A kind of Intelligent access control system based on STM32 Microcontroller Unit

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ABSTRACT

In recent years, with the construction and development of computer technology, sensing technology, identification technology and 5G network in our society, Microcontroller Unit (MCU) technology has entered a rapid development stage, constantly changing the production and lifestyle of our society. On this basis, production and lifestyle are constantly developing towards comfort and intelligence, which has become a social trend. Based on this background, an access control system with single-chip microcomputer as the core of the system is designed. The core component of this access control system is STM32f103vet6 single chip microcomputer, which uses human infrared, touch screen, steering gear, RFID and other sensors and modules to realize the functions of password, IC card identification and fingerprint identification. And alarm function of buzzer and LED lamp; The opening and closing function of the door lock. On this basis, a voice broadcast function is developed, which can automatically broadcast the reserved information of visitors. At the same time, WeChat applet is developed for remote access.

Keywords: Embedded single chip microcomputer, access control system, intelligent monitoring, RFID, remote access

1. INTRODUCTION

In our daily knowledge, the so-called access control is a control device that restricts access to visitors at the entrance and exit of a channel. Intelligent access control system in the past is a mechanical door lock, itself is more primitive and simple. But at the same time, the simple mechanical lock is limited by its own composition of materials, its upper limit is very low, and it is always a simple mechanical device, so the door lock of a pure mechanical device, although its design structure is reasonable, does not have the same performance as the intelligent door lock in terms of security and management[1]. The invention and popularization of electronic magnetic card lock and electronic combination lock have improved the management degree of access restrictions on entrance and exit visitors to a certain extent, making the access control system enter the era of electronic lock from the traditional mechanical lock, but with its more and more extensive application, they themselves have a high failure rate, slow opening and closing speed, and rigidity[2-8].

Therefore, a low failure rate, high processing efficiency, flexible and convenient intelligent access control system is needed to replace the traditional mechanical locks and later developed electronic locks.

2. GENERAL SYSTEM FORMULA

This research applies the embedded single chip microcomputer technology to the control of the access control system and takes STM32f103 single chip microcomputer as the core component. The design of the intelligent access control system is expected to be divided into three parts, the first part is as the identity of the visitor to collect the information collection part, the second part is the information processing part of the collected visitor information to the original system to compare the written information, the third part is the execution of different reserved instructions according to the information comparison results.The overall design of the system is shown in Figure 1.
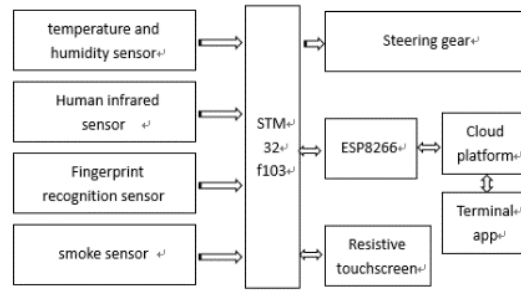
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Figure 1. General design of the system.

3. SENSOR DESIGN

3.1 The radio frequency sensor

This design uses the RC522 module of the radio frequency identification devices (RFID) technology as an identification module of the access control system based on the following reasons: 1) the carrier of RFID generally has the characteristics of antimagnetic, waterproof and high temperature resistance, so its stability is strong; 2) the module is a highly integrated non-contact read/write card chip. It is low voltage, low cost and small size, considered to be a very cost-effective product among the modules of the RFID series. The specific working parameters of the module are shown in the following Table 1.

This module has LC series resonant circuit. When the card reader emits a set of fixed frequency electromagnetic waves, the two frequencies are the same to generate resonance so that there is charge in the capacitor. When the accumulated charge reaches 2V, the capacitor provides working voltage for other circuits to read the data in the card in Table 1.

Table 1. Parameters of the RC522.

Parameter	Value	Parameter	Value
Working current	3～26mA	Size	37.5mm×33mm
Resting current	<80uA	Ambient operating temperature	-20～80°
Peak current	<30mA	Ambient storage temperature	40～85°
Working frequency	13.56MHz	Ambient relative humidity	5%～95%

3.2 The temperature and humidity sensor

DHT11 temperature and humidity sensor module uses a single bus communication mode to transfer the acquired data to the single chip computer, and a complete data transmission is 40bit high first out; Therefore, this communication method is more stable and accurate, and can work in most ranges in Table 2.

Table 2. Operating parameters of the DHT11 T/H sensor.

Parameter	Value	Pin	
Temperature measuring range	0°C~+50°C	VCC	3.3V
Humidity measuring range	20%RH~95%RH	GND	GND
power supply mode	DC 3.3~5V	PUT	PE6
output	digital，serial data，sigle bus		
weight	8g		
PCB size	32*14mm		

3.3 The human infrared sensor

The SR501 human infrared induction module will be blocked in the following period of time after the data output after each induction of personnel (high level becomes low level). The following Table 3 is the working parameter table of the infrared module in Table 3.

Table 3. Working parameters of the SR501 infrared sensor.

Parameter	Value	Parameter	Value
Working voltage	Dc4.5v~20v	Induction range	<120°,<7 meters
Quiescent dissipation	50ua	Working temperature	-15~+70°C
Output	3.3v，0v	Pcb size	32*24mm，screw pitch：28mm，stud size：2mm
Delay time	Adjustable (8~200second)	Trigger mode	L:Unrepeatable，h :Repeatable，default

3.3The smoke sensor

The occurrence of home, shopping mall, and warehouse fire is dangerous, the design of In the cost consideration, choose the lower cost of MQ2 smoke sensor. The sensor uses the chemical properties of tin dioxide as a gas sensitive material to realize the detection function of gas. The following is the working parameter table of the smoke sensor module and the appearance design and the pin connecting the module and the MCU chip in this design in Table 4.

Table 4. Working parameters of the MQ2 smoke sensor.

Parameter	Value	Pin	
Loop Voltage	<=24V	Do	Pc4
Heater Voltage	5V	Ao	Pc10
Parameter	**Value**	**Pin**	
Load Voltage	Adjustable	Vcc	5V
Sensitivity	>=5%	Gnd	Gnd
Density Slope	<=0.6%		

3.4 The fingerprint recognition sensor

From the fingerprint sensor module can store fingerprints and cost-effective two aspects to consider, the fingerprint recognition module used is the AS608 fingerprint module. The AS608 module used in this case can store 300 different fingerprints, which can meet the needs of most cases.

The following is the working parameter table, and the appearance design and the pin connecting the module with the MCU chip in this design in Table 5.

Table 5. Working parameters of the AS608 fingerprint sensor.

Parameter	Value	Pin	
Resolution ratio	500dpi	Touch vin	3.3v
Supply voltage	3.3v	Touch out	Pb12
Supply current	<60ma	Vin	3.3v

Communication interface	Usb/uart	Tx	Pa3
		Rx	Pa2
Fingerprint entry time	<1 second	Gnd	Gnd

4. COMMUNICATION DESIGN

For meeting the design requirements of low cost, high performance, easy development and strong stability, and also meeting the development requirements in the future product upgrade, the ESP8266 module is selected as the WI-FI communication module for this research, so that it can carry out remote communication to achieve the remote access function of the system.

The module has three working modes: ST mode, AP mode and ST+AP mode. The main steps of communication between the module and the cloud server are shown in the following Figure 2. Below is the table of Pin assignment for the WI-FI module in Table 6.
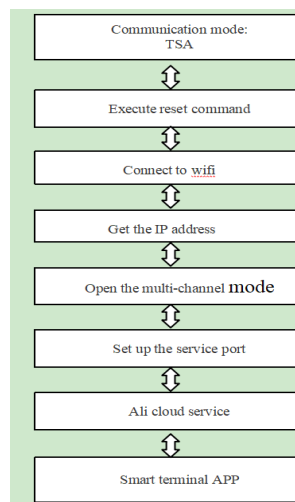

Figure 2. The ESP8266 module connecting with the cloud server steps.

Table 6. Esp8266 Pin assignment.

Esp8266	MCU	Esp8266	MCU
URXD	PB10	CH-PD	PB8
UTXD	PB11	RST	PB9

5. OTHER HARDWARE DESIGN

The principle of the steering machine is to receive PWM signals, so that the internal circuit generates a bias voltage, triggering the motor through the reduction gear to drive the potentiometer to move, the voltage difference is zero, the motor stops, to achieve the desired servo effect. The specific control of the steering gear is to give the steering gear a specific PWM signal and rotate the steering gear to a specific Angle.

The touch screen is used to display the environmental parameters of the intelligent access control system detected by the sensor, feedback different data parameters, and display the operating status of each device in the system. At the same time, managers can manually control external devices through the touch screen. According to the control requirements of the intelligent access control system, the design uses the MCU 2.8 inch resistance touch screen as the display and control equipment of the environmental parameters of the access control system. It has the characteristics of high resolution of HD true color, strong anti-interference performance, powerful function, low power consumption and energy saving, and can fully meet the requirements of the system.[9-13]

6. SOFTWARE DESIGN

There are two software development tools for this design, one is Keil uVision5 and the other is Visual Studio Code. Among them, Keil uVision5 is used for the development of microcontroller programs, and Visual Studio Code is used for the development of Intelligent terminal APP. First of all, IC card identification function debugging is as Figure 3 (a).Password function test is shown as Figure 3(b). Fingerprint recognition function test is shown as Figure 3(c)..The steering gear function and sensors debugging are all successful shown as Figure 3(d).
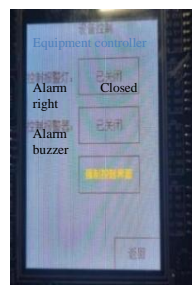
7. CONCLUSION

This intelligent access control system design is based on STM32 MCU. It has realized the following functions:1). Can detect the smoke concentration of temperature and humidity around the access control system.2). Can identify whether someone has entered the scope of the access control system.3).IC card identification, fingerprint identification, password identification, intelligent terminal APP identification to open the access control.4). Can be LED and buzzer alarm.5). Can broadcast information by voice.6). Visitor information can be displayed.This study can provide people with a variety of identification to open the door by the SCM based access control system, to meet the laboratory, warehouse, home and other environments of access control, with simple operation, low power consumption, high precision and high reliability characteristics.
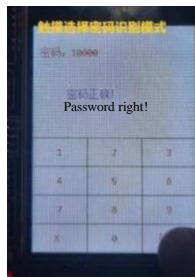
| (a)IC card test | (b)Password test | (c) Fingerprint test | (d) Sensors test |

Figure 3. System test.

REFERENCES

[1] Lang, Z, W. and LI, Y., "Design and optimization of electromagnetic lock structure," Micromotor, 54(02), 31-34 (2021).
[2] Zhang, D., "Design of intelligent lock based on STM32 MCU," Light source and illumination, 02, 85-86 (2021).
[3] Lv, W, H. and Li, S, J., "Application research of face recognition access control system in college apartment management," Computer knowledge and technology, 17(31), 137-138 (2021).
[4] Lin, J, Q., Tang, Y, F., Zheng, H, P. and Ma, Z, F., "Intelligent access control system design based on Internet of Things cloud platform," Internet of Things, 12(01), 95-98 (2022).
[5] Lin, R, Q., Tan, W, N., Chen, Z, Y. and Qin Q. "Design of Face Recognition Access Entrance Guard System with Mask Based on Embedded Development," Journal of Physics: Conference Series, 1883(1), 1-2 2021.
[6] Huang, S, F., Qu, F, K. and Wu, T, G., "Design of a multifunctional entrance guard system using GSM and fingerprint identification," Journal of Physics: Conference Series,1550(4), 1-2 (2020).
[7] Zhang, Y. and Liu, J, F., "New intelligent security door based on STM32," Electronic design engineering, 30(03), 58-62 (2022).
[8] Su, S, X., Ma, X, H., Yang, Nan., Li, J., "Research and design of intelligent access control system in laboratory based on Internet of Things," Automation and instrumentation, 37(02), 105-108 (2022).
[9] Tushar, R, K., Rowshon, A., Md, S, I., Semanto, M, M., Tanseer. A., "Improved Embedded Vehicle Safety System With STM32," 22nd International Conference on Computer and Information Technology (ICCIT), IEEE, 1-2 2019.

[10] Liu, W, H. and Dai, J, D., "Design of Attitude Sensor Acquisition System Based on STM32," Fifth International Conference on Instrumentation and Measurement, Computer, Communication and Control (IMCCC), IEEE, 1-2 (2015).

[11] Yang, S., Chen, Y, D. and Sun, J., "Design of the General Video Driver Interface Based on STM32," IEEE International Conference on Mechatronics and Automation (ICMA), IEEE, 1-2 (2022).

[12] Wu, R, J., Chen,Y. and Ke, H, H., "STM32 microcontroller-based closed-loop speed control drive system design for FOC motors," IEEE Asia-Pacific Conference on Image Processing, Electronics and Computers (IPEC), IEEE, 1-2 (2022).

[13] Zhang, H, F. and Zhao, J., "The design of RF data acquisition system based on STM32 and FPGA," International Conference on Multimedia Technology, IEEE, 1-2 (2011).