery and collection process of food delivery and collection users, on the basis of temperature control technology, a smart takeaway cabinet with necessary functions is designed. Based on the above analysis, the main technical modules of the intelligent takeaway cabinet system include openWRT-based intelligent access and retrieval technology, temperature control technology, human-computer interaction technology and fault alarm technology. Intelligent access technology can realize the needs of food delivery workers to put takeaways into takeaway cabinets and take meals from users, and realize the access technology of takeaway according to the user's relevant information. Temperature-controlled technology intelligently insulates according to the current temperature of the takeaway. Human-computer interaction technology is mainly to prevent others from taking meals at will, and to ensure the security of takeaway access by setting dynamic passwords. Fault alarm technology is mainly used for intelligent takeaway cabinet system in some functions can not be used normally when the feedback of the total system, so as to timely maintenance.

## 2. The Core Technology of Smart Takeaway Cabinet

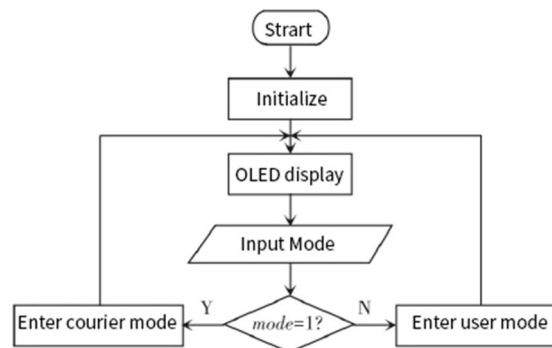
The core technology of the intelligent takeaway smart cabinet management system mainly includes intelligent access and meal technology, temperature control technology, human-computer interaction technology, and fault alarm technology. Intelligent access to meal technology can achieve the basic functions required by food delivery staff and meal users, temperature control technology to achieve temperature control of meals in the takeaway cabinet, human-computer interaction technology to achieve the necessary information interaction when accessing meals, fault alarm technology can provide convenience for later system maintenance.

### 2.1. Intelligent Access Meal Technology Based on OpenWRT

In the OpenWRT-based intelligent takeaway cabinet department under the campus, community and office building, after the delivery staff delivers the takeaway to the specified location, they can directly scan the QR code on the takeaway product label, open the cabinet door, and save the takeaway. Customers can go downstairs to pick up their meals at any time after receiving text messages, reducing waiting times and avoiding direct contact with food delivery staff, "retaining the user experience." The system uses the STM32 embedded development platform, combined with WiFi and Bluetooth modules, and openWRT technology to achieve self-service pickup. The system makes the privatized express box a product composition of the smart home, forming a new market demand and development needs.

The main program part of the system mainly selects to enter different working modes, and the overall design process is shown in Figure 1. First, initialize, including clock, delay, serial port baud rate, LED display and keys and other modules; then will update the display screen, display the work name and other information; by detecting the switch of the key, to determine what kind of working mode will be transferred in the 2 different options; if there is a key press, then enter the courier mode, if not, enter the user mode.

The main program part of the system mainly selects to enter different working modes, and the overall design process is shown in Figure 1. First, initialize, including clock, delay, serial port baud rate, LED display and keys and other modules; then will update the display screen, display the work name and other information; by detecting the switch of the key, to determine what kind of working mode will be transferred in the 2 different options; if there is a key press, then enter the courier mode, if not, enter the user mode.



**Figure 1.** System general flowchart

The delivery mode part is mainly used for food delivery workers to store takeaways, as shown in Figure 2. In the process, the parameters are initialized first, then the project name and the current working mode are displayed; then the delivery man enters the user's mobile phone number through the keystroke. If the input mobile phone number is less than 11 digits or more than 11 digits, the step of entering the mobile phone number is returned; if the 11-bit requirement is met, the cabinet door is opened by placing a relay signal of 1; thereafter, the cabinet door will be detected in a loop; when the cabinet door is closed, the infrared signal will detect whether there is an item in the box; if there is no item, the infrared signal is 0, return to the input mobile phone number interface, if there is an item, the infrared signal is 1, the verification code is randomly generated through the unlock code module and the verification code is sent through the SIM800c module.

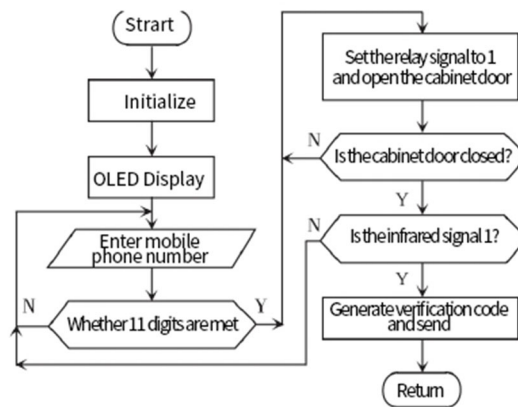


Figure 2. Courier mode flowchart

The user pickup part is mainly used for user pickup, and the specific process is shown in Figure 3. First the parameters are initialized; then the project name and the current working mode are displayed; then the verification code obtained by the user enters the key input; if the verification code is entered incorrectly, the step of entering the verification code is returned; if the verification code is correct, the cabinet door is opened by placing the 1 relay signal; thereafter, the cabinet door is always detected; when the cabinet door is closed, the infrared signal detects whether there is an item in the box; if there is no item, the infrared signal is 0, and the verification code information saved inside is cleared, if there is an item, If the infrared signal is 1, the captcha information is retained so that the captcha code can continue to be used next time.

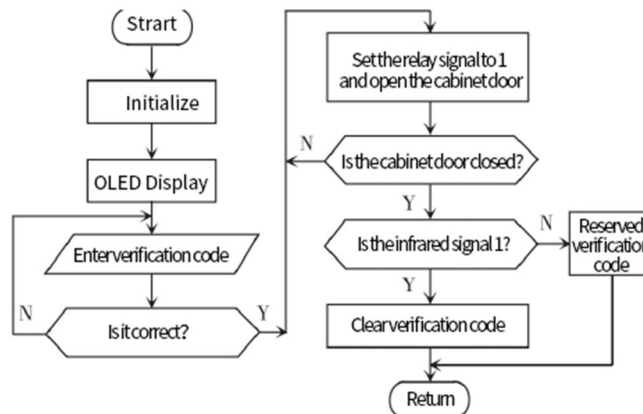


Figure 3. User mode flowchart

## 2.2. Temperature Control Technology

The application of temperature control systems in various walks of life in China has been very extensive, but from the perspective of domestically produced temperature controllers, the overall level of development is still not high, and compared with Advanced countries such as Japan, the United States, and Germany, there is still a large gap. Mature temperature control products are mainly based on "point" control and conventional PID controllers, which can only adapt to the general temperature system control, and the single-chip microcomputer can be tried to be used for intelligent and adaptive control instruments in higher control occasions.

This product mainly uses the temperature sensor DS18B20, which reads the measured temperature value and converts it. Detailed data for this sensor:

Temperature measurement range: -55 °C ~ +125 °C, the inherent temperature measurement resolution of 0.5 °C, the accuracy error is less than 1 °C.

The sensor uses temperature-sensitive elements to convert the temperature change into a change in the electrical signal, the temperature change and the change in the electrical signal have a certain relationship, the electrical signal can use the analog-to-digital conversion circuit that is, A / D conversion circuit to convert the analog signal into a digital signal, and the digital signal is then sent to the processing unit, such as a microcontroller or PC. This completes the basic temperature measurement function.

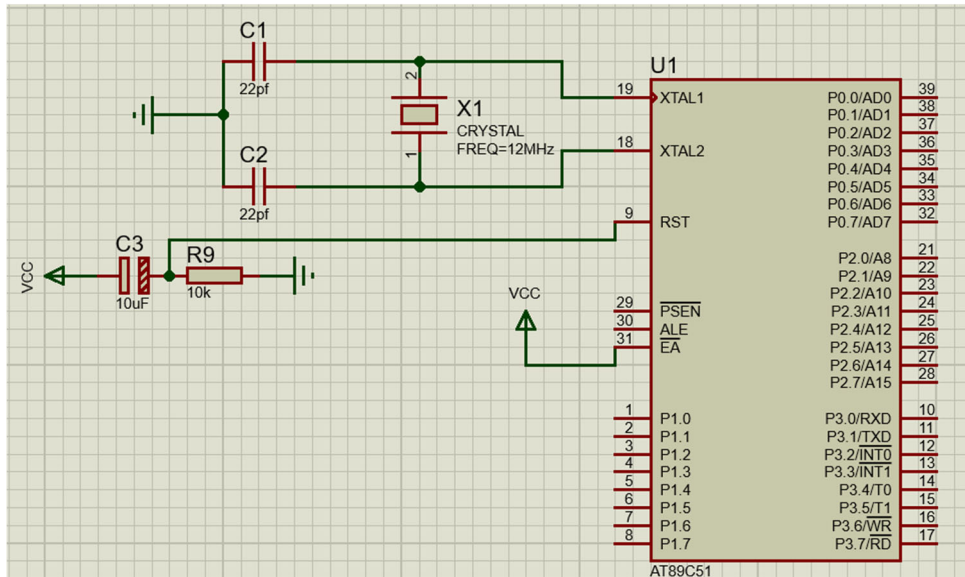


Figure 4. Minimum system diagram of a microcontroller

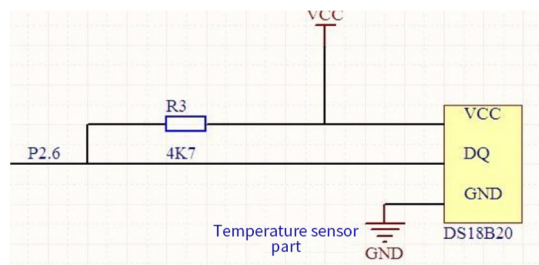


Figure 5. Schematic of the temperature sensor

### 2.3. The Originals Used in This Technology Mainly Include

#### 1. TEC1-12706 Semiconductor Refrigeration Sheet

Electronic refrigeration, also known as semiconductor refrigeration, or differential electric refrigeration, is a discipline developed from the 50s between the edge of refrigeration technology and semiconductor technology, which uses the P-N junction composed of special semiconductor materials to form a thermoelectric coupling pair, resulting in the Peltier effect, that is, a new refrigeration method through direct current refrigeration, and compression refrigeration and absorption refrigeration and called the world's three major refrigeration methods.

Semiconductor refrigeration principle: A type N and P semiconductor ion with metal connector soldered into an electric couple, when the DC current flows from the N pole to the P pole, the upper heat absorption phenomenon is generated, this end is called the cold end and the lower end produces an exothermic phenomenon, which is called the hot end. Because a single electric coupling produces a small thermal effect, dozens or hundreds of pairs of electric couplings are actually combined into thermopiles, that is, thermoelectric refrigeration components. Therefore, the refrigeration of semiconductors - heat absorption and exothermic heat

absorption are caused by the flow of carriers through the node, and the energy transfer caused by the change of potential energy is the essence of semiconductor refrigeration.

## 2. BT139-600E Triac

The heating temperature of the microcontroller is achieved by means of triac. The triac tube and heating wire are connected in series at AC 220V and 50Hz mains circuits. In a given cycle T, the microcontroller can change the power of the heating wire as long as it changes the corresponding port potential of the thyristor to achieve the purpose of regulating the temperature.

## 2.4. Human-Computer Interaction Technology

In the campus, community, office building downstairs layout intelligent takeaway cabinet system, the delivery staff will be taken to the designated location, you can directly scan the two-dimensional code on the takeaway goods label, open the cabinet door, put the takeaway into the cabinet, and then through the application of GSM module technology of the delivery system to send the meal information to the customer, the customer can go downstairs at any time after receiving the SMS to pick up the meal, reducing the waiting time and avoiding the direct contact of the delivery staff, you can optimize the experience of the buyer and seller together, reduce unnecessary disputes.

This module is mainly controlled by the SIM800c chip of the GSM network. Sim800c has stable performance, compact appearance and high cost performance, which can meet the various needs of customers. The SIM800c operates at 850/900/1800/1900MHz and enables low power transmission of voice, SMS, data, and fax information. The SIM800c measures 24\*24\*3mm and is suitable for a variety of compact product design needs.[12-14] At the same time, by supporting advanced features such as Bluetooth, customers can quickly develop and save costs. The design flow of this R&D module is shown in the following figure.

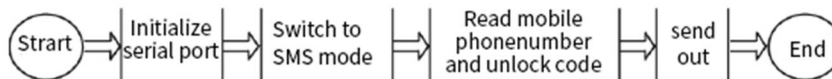


Figure 7. SMS sending and receiving schematic

## 2.5. Fault Alarm Technology

In the process of putting the smart takeaway cabinet into use, it may encounter a faulty situation, at this time it is necessary to rely on the fault alarm system designed in the smart takeaway cabinet to send out prompts, remind the user of use, prevent the user from causing some unnecessary injuries, and the alarm system can allow the company to send maintenance personnel in time to carry out targeted maintenance.

The originals used in this system mainly include:

### 1. STC89C51

The STC89C5 is a low-voltage, high-performance CMOS 8-bit microprocessor with 8K bytes of programmable erasable read-only memory (FPEROM—Falsh Programmable and Eras-able Read Only Memory), commonly known as a microcontroller. The erasable read-only memory of the microcontroller can be erased 1000 times repeatedly. The device is manufactured using STC high-density nonvolatile memory manufacturing techniques and is compatible with the industry standard MCS-51 instruction set and output pins. Due to the combination of a versatile 8-bit CPU and flicker memory in a single chip, the STC's STC89C52 is a high-efficiency microcontroller..

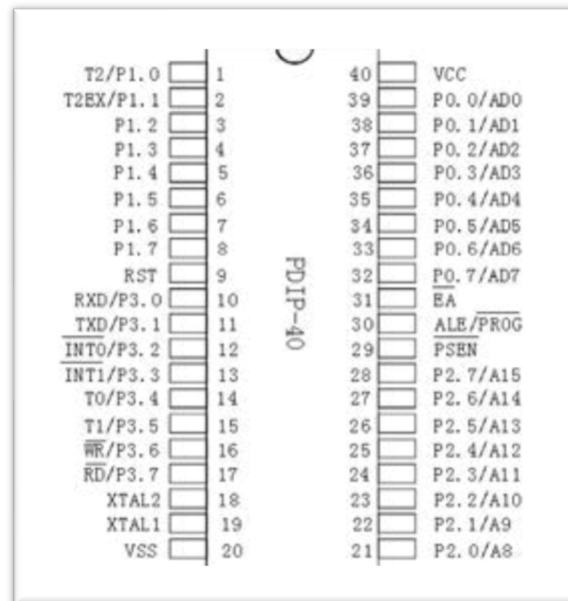


Figure 8. Schematic

## 2. DS18B20 digital temperature sensor

The DS18B20 is DALLAS' latest single-wire digital temperature sensor, which is small and economical. It is the world's first temperature sensor to support a "first-wire bus" interface. The unique and economical nature of the FPS makes it easy for users to assemble sensor networks, introducing new concepts for the construction of measuring systems. It measures a temperature range of -55 to +125°C. The field temperature is transmitted directly in the digital mode of "first-wire bus", which greatly improves the immunity of the system. Suitable for on-site temperature measurement in harsh environments, such as environmental control, equipment or process control, temperature measurement consumer electronics, etc. Unlike the previous generation, the new product supports 3~5. The 5V voltage range makes system design more flexible and convenient. And the new generation is cheaper and smaller. The DS18B20 can program a resolution of 9 to 12 bits with an accuracy of ±0.5°C. Smaller packages and wider voltage ranges are available. The resolution setting and the user-set alarm temperature are stored in the EPROM and are saved after power failure.

## 3. Conclusion

The design and implementation of the intelligent takeaway cabinet management system can reduce the contact during the takeaway delivery and pick-up process, meet the basic needs of epidemic prevention and control, and reduce the probability of disputes between takeaway workers and users. The system mainly uses OpenWRT's intelligent access and meal technology, temperature control technology, human-computer interaction technology and fault alarm technology, and completely plans a smart takeaway cabinet with multiple functions. In the later optimization and design, it will be continuously upgraded based on the above modules.

## Acknowledgments

This work was partially supported by National innovation and entrepreneurship training program for College Students (No. 202011488023).

## References

- [1] ASTOM J KWITTENMARK B. Computer controlled systems [M]. Prentice\_Hall, 1984.
- [2] Zhou Jiakang, Ma Guangfu, Hu Qinglei, et al. Delay depending decentralized adaptive attitude synchronization tracking control of spacecraft formation [J]. Chinese Journal of Aero-nautics, 2012, 25( 3) : 406-415.
- [3] PANTELEY E, LORIA A. On global uniform asymptotic stability of nonlinear time-varying systems in cascade [J]. Systems & Control Letters, 1998, 33( 2) : 131-138.
- [4] WANG Chao. Development of miniature temperature control box based on semiconductor refrigeration technology[D]. Xi'an:Shaanxi Normal University,2014.]
- [5] WANG Orange,HONG Mei. Design of incubator system based on STM32 microcontroller[J]. Journal of Changchun University (Natural Science Edition), 2015,25(4): 13-16.
- [6] ZONG Zhenhai,WANG Yaping,CHEN Zhizhi. Design of piglet intelligent constant temperature nursery box based on STM32[J]. Zhejiang Agricultural Sciences, 2014(1): 128-130.
- [7] WANG Zhi,SUN Qiang. Design of Semiconductor Refrigeration Chip Control System Based on STM32[J]. Electronic Design Engineering, 2015, 23( 18): 100-102.
- [8] CHEN Yonglu,ZHANG Li. Design and Implementation of Temperature Control System Based on Microcontroller[J]. Modern Electronics, 2015(2): 73-76.