



Design and Implementation of Goods Storage Cabinet Based on K210 Face Recognition

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Abstract. This design is based on the fact that public lockers will be used to store items in shopping and supermarkets in an epidemic environment. It is necessary to reduce long-term stay in public places and avoid contact with public goods under epidemic prevention and control, and to store them safely, quickly and intelligently. In this paper, the design of face recognition intelligent locker will be realized through STM32F103 and K210 camera. Obtain the information of important parts of human face, process and save the face data, and then control the accuracy through face comparison, so as to ensure the reliability and safety of the system, realize rapid access to articles through human face information, and effectively reduce the time spent in public places and contact with public articles. Use STM32 to control the automatic door switch to reduce contact and improve safety. When retrieve articles, that article can be retrieved directly by recognizing faces, and the storage cabinet door will be automatically close after being taken out, thus greatly improving the efficiency and safety of the storage cabinet.

Keywords: Face Recognition; STM32F103; Lockers; K210

1 Introduction

With the development of society, the progress of science and technology and the current special environment, goods storage also plays a more important role. In order to improve the convenience of people's travel, people's demand for storage is increasing in the process of study, work, exercise, travel, etc [1]. In recent years, there have also been relatively novel ideas and objects, especially in the express delivery industry in China. For example, the hive solves the problem of express lockers for storing users' goods,

† Corresponding author brief introduction: Tan Hanhong, female, master, associate professor, research direction is electronic system design automation, embedded system and intelligent control.

and the face recognition lockers made this time reduce the phenomenon of people staying in queues for a long time in supermarkets, shopping malls, schools and other public places [2]. In order to reduce people's staying in the same space for too long and contact with public goods, which leads to the spread of epidemic situation, the electronic locker system based on facial recognition technology is convenient, fast and automatic when accessing goods. It is applied to the functional test and performance test on the embedded platform. The system runs stably and reliably, has good real-time performance and high accuracy, and meets the basic requirements in the actual storage scene [3]. On this basis, the automatic switch of locker is added to reduce contact and ensure safety.

2 System design

In this design, M3 core microcontroller STM32F103C8T6 is used as the main control chip. This system mainly includes: STM32F103C8T6 minimum system module, K210 module, LCD liquid crystal display module, OV2640 camera module and steering gear module. This design focuses on the function of face recognition, the function of saving and picking up items in the express cabinet. In this design, STM32F103 and K210 are selected for serial communication to realize interactive information transmission. STM32F103 chip adopts minimum system and steering gear module, steering gear uses timer to control PWM duty ratio to realize steering gear angle rotation, K210 camera module realizes gray processing of face image for face recognition and assists equalization processing [4] and algorithm processing, and realizes automatic switching through face recognition combined with STM32F103 serial communication.

The hardware circuit uses STM32F103 minimum system to communicate with K210 module to drive the steering gear of the module to realize the opening and closing function. When K210 displays information through LCD screen and feeds back to the user to realize human-computer interaction, it sends instructions to STM32, and outputs PWM through STM32 minimum system to control the steering gear rotation angle, and controls the steering gear to only control the opening and closing of one steering gear, and finally designs and realizes the face recognition system. The overall block diagram is shown in Figure 1. System design schematic diagram is shown in Figure 2.

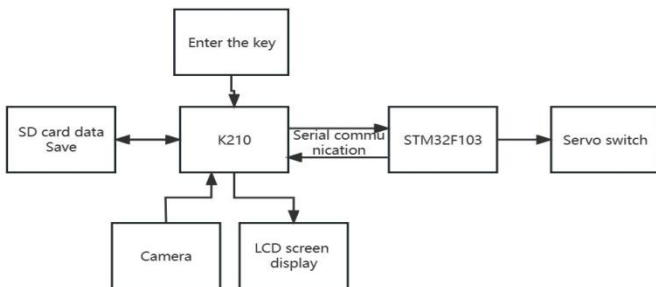


Fig. 1. Overall system block diagram

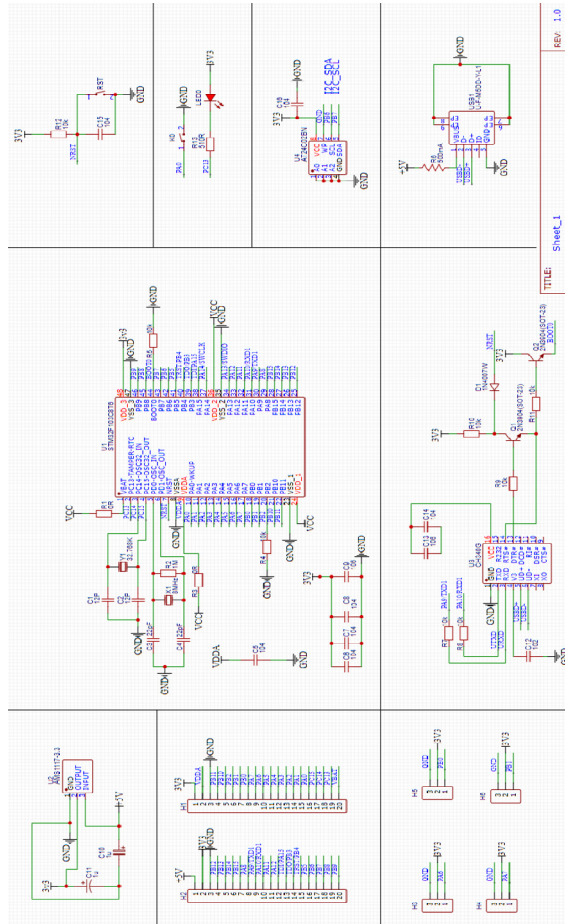


Fig. 2. System design schematic diagramsystem software design

Face recognition is realized by the cooperation of camera module, and the opening and closing are controlled by STM32. How to open and close multiple lockers in an orderly way at the same time? After entering the face, the lockers will be opened and counted this time. When the user needs to take out the items, the lockers will not be opened again after counting twice, and then the other lockers will be opened[5]. Considering that the user will come to access the items again, for the convenience of next time, it is no longer necessary to enter the face, and the step of entering the face can be opened without it, as shown in Figure 3.

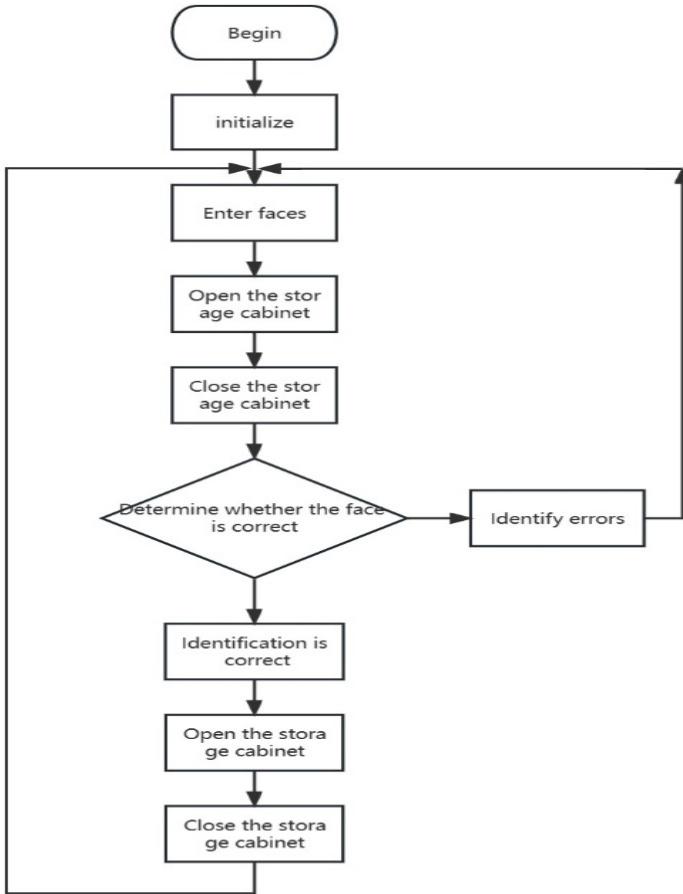


Fig. 3. Flow chart of main program

3 Debugging and analysis

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To control the switch of the steering gear by STM32F03C8T6 single chip micro-computer, it is necessary to debug the PWM duty ratio of each steering gear accurately to improve efficiency, which is also an important part of control[6]. It is divided into several steps as follows:

- a) Test whether the power supply is on, check the working status, and see if there is anything wrong with the power supply of the module.
- b) After electrifying, check the working condition of the single chip microcomputer, whether the lamp is lit and whether the writing is normal.
- c) Check whether the function of the steering gear module is intact and whether the rotation angle is correct.
- d) Check whether the camera module store is normal and whether it is normal at first.
- e) Check whether the face recognition is accurate and whether the recognized image is displayed normally.

4 Comprehensive debugging

Before module assembly, write the program of each module in advance, and then integrate it into the power-on test object. The camera module displays the initial state of the locker, and the information of the locker is shown in Figure 4.



Fig. 4. Express cabinet display

The face information is entered in advance through the camera module, and after the face information is stored, the information will be sent to STM32 through serial communication. STM32 controls the storage cabinet door to open automatically, and the storage cabinet door is controlled by the steering gear. STM32 will control the steering gear to close the storage cabinet door automatically with the removal of articles.

The picking process is to recognize the face information entered in advance by coming to the camera module, and then the face information will be fed back to the camera LCD module to remind the user that the recognition is successful, as shown in Figure 5. Then STM32 will control the steering gear to rotate at an angle to open the storage cabinet door, and then STM32 will control the steering gear to rotate and automatically close the storage cabinet door with the taking out of articles.

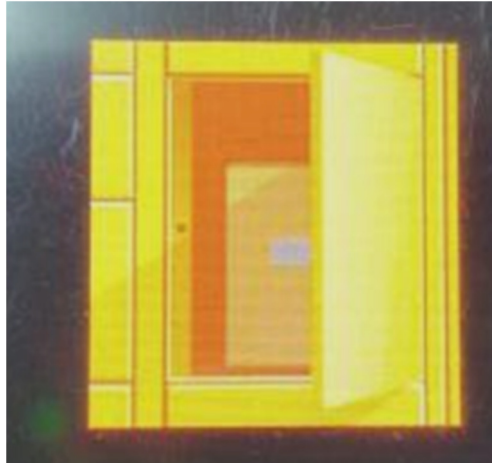


Fig. 5. Identification completed

When the face information is not entered in advance and comes to the camera module, it will not be recognized. When it is re-recognized, it will be compared with the face information entered in advance. When the comparison number exceeds 85%~90%, it will be recognized as the face information that has been entered in advance. Then, the data will be sent to the STM32 single chip microcomputer through serial communication, and then the STM32 single chip microcomputer will process it and other instructions are shown in Figure 6.

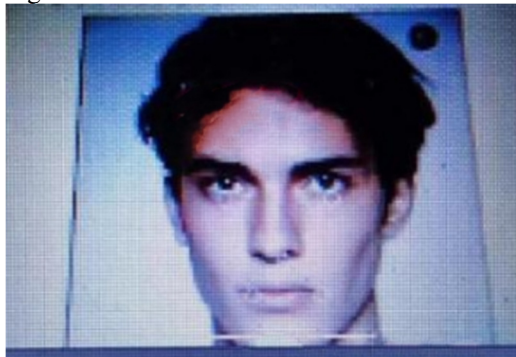


Fig. 6. Correct identification

Since the face information is not pre-input during recognition, the K210 will compare the face information with the input face information in real time. If the input face information is inconsistent with the pre-input face information, the matching will fail. The value will only jump within a certain range and will not exceed the value 80. As shown in Figure 7, the input face information is inconsistent with the pre-input face information, and the value shows 61.7, which is less than 80, and the matching fails.



Fig. 7. Error Identification

After the camera module is determined, the steering gear module is debugged. The hardware wiring of the steering gear is relatively simple, with only three wires: power wire, signal wire and ground wire. The steering gear of SG90 model is adopted, which consumes about 10mA in idle time and 100-250mA in rotation. At the beginning, the steering gear angle is set to close to ensure that the storage cabinet door is closed. The initial setting pulse width is 1ms, and the angle at which the book output shaft of the steering gear will move to the minimum position is 0 degrees, as shown in Figure 8.



Fig. 8. Steering gear 0 degree

After receiving the correct recognition signal through STM32, control the steering gear to rotate and simulate the opening of the storage cabinet. Set the pulse width to 1.5ms, and the steering gear will rotate from 0 to 90 degrees to meet the requirements of the opening and closing of the storage cabinet, as shown in Figure 8. When the user finishes accessing, it will automatically return to 0 degree and the analog storage cabinet will

be closed. In order to prevent the same user from re-identifying the storage cabinets used before re-opening after accessing them, if it is necessary to identify the stored items, other storage cabinets will be opened to ensure that there are no errors in the storage cabinets and ensure safety. Considering the users who come to store goods, they can directly open the storage cabinet to store goods after hiring faces once and then storing goods without entering faces. Steering gear 90 degrees is showed in Figure 9.



Fig. 9. Steering gear 90 degrees

5 Conclusion

In this paper, the expected design contents, such as face recognition, LCD display, PWM control, steering gear control and so on, can be accurately controlled and applied. However, in the application process, it can effectively reduce the stay time of people, and can quickly store and take out items, which is also more convenient and faster in combination with the foundation of life. Compared with the complicated and complicated process before, the traditional password and QR code are replaced by face recognition through research and practice, and the response speed and safety are far higher than now. The hardware of this design is also relatively simple, and they are all common devices in the market, and the price is relatively affordable. Other devices can also be used as replacement changes. Therefore, the common chips in the market are used to coordinate and connect with each other by means of face recognition, and their respective performances and advantages are brought into play.

Supported projects

2022 Dongguan City Social Development Technical Project- "Key Technology Research of Intelligent Drug Delivery Robot" (20221800903652); 2021 provincial first-

class undergraduate course "Single Chip Microcomputer Principle and Application" (certificate number: 202210728); 2021 Ministry of Education Industry-University Co-operation Collaborative Education Talent project- "Construction of school-enterprise integration innovation practice base for electronic information engineering under the background of new engineering" (202102521048); 2022 Guangdong University of Science and Technology's school-level teaching achievement cultivation project -"industry-university-research-innovation" integrated electronic information engineering innovative talent training model Exploration and Practice (GKZLGC2022229)

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