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Methodology Article

Design of the Anti-Omission Shared Lockers System Based on the Single Chip Microcomputer

Ying Pan*, Guoqing Jia, Qian Lin

College of Physics and Electronics Information Engineering, Qinghai Nationalities University (Xining), Xining, China

Email address:
15709784650@139.com (Ying Pan)

*Corresponding author

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Abstract: In recent years, shared lockers have been widely used in supermarkets, libraries, exhibition halls and other places due to their features of high safety, reliability and convenience. However, existing lockers, because of their depth, tend to lose small items and are difficult to find. In addition, traditional barcode lockers are also easy to lose barcode. Based on this background, this paper presents a design scheme of the system for anti-omission of the shared locker based on the single chip microcomputer (SCM). In the scheme, STC89C52 single chip microcomputer is used as the main control chip, and the pressure sensor is used to detect whether there are things in the shared lockers and send the information to STC89C52 single chip microcomputer to achieve anti-omission function. Supplemented by relevant keyboard module, which is the input module of the system. Furthermore, display module and voice module are the output module of the system. The fingerprint module is used to input the user's information and used the information to open the door of shared lockers. GSM (global system for mobile communication) module is used to get help from administrator when the user needs to help, and so forth. This system can realize the function of preventing omission and it is simple to operation, high security, easy to manage by the administrator.

Keywords: STC89C52 Single Chip Microcomputer, Shared Lockers, Anti-Omission

1. Introduction

Lockers, one approach for delivery of purchased goods, can play an interesting role by supporting collaborative economy [1]. Lockers are generally divided into household lockers and business lockers, which are mainly used to facilitate people's use and store different items. It is also a must-have item for families or dormitories with small spaces. It can make full use of the space to accommodate more living items, and it can also decorate people's home. Shared lockers are widely used in our daily life due to their features of high security, high reliability and convenience. It can provide short-term storage services in many scenarios, such as factories, offices and hospitals.

However, most of the lockers applied at the present stage are barcode lockers [2]. This type of lockers is the most common lockers in our life, which is provided to users for free in many shopping malls. They provide one-time use only, if be in the process of taking content carelessly close cupboard door, that will not be able to open cupboard door afresh, also exist the circumstance that user loses small ticket to be unable to open. Even if re-leased, random open cabinets will not be used previously, which can only be resorted to staff.

Considering that the bar codes of such lockers are easy to be lost and are not environmentally friendly. Moreover, the traditional shared lockers are easy to lose small items and it is not easy to manage by administrator. This paper proposes a design scheme of the anti-omission shared lockers system based on the single chip microcomputer [3-4]. The system uses the combination of software and hardware to realize the function of anti-omission. The SCM is widely used because of its superior performance and low price [5-13]. It is the core processor in this system. Fingerprint identification is a widely used technology in various industries at present [14]. In this system, fingerprint identification can improve the overall security of storage cabinets. The keyboard module is used to simulate the button of the locker, and LCD12864 display

module and voice module are used to prompt the user to operate [15-17], so as to realize the simulation of the actual system of the shared locker.

2. System Composition

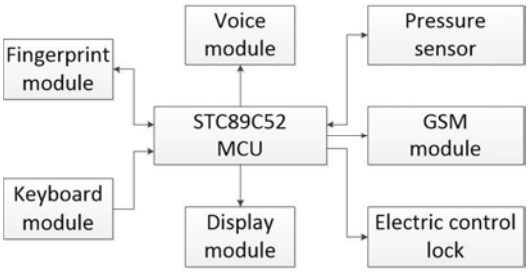

Figure 1. *The system structure diagram.*

This system mainly includes STC89C52 single chip microcomputer control module, which is the core part of the system. The pressure sensing module is mainly responsible for weighing, detecting whether the objects are overweight or missing in the lockers. The keyboard module is used to input. The display module and voice module is responsible for prompt. The GSM module is responsible for sending messages for help to administrators. The fingerprint module is used for fingerprint information input and reading. Electric lock is used to control the open of the door. The system structure diagram is shown in figure 1.

3. Hardware Design

3.1. The Minimum System

The STC89C52 chip is a low-power, high-performance microcontroller produced by STC. It has 8K byte system programmable flash memory. The STC89C52 chip provides highly flexible, ultra-efficient solutions for many embedded control application systems. The minimum system includes the power supply circuit, the clock circuit, the reset circuit and so on. The microprogrammed control unit (MCU) minimum system and its connection to the parts are shown in figure 2. The clock circuit decides the working speed of the single chip microcomputer. It adopts internal clock mode to provide clock signal for MCU system. The reset circuit determines the starting state of the single chip microcomputer to complete the starting process of the single chip microcomputer. The reset circuit generates a reset signal to complete the microcontroller to start and determine the starting state of the microcontroller. Reset circuit adopts the way of automatic reset by power on and button reset. As long as the high level which is added to RST pin lasts longer than 2 machine cycles, MCU can be reset normally.

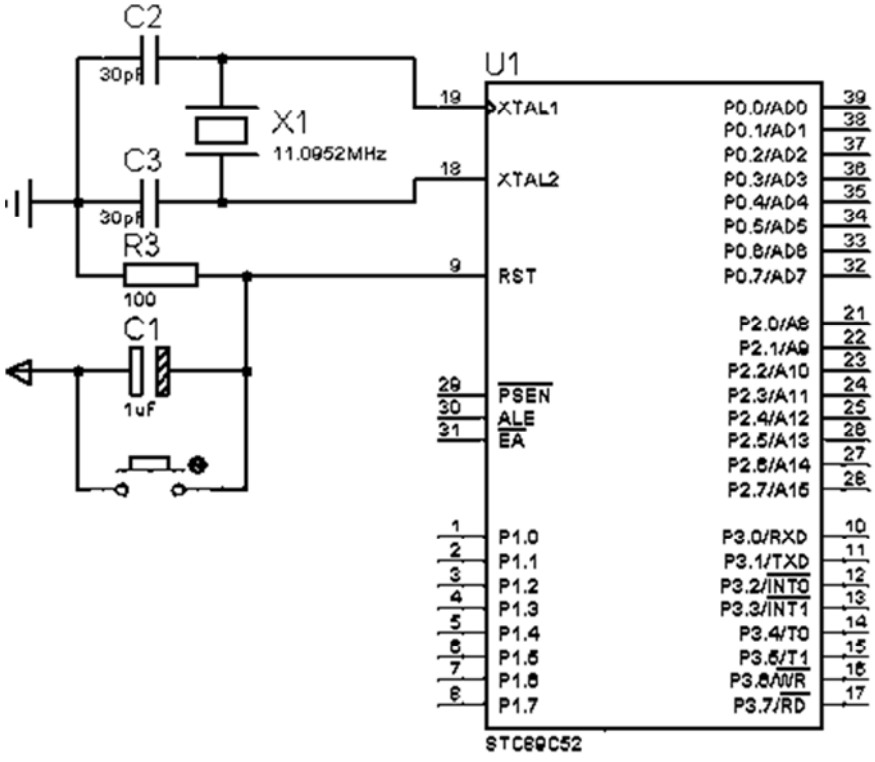

Figure 2. *The MCU minimum system.*

3.2. Fingerprint Module

With the development of technology, the application of fingerprint identification is more and more extensive. Fingerprint features such as uniqueness, lifelong invariability and no loss, and it has become the most mature biometric identification technology with its unique advantages.

The core of fingerprint image pattern recognition is to extract the organization form and order of fingerprint image components. These elements include texture, flow direction, center point, triangle point and detail feature point. The lines

of the skin on the inner surface of our fingers will form various patterns. The lines of the skin will be different in patterns, breakpoints and intersections, and they will be called "features" in the information processing. The features of each finger are different, that is, unique. With this uniqueness, we can match a person to his fingerprints, and verify his true identity by comparing his fingerprints to those of a previously-preserved fingerprint. The fingerprint identification system can automatically, quickly and accurately identify the individual identity through the collection, analysis and comparison of fingerprints through special photoelectric conversion equipment and image processing technology.

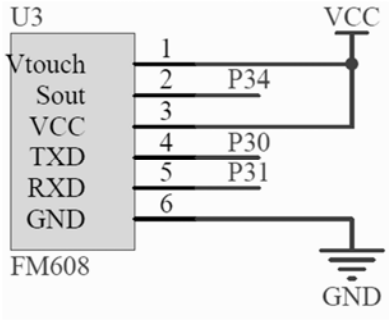

Figure 3. *The connection between fingerprint module and MCU.*

The system mainly includes fingerprint image acquisition, fingerprint image processing, feature extraction and matching. The optical fingerprint module of the series of FM-70 series, with high-performance and high-speed DSP processor as the core, combined with the optical fingerprint sensor with the company's independent intellectual property rights. It has the intelligent module with the functions of fingerprint input, image processing, fingerprint comparison, search and template storage without the management of the upper computer. Therefore, we use the FM-70 series optical fingerprint module, its port TXD and RXD are connected respectively with the port P3.0 and P3.1 of the SCM. The connection between fingerprint module and MCU is shown in the figure 3.

AT24C02 is a 2k-bit serial CMOS E2PROM containing 256 8-bit bytes. CATALYST's advanced CMOS technology substantially reduces the power consumption of the device. AT24C02 has a 16-byte page write buffer. The device operates through the IIC bus interface and has a dedicated write protection function. In the system we use AT24C02 to Memory users' fingerprint information. The connection between AT24C02 and MCU is shown in the figure 4.

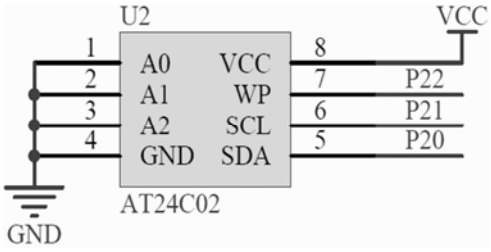

Figure 4. *The connection between AT24C02 and MCU.*

3.3. Pressure Sensing Module

HX711 is a 24bit A/D converter chip specially designed for high-precision electronic scales. Compared with other chips of the same type, this chip integrates peripheral circuits required by other chip of the same type, including stabilized voltage power supply, on-chip clock oscillator, etc., which has the advantages of high integration, fast response speed and strong anti-interference. This system adopts the pressure sensor module with HX711 A/D converter as the main part to reduce the cost of the whole system and improve the performance and reliability. The schematic diagram of HX711 A/D converter is shown in figure 5.

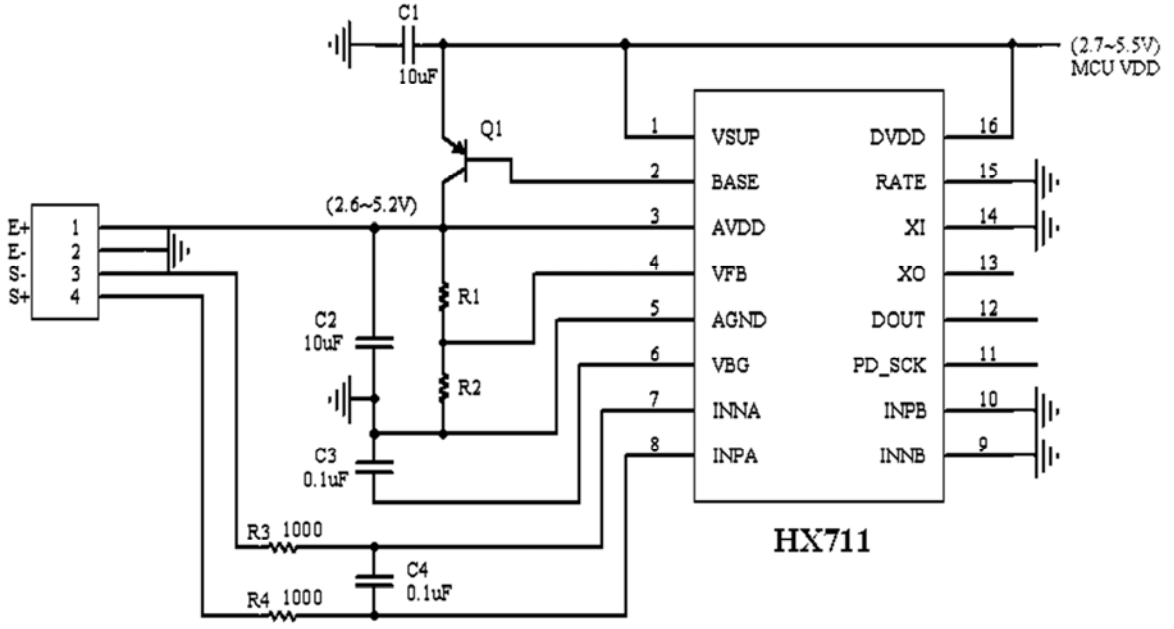

Figure 5. *The schematic diagram of HX711 A/D converter.*

The interface and programming between the chip and the back-end MCU chip are very simple. All the control signals are driven by the pin, and there is no need to program the register inside the chip. The input select switch can optionally select channel A or channel B, connected to its internal low-noise programmable amplifier. The stabilized power supply provided within the chip can be supplied directly to the external sensor and the A/D converter within the chip, without additional analog power supply on the system board. The clock oscillator in the chip does not require any external device. Power on automatic reset function simplifies the initialization process of starting up.

The data output pin DOUT and digital input pin PD_SCK of the chip are connected to the I/O port of the single chip, and the RATE is grounded to the X1 pin, then the clock oscillator inside the chip can be used to determine its data output RATE to be 10Hz. The serial communication line consists of pin PD_SCK and DOUT to output data, select input channels and gain. When the DOUT of the data output pin is high, it indicates that A/D converter is not ready to output data. At this point, the serial clock input signal PD_SCK should be at low level. When DOUT changes from high to low level, PD_SCK should input 25 to 27 clock pulses. The rising edge of the first clock pulse will read out the highest value of the output 24-bit data until the completion of the 24th clock pulse, and the output of 24-bit data is completed bit by bit from the highest value to the lowest value. The 25th to 27th clock pulses are used to select the input channel and gain for the next A/D conversion.

Its reference driver code is

```
sbit HX711_DOUT=P3^6;
sbit HX711_SCK=P3^7;
unsigned long HX711_Read(void)
{
unsigned long count;
unsigned char i;
HX711_SCK=0;
count=0;
while(HX711_DOUT);
for(i=0;i<24;i++)
{
HX711_SCK=1;
count=count<<1;
HX711_SCK=0;
if(HX711_DOUT)
count++;
}
HX711_SCK=1;
count=count^0x800000;
HX711_SCK=0;
return(count);
}
```

In this system, the pressure sensor with the HX711 module converter is used to detect whether there is an item in the cabinet and whether the item is overweight. The pressure sensor has four output pins, namely power supply, grounding, HX711_DOUT and HX711_SCK, in which HX711_DOUT and HX711_SCK are connected to I/O port P3.6 and P3.7 of the single chip, respectively.

3.4. Voice Module

In this design, the speech module mainly plays the role of prompting operation for customers. This is the YS-M3 speech playback module, which has 9 direct trigger ports: A1-A9. These 9 ports are corresponding to 9 MP3 audio files. The module's trigger mode is low level trigger. It can also be connected to a speaker or to a stereo via a built-in headphone jack. The connection between the voice module and the MCU is very simple. Only a number of I/O ports of the MCU are needed to control the playback of the corresponding speech files through the MCU. The physical graph of the voice module is shown in figure 6.

Figure 6. *The physical graph of the voice module.*

3.5. Display Module

The display module used in this system is LCD12864, which is a lattice graphic liquid crystal display module with 4-bit/8-bit parallel, 2-line or 3-line serial multiple interface modes, and contains national standard level I and level II simplified Chinese font library. It has a display resolution of 128x64, with 8192 characters with 16*16 points, and 128 ASCII characters with 16*8 points. By using the flexible interface mode and simple and convenient operation instruction of the module, the human-computer interaction graphical interface in Chinese can be constructed. It can display Chinese characters on lines 8x4, 16x16, or it can finish the graphic display. The liquid crystal display scheme composed of the module is much simpler than the other type of lattice liquid crystal display module, and the price of the module is slightly lower than that of lattice liquid crystal. The connection between the display module and the microcontroller only needs to occupy a number of I/O ports of the microcontroller. By writing the program, the display of Chinese characters, English characters, symbols and other characters can be realized. Its connection with the

microcontroller is shown in figure 7.

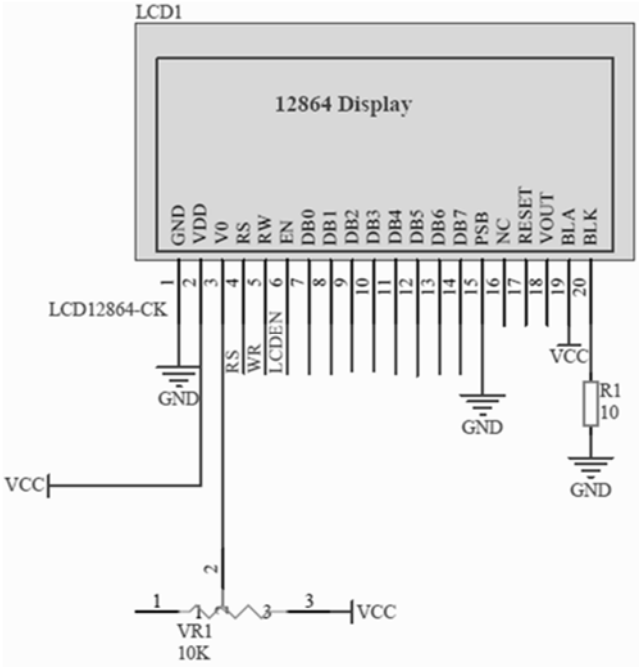

Figure 7. *The module connection with the microcontroller.*

3.6. GSM Module

Global mobile communication system is known as GSM, which is the most widely used mobile phone standard. More than 1 billion people in more than 200 countries and regions around the world are using GSM phones. The biggest difference between GSM and previous standards is that its signaling and voice channels are both digital, so GSM is regarded as a second generation (2G) mobile phone system.

This system adopts the SIM900A as GSM module. It belongs to dual-frequency GSM/GPRS module, totally adopting SMT package form, with stable performance, exquisite appearance and high cost performance. The SIM900A adopts industrial standard interface with working frequency of GSM/GPRS 900/1800MHz. It can realize voice, SMS, data and fax information transmission with low power consumption. In addition, the size of SIM900A is 24*24*3mm, which is suitable for various design requirements in M2M applications, especially for the design of compact products.

The GSM module in this system is mainly used to send text messages to the locker administrator for help when the user needs help. The connection method is as follows: 52MCU TXD (port P3.1) is connected to 5VR (port RXD). The RXD (port P3.0) of 52 MCU is connected to 5VT (TXD). MCU GND is connected to SIM900A module GND; VCC_MCU access (input) of SIM900A module 5V; The VCC access (input) of the SIM900A module is 5V.

The role of GSM module in this system provides users with the convenience of asking administrators for help. When the lockers have problems, the user can send a text message to the user via the help button.

3.7. Electric Control Lock

Electric lock is a mechanical lock controlled by relay. The terminal of the electric lock is actually an electromagnet, which controls a simple mechanical device to switch the door. But electromagnets work through a series of commands. In this system, when the fingerprint module is successfully recorded or compared, it will send a information to the single chip microcomputer to control the electronic control lock to open the door.

4. Software Design

The system software design adopts C language programming, and the integrated development environment is Keil 4, which is a software development system compatible with C language, and can complete the process of compiling, linking, debugging and simulation. Compared with assembly language, C language has strong readability and calculation ability, and is very portable, easy to learn and easy to use, which can reflect the advantages of high-level language. The window management system of Keil 4 is flexible and supports multiple display Windows.

In order to realize the above functions, the software design of the system is designed as followings and the flow chart of system design is shown in figure 8.

1) In the initial state, the LCD12864 display module shows "welcome, please press the ‘SAVE’ key to save the package, and press the ‘TAKE’ key to take the package";
2) When the user presses the ‘SAVE’ button, the LCD12864 display shows "please input fingerprint", and the voice module plays the voice file No.1, the content of file No.1 is "please input fingerprint", and the fingerprint module begins to work and prepare to input fingerprint;
3) Fingerprint input successfully, LCD12864 display module shows "fingerprint input successfully, please close the cupboard door after put items", voice module plays the voice file No.2 at the same time, the content of file No.2 is "fingerprint input successfully, please close the cupboard door after put items", the cupboard door open, and on the LCD12864 screen shows "cupboard door is open, your container number is ‘***’". Users put into their items, when the goods’ weight is exceeded to the maximum limit set, LCD12864 display module will show "items are overweight, please remove some items", voice module plays the voice file No.3, content is "items are overweight, please remove some items", cupboard door can’t be closed. Only users’ items weight is lower than the maximum, cupboard door can be closed;

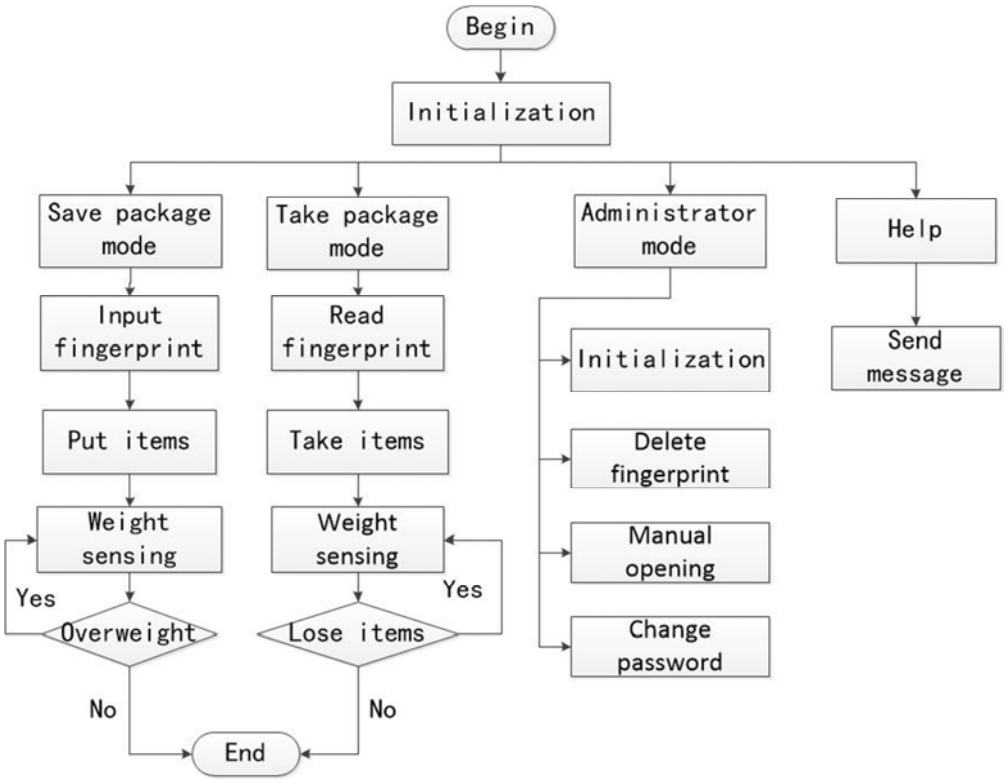

Figure 8. *The flow chart of system design.*

4) When the user press the "TAKE" key, LCD12864 display module shows "please input fingerprint", the voice module plays the voice file No.1. When the fingerprint information input is successfully, cupboard door open. Similarly, LCD12864 display module shows "cupboard door is open, your container number is '***', please remove all items", voice module plays the voice file No.4 at the same time, the content is "cupboard door is open, please remove all items".
5) The system cannot close the door when the user fails to pick up all items. When the weight value of the pressure sensor to MCU is within the set range, display module shows "you have lost items, please take all items", and the voice module plays the voice file No.5, the content of it is "you have lost items, please take all items". The pressure sensor is always in the state of weighing during this period and the information is transmitted to the MCU for processing. Only when the pressure is very small and close to 0g, the pressure sensor gives a change signal of state to the microcontroller and the door of the cabinet can be closed. Moreover, the fingerprint information and the door information of the corresponding cabinet will be cleared after the door is closed.
6) The system sets the administrator mode. When the user is an administrator, press the "ADMINISTRATOR" key and input the administrator password, he can enter the administrator mode. Function 1 is "initialization": the administrator can use this function to open all cabinet doors to see if any user left out items and carry out maintenance work. Function 2 is "delete fingerprint": the administrator can delete the fingerprint information of any cabinet door to initialize the current cabinet door. Function 3 is "manual opening": any cabinet door can be opened by input cabinet door number. Function 4 is "change password": the password of getting into administrator mode can be changed;
7) When the user presses the "HELP" button, the MCU receives the instruction to send the help message to the administrator by enabling the GSM module.

5. Conclusion

In this paper, a design scheme of a MCU-based system for anti-omission of a shared locker is proposed. Compared with ordinary lockers, omission prevention is the biggest innovation and difficulty of the system. The design of omission prevention provides great convenience for users, prevents the loss of users' items and avoids some unnecessary troubles for users. At the same time, the use of GSM module also plays an important role in the management of administrators. The method of fingerprint access saves consumables. Moreover, compared with bar code lockers, it also prevents the inconvenience caused by losing bar code and improves the security of the system. The use of voice module brings convenience to users' operation. The design has the advantages of functional utility, simple operation, high security and easy to manage by the administrator. It can better serve the general public and has high value of application.

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