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※ Graduation Project ※
※ Materials for the ※
※ Class of 2024 ※
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Graduation Project

Project	**Design and Implementation of Escalator control system based on STM32**
Name	**Yuqi Hao**
Student ID	**200620432**
Faculty	**School of Information and Electronic Engineering**
Major	**Electronic Information Engineering**
Supervisor	**Associate Professor Qiuxiang Zhu**

June 07, 2024

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※ Graduation Project ※
※ Materials for the ※
※ Class of 2024 ※
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Graduation Project Plan

Project	**Design and Implementation of Escalator Control System Based on STM32**
Name	**Yuqi Hao**
Student ID	**200620432**
Faculty	**School of Information and Electronic Engineering**
Major	**Electronic Information Engineering**
Supervisor	**Associate Professor Qiuxiang Zhu**

January 31, 2024

1. Teaching objectives of the design

(1) Cultivate students' development and design capabilities, and improve their ability to analyze and solve problems using the knowledge and skills they have learned.

(2) Conduct a comprehensive and systematic review and summary of the knowledge learned. Through the analysis of specific topics, combine theory with practice, consolidate and develop the knowledge learned, and master correct thinking methods and basic skills.

(3) Improve independent thinking ability and work style of unity and cooperation.

(4) Improve programming and software application skills.

(5) Mastered the methods of literature retrieval and information query.

2. Main content of design

(1) Understand the specific situation of the escalator and design and select the corresponding hardware modules.

(2) Solve the problems existing in traditional escalators, introduce intelligence and safety into them, and improve user experience.

(3) Design an escalator control system, which mainly includes infrared tube detection module, drive module and sound and light alarm module.

(4) To achieve specific functions:

1) Use MX1508 to drive two DC motors to simulate going up and down escalators (one forward rotation represents going up, and one reverse rotation represents going down).
2) Each escalator will count the number of people. If the number of people on the escalator is not 0, it will run at high speed. If the number of people on the escalator is 0, it will run at low speed.
3) Each escalator has two buttons, which serve as emergency brake buttons. When pressed, the elevator stops running. Press it again and the elevator will run normally.
4) The gravity is detected by the gravity detection module, and when it is overweight, an audible and visual alarm is issued.
5) The system recognizes special emergency keywords through the voice recognition module and automatically stops the escalator.
6) The voice broadcast module is used to remind escalator passengers of the current escalator status.
7) The display module can show information such as the number of people going up

and down the escalator, the operating status, etc.

8) Through the Bluetooth module, the escalator operation status can be sent to the mobile phone, which can start and stop the escalator and modify the weight threshold.

3. Basic requirements for design

(1) The graduation project theme is related to the major studied. The graduation thesis should have a prominent focus, substantial content, sufficient arguments, strong demonstration, reliable data, compact structure, clear levels, clear charts, standard format, fluent text, neat handwriting, and correct conclusions.

(2) All units of measurement used in the thesis shall be based on international standard units.

(3) Explanations should be given to the figures and tables in the paper, and they should be uniformly numbered and titled and placed in the corresponding positions. If there are too many figures of the same type, they can also be listed as appendices at the end of the paper.

(4) The length of the thesis should be more than 6,000 words. Graduation thesis should be printed on A4 paper according to the school's requirements.

(5) The format of reference citation should comply with national standards.

4. Schedule

Serial number	Design content at each stage	Expiration date
1	Determine the topic	January 31, 2024
2	Issue a task order	January 31, 2024
3	Thesis defense	March 16, 2024
4	Submit first draft	April 03, 2024
5	Submit the second draft	April 20, 2024
6	Submit the third draft	May 08, 2024
7	Submit final draft	May 22, 2024
8	Reply	May 25, 2024

5. References

[1] L. Li, Z. Wang. A simple method for building an escalator control system test device[J]. China Elevator, 2022, 33(24): 28-34.

[2] G. Li, Q. Duan. Risk assessment of escalator electrical system based on functional safety[J]. China

Elevator, 2022, 33(23): 43-44, 49.

[3] F. Gao, H. Yan. Research and development of a non-contact escalator operation safety parameter detection system[J]. China Elevator, 2022, 33(11): 36-38, 41.

[4] F. Dai. Design of a high-safety escalator operation control system[J]. China Elevator, 2020, 31(17): 25-27.

[5] H. Cao. Design of full frequency conversion speed control escalator based on PLC[J]. China New Communications, 2019, 21(21): 122-123.

[6] X. Li, X. Miao. Conceptual design of escalator simulation test system based on single chip microcomputer[J]. China Elevator, 2019, 30(12): 12-20.

[7] Z. Li. Application of PLC in medium-height escalator control system[J]. Shandong Industrial Technology, 2018, (13): 107-108.

[8] W. Wu. Design and research of full frequency conversion speed control escalator based on PLC[D]. Hangzhou: Zhejiang University of Technology, 2017.

[9] C. Jiang. Research on anti-reverse protection of escalator sensor[J]. Science and Technology, 2017, (5): 12.

[10] W. Jiang, X. Li. Design of escalator electrical control system based on PLC[J]. Heilongjiang Science and Technology Information, 2017, (1): 48.

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※ Graduation Project ※
※ Materials for the ※
※ Class of 2024 ※
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Opening Report of Graduation Project

Project	**Design and Implementation of Escalator Control System Based on STM32**
Name	**Yuqi Hao**
Student ID	**200620432**
Faculty	**School of Information and Electronic Engineering**
Major	**Electronic Information Engineering**
Supervisor	**Associate Professor Qiuxiang Zhu**

March 14, 2024

Design Topic	Design and Implementation of Escalator Control System Based on STM32

Basis of the project: 1) Design plan (main tools used in the design, expected functions and parameter requirements, main functional modules, etc.).

2) Your own opinions (mainly thoughts on the formulation of design plans, design difficulties and solutions, and design innovation).

1 Design Plan

1.1 Main tools used in design

Programming language: C language;

Software tools: Microsoft Visio (flowchart drawing auxiliary tool), AD (schematic and PCB drawing software), Keil μVision5 (C language software development system) ;

Hardware equipment: PC, thin film pressure sensor, DC motor, infrared radiator, power bank, etc.

1.2 Expected functions and parameter requirements

This system consists of ST M32 microcontroller, thin film pressure sensor module, voice recognition module, Bluetooth module, DC motor driver module, buttons and power supply. The specific functions are as follows:

(1) DC motor drive module: Use MX1508 to drive two DC motors to simulate going up and down escalators.

(2) Infrared radiator detection module: Each escalator will count the number of people. If the number of people on the escalator is not 0, it will run at high speed. If the number of people on the escalator is 0, it will run at low speed.

(3) Button module: Each escalator has two buttons, which serve as emergency brake buttons. When pressed, the elevator stops running. When pressed again, the elevator runs normally.

(4) Gravity detection module: detects gravity and issues an audible and visual alarm when overweight.

(5) Voice broadcast module: reminds passengers of the current escalator status.

(6) Display module: can display the current escalator up and down, operation and stop status and other information.

(7) Bluetooth module: can send the escalator operation status to the mobile phone, which can start and stop the escalator and modify the weight threshold.

(8) Voice recognition module: When a danger occurs, the system can recognize special emergency keywords and stop the escalator.

1.3 Main functional modules

This design uses a single-chip microcomputer as the core controller, and other modules together form the entire system of this design, including the central control part, the input part and the output part. The central control part uses a single-chip microcomputer controller, whose main function is to obtain the data of the input part, and finally control the output part after internal processing and logical judgment. The input consists of five parts. The first part is the infrared counter-radiation sensor module, through which two pairs of infrared counter-radiation tubes are used to count the number of people; the second part is the voice recognition module, through which the voice is recognized , and when a specific voice for help is recognized , the escalator is automatically stopped; the third part is the film pressure detection module, which detects gravity through the gravity detection module; the fourth part is the button module, which scans the buttons. If the emergency stop button is pressed, it will stop urgently, and if the emergency stop button is not pressed, it will stop urgently; the fifth part is the power supply module, through which the entire system can be powered. The output consists of four parts. The first part is the DC motor drive module, which drives two DC motors to simulate the up and down escalators (one forward rotation represents the up and one reverse rotation represents the down); the second part is the sound and light alarm, which will sound and light alarm when overweight is detected; the third part is the display module, through which the current information status of the escalator can be obtained; the fourth part is the voice broadcast module, through which the escalator passengers are reminded of the current escalator status. In addition, this design also has a Bluetooth module, which can transmit the data received by the microcontroller to the Bluetooth APP on the mobile phone, and can also send commands such as starting and stopping the escalator and modifying the weight threshold through the Bluetooth APP to control the entire system. The specific system block diagram is shown in Figure 1.

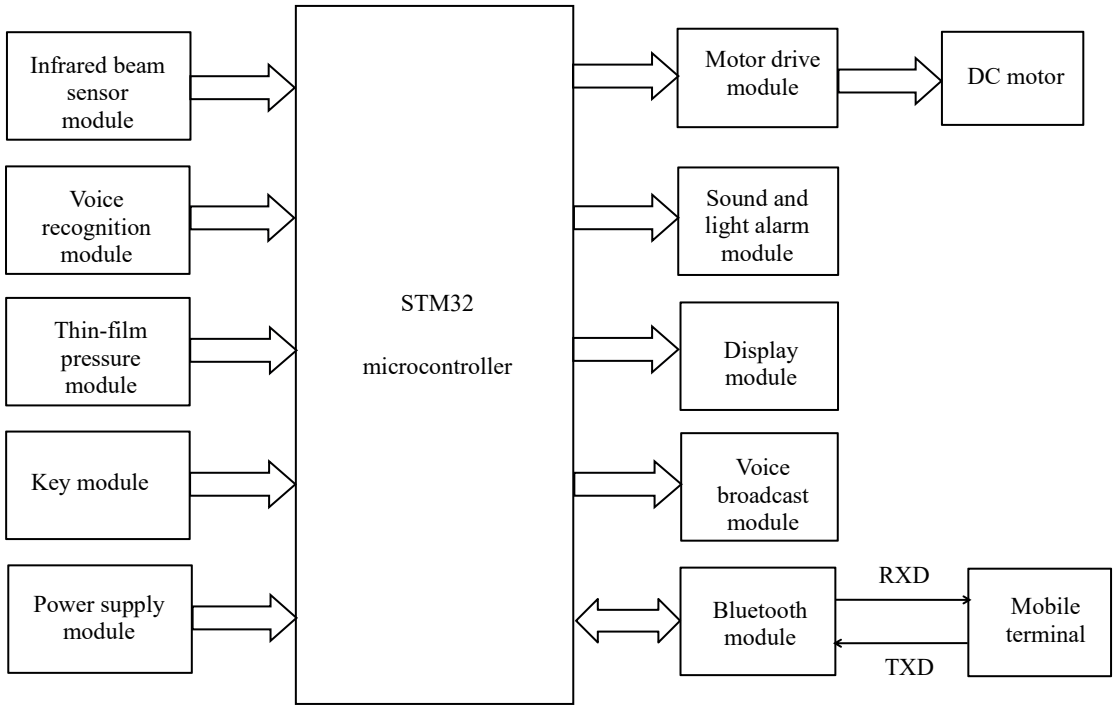

Figure 1 System main function block diagram

2 My own opinion

With the continuous acceleration of urbanization, the demand for transportation is growing. As an important part of urban transportation facilities, escalators, while providing convenient travel, also face more management and safety challenges. There are some problems with the traditional escalator operation mode, such as high energy consumption, insufficient safety, and uncomfortable riding experience. Therefore, designing an escalator control system based on a single-chip microcomputer has become an important topic at present.

This project aims to use modern microcontroller technology to introduce intelligence and safety into the operation and management of escalators to improve passengers' travel experience and ensure their safety. As a common means of transportation in people's daily lives, the operating efficiency, comfort and safety of escalators directly affect passenger satisfaction. By introducing an escalator control system, the following goals can be achieved:

Improve operating efficiency and comfort : Through intelligent control, the operating speed can be automatically adjusted according to the number of passengers on the escalator,

reducing energy consumption and improving riding comfort; Enhance safety: The introduction of the emergency braking function can immediately stop the escalator in an emergency to ensure the safety of passengers. The overweight alarm function can also remind passengers to reduce the load and reduce the risk of accidents; Remote monitoring and control: Through the Bluetooth module, the operating status of the escalator can be transmitted to the mobile phone in real time, so that maintenance personnel can monitor the status of the escalator at any time, perform remote diagnosis and control; Adapt to future development: With the continuous advancement of science and technology, people's demand for the intelligence and convenience of transportation is also increasing. Designing an automatic escalator control system based on a single-chip microcomputer can not only meet current needs, but also provide a good foundation for future development.

To sum up, the design background of this project is to solve the problems existing in traditional escalators, introduce intelligence and safety into them, improve user experience, and contribute to the upgrading and improvement of modern urban transportation facilities.

I think we should first understand the feelings of ordinary users about the use of escalators , and learn about the sales of escalator systems through Taobao, Tmall, JD.com, etc., and then learn about the current status of escalators through CNKI, VIP, smart home, electronic reading room, Baidu Encyclopedia, etc. Then we should determine the design function, select the device to realize the function, draw the schematic diagram and PCB, solder the actual object, debug, and finally realize the function of this design.

Main contents of the design:

The escalator control system is designed by using the single-chip microcomputer STM32F103C8T6 as the main control module. Various peripheral hardware are added to detect various data and transmit data through the single-chip microcomputer. The escalator can achieve reliable up and down movement. When no one is on the escalator, the motor will automatically reduce the speed to save power. There is also an emergency stop button next to the escalator, which can effectively protect it in the event of an accident. When there are too many people on the escalator and it is overweight, an audible and visual alarm will automatically be issued to remind the people who have just boarded the escalator, which can minimize the occurrence of accidents. If an accident really occurs, the voice recognition device can automatically stop the escalator when it receives the call for help from the person to prevent the situation from further deteriorating. The system can display information such as the number of people going up and down the escalator, the operation and stop status, etc. through the display module. The operation status of the escalator can also be sent to the mobile phone through the Bluetooth module, and the mobile phone can start and stop the escalator and modify the weight threshold.

Completion deadline and main measures to be taken :

1. Time schedule for completing the design:

Confirm the topic and issue the task book on January 31, 2024

Design thesis defense March 16, 2024

Submit first draft on April 3, 2024

Second draft due April 20, 2024

Submit the third draft on May 8, 2024

Final draft due May 22, 2024

Graduation Project Defense May 25, 2024

2. Main measures taken:

(1) Consult literature extensively through channels such as CNKI, read relevant professional books, and determine the topic.

(2) Through the literature review method, you can think deeply and get ideas for writing

your paper.

(3) Clarify ideas, define the scope and framework, key and difficult technical research, experimental simulation and emulation, and focus on innovative points and specific details.

(4) Make the actual object according to the design and check the functional completion of the object.

(5) Design, code, write, revise, finalize and complete the graduation project.

Main references:

[1] Z. Chen, S. Li, H. Tan. Design of a temperature monitoring device for escalator braking resistor[J]. China Elevator, 2023, 34(7): 67-68, 84.

[2] L. Wang, C. Chang. Design and inspection of non-manipulated reversal protection for escalator[J]. Special Equipment Safety Technology, 2023, (3): 28-29.

[3] Y. Xiao, C. Lu, Y. Shen. Design of a stopping distance detection system for escalators and moving walks[J]. China Elevator, 2023, 34(4): 25-26, 30.

[4] Z. Zhou, Z. Jiang. Escalator speed project test based on single chip signal detection and simulation[J]. Special Equipment Safety Technology, 2023, (2): 46-48.

[5] G. Feng, Y. Zhang, B. Gan, et al. Design and finite element analysis of escalator anti-fall device[J]. Mechanical Manufacturing & Automation, 2022, 51(5): 85-87.

[6] D. Wang. Design and calculation of escalator auxiliary brake[J]. China Elevator, 2022, 33(19): 36-38.

[7] M. Wei. Research on PLC single chip control of escalator[J]. Today's Manufacturing and Upgrading, 2022, (9): 62-65.

[8] Z. Chen, H. Tan, S. Li. Design of an escalator with adaptive entrance and exit passenger status[J]. China Elevator, 2022, 33(12): 62-64.

[9] H. Huo. Discussion on PLC single chip control of escalator[J]. Journal of Jiamusi Vocational College, 2020, 36(1): 189-190.

[10] X. Li, X. Miao. Conceptual design of escalator simulation test system based on single chip microcomputer[J]. China Elevator, 2019, 30(12): 12-20.

[11] S. Hu. Design of escalator control system based on PLC[J]. Electronic World, 2015, (20): 65-67.

Supervisor's comments:

The student chose "Design and Implementation of Escalator Control System Based on STM32" as the graduation project topic, which mainly includes infrared counter-radiation sensor module, voice recognition module, film pressure detection module, button module, DC motor drive module, sound and light alarm module, display module and voice broadcast module, etc., which has certain theoretical and practical use value. This topic is determined by the student after referring to a large amount of literature, conducting a certain market demand analysis, and analyzing and discussing with the instructor. It is in line with the professional training program and training objectives, can consolidate students' basic knowledge, and improve students' research ability and skills. The proposed research methods, research ideas and research plans are reasonable, feasible, and of moderate difficulty. Students can complete the design of this topic within the scheduled time, and agree to start the topic!

Sign:

Date:

<table>
<tr><td colspan="7">The Opening Report Meeting</td></tr>
<tr><td>Time</td><td colspan="3">March 19, 2024</td><td>Place</td><td colspan="2">Tencent Meeting 291-464-746</td></tr>
<tr><td rowspan="5">Attending meeting member</td><td>Name</td><td>Position (title)</td><td>Name</td><td colspan="2">Position (title)</td><td>Name</td><td>Position(title)</td></tr>
<tr><td>Weichu Xiao</td><td>Professor</td><td></td><td colspan="2"></td><td></td><td></td></tr>
<tr><td>Saichun Hu</td><td>Associate Professor</td><td></td><td colspan="2"></td><td></td><td></td></tr>
<tr><td>Yong Ye</td><td>Lecturer</td><td></td><td colspan="2"></td><td></td><td></td></tr>
<tr><td>Maolin Li</td><td>Teaching Assistant</td><td></td><td colspan="2"></td><td></td><td></td></tr>
<tr><td colspan="7">Meeting Minutes:

1. How do you plan to control the speed and stability of the motor?
A: I will change the PWM signal, which is a square wave with adjustable duty cycle, in the program, so that the voltage at both ends of the controllable motor changes accordingly, thereby achieving motor speed control. In the high-speed mode of the motor, it cannot be made too fast, which will lead to instability. In the low-speed mode, it cannot be too slow, which will lead to difficulty in starting and jamming during operation. It should be adjusted to an appropriate speed.
2. Is there any difference between your design and a normal escalator?
A: The escalator can automatically adjust the running speed according to the number of passengers on the escalator to reduce energy consumption; overload alarm function
It can also remind passengers to lighten their load and reduce the risk of accidents; it can also be remotely monitored and controlled via Bluetooth.
3. What role can your display function play?
A: For example, the current escalator weight, escalator overweight threshold, the number of people going up and down, and status information.

Host:
Recorder:
Date:</td></tr>
<tr><td>Opinions of the guidance group</td><td colspan="2">Signature of responsible person:

Date:</td><td>Opinion of the College</td><td colspan="3">Signature of responsible person:

Date:</td></tr>
</table>

Hunan City University Graduation Comprehensive Training Mid-term Checklist

Faculty: School of Information and Electronic Engineering

Class: 2006204

Pass	Yellow Card Warning	Failure

Date of filling: April 2024

Student Name	Yuqi Hao	Student ID	200620432	Supervisor	Qiuxiang Zhu
Title	Design and implementation of escalator control system based on STM32				
Start and end time	January 31, 2024 to April 24, 2024	Place	On campus	Telecommunications Building 104	
			Off-campus		
Plan progress	Confirm the topic and issue the task book on January 31 , 2024 Design thesis defense 2 March 16 , 2024 Submit first draft on April 3 , 2024 Second draft due April 20 , 2024				
Current completion status	Second draft completed				
Progress Status	☑Good □General □ Delay (within 3 weeks) □Severe delay (more than 4 weeks)				
Attendance	Perfect attendance	Ask for leave	Not signed in	Instructor's signature:	
		2 days	0 times		
Instructor's comments	Does the student take the initiative to discuss issues with the instructor?	☑Yes	□ No	Instructor's signature:	
	Whether a yellow card warning is recommended based on the student's progress?	□ Yes	☑No	Instructor's signature:	
Inspection team conclusion	☑Qualified	□ Yellow Card Warning	□ Unqualified	Instructor's signature:	
Reasons for delay and Solution	Student fill in				
	To be filled in by the instructor				
Review opinion	The student's current progress in comprehensive graduation training	□ Actively improve	□Improved	□No improvement	
College inspection conclusion	Progress	□ Normal	□ Yellow Card Warning	□Serious lag	

Note: 1. This form is to be filled out truthfully by the student and the instructor , one copy for each student, and the professional inspection team will review the conclusion .

2. Please fill in √ in the corresponding column when selecting an item.

3. Good: progress is ahead of plan; Average: can be completed on time; Delayed: can be completed after speeding up the progress; Severely delayed: there is a high possibility that the task cannot be completed.

Dean's Signature: **April 2024**

Graduation Design Defense Application Form

Student ID	200620432	Name	Yuqi Hao	Faculty	School of Information and Electronic Engineering	
Major	Electronic Information Engineering				Instructor	Qiuxiang Zhu
Design topic name	Design and implementation of escalator control system based on STM32					

Design requirements and process plan

Start and end time	Requirements	Completion	Instructor sign
January 31, 2024	Determine the topic and issue the task book	Completed	
March 16, 2024	Design thesis defense	Completed	
April 03, 2024	Submit first draft	Completed	
April 20, 2024	Submit the second draft	Completed	
May 08, 2024	Submit the third draft	Completed	
May 22, 2024	Submit final draft	Completed	

Brief introduction to graduation project features (quantity, quality, innovation):

This graduation project is about 13,000 words long and completes the design and implementation of an escalator control system based on the STM32F103C8T6 chip. This design includes an infrared beam sensor module, a voice recognition module, a film pressure detection module, a button module, a DC motor drive module, an audio and light alarm module, a display module, and a voice broadcast module. It realizes functions such as operation control, number counting, emergency braking, overweight alarm, voice recognition, voice broadcast, and data display. In terms of innovation, voice and Bluetooth emergency stop escalator functions are added to improve the safety of the escalator; an overweight alarm function is added to reduce the risk of accidents.

Do you agree to participate in the defense?

The student designed an escalator control system with STM32F103C8T6 microcontroller as the core. The test results show that the system can realize operation control, people counting, emergency braking, overweight alarm, voice recognition, data display and other functions, and has certain practical value. The design text written is in a standardized format, with clear levels and reasonable structure, which meets the requirements of undergraduate graduation design. In the design process, various design requirements can be completed according to the schedule, and the organization and discipline are strong. I agree to participate in the defense.

Main instructor (signature) :

Date:

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Student Graduation Project Defense Evaluation Form

Project Name	**Escalator control system based on STM32 Design and Implementation**
Name	**Yuqi Hao**
Student ID	**200620432**
Faculty	**School of Information and Electronic Engineering**
Major	**Electronic Information Engineering**
Instructor	**Associate Professor Qiuxiang Zhu**

May 22, 2024

Graduation Project Instructor Evaluation Form

Major: Electronic Information Engineering Student: Yuqi Hao

Topic: Design and implementation of escalator control system based on STM32

	Level and score / item Head (Full score for this item)		Comments point wait class A	B	C	D	each files have to point A	B	C	D	score
refer to guide teach division 40%	Complete the mission at level and quality 50	1. Data collection and collation and argumentation (10)	complete	More complete	Basically complete	Difference	9-10	7-8	5-6	≤ 4	**9**
		2. Basic concepts and theoretical background (10)	Clear and correct	Basically clear Basically correct	Still clear Still correct	Not sure Incorrect	9-10	7-8	5-6	≤ 4	**9**
		3. Calculation method and results (15)	Correct, more computer applications	Basically correct Small amount of applications	Still correct Application	Incorrect Not applied	13-15	10-12	7-9	≤ 6	**14**
		4. Independent insights and application value (5)	Yes, Larger	Yes, general	Yes, No or None, General	None, None	5	4	3	≤ 2	**4**
		5. Instructions and drawings (10)	Clearly structured, correct, meticulous and neat, with correct foreign language abstracts	Basically correct, more serious, more clear	Still correct, still serious, basically correct	Many mistakes, serious, incorrect	9-10	7-8	5-6	≤ 4	**8**
	Ability to work independently 30	6. Plan formulation and selection (10)	Completed independently and correct	Basic independence Done Correctly	Can complete the basic tasks independently	Cannot complete independently and makes many mistakes	9-10	7-8	5-6	≤ 4	**8**
		7. Specifications and manual usage (8)	skilled	Basic proficiency	Fair	Basically no	8	7	6	≤ 5	**6**
		8. Programming, analysis and processing of computer results, reading of domestic and foreign literature (12)	Proficient in actively reading and digesting citations	Basic proficiency in reading and citing	Still OK Check references	Basically no Check references	11-12	9-10	7-8	≤ 6	**10**
	Work attitude 20	9. Observe discipline (10)	good	better	generally	Difference	9-10	7-8	5-6	≤ 4	**10**
		10. Take care of public property and maintain a good environment (5)	good	better	generally	Difference	5	4	3	≤ 2	**5**
		11. Work responsibility and initiative (5)	powerful	better	generally	Difference	5	4	3	≤ 2	**5**

Review comments of the Supervisor

Comments:

Yuqi Hao's topic "Design and Implementation of Escalator Control System Based on STM32" has certain practical significance. It basically completes the specified tasks. It uses STM32 microcontroller as the control center of the escalator system to realize operation control, number counting, emergency braking, overweight alarm, voice recognition, voice broadcast, data display and other functions. The design text written is in a standardized format, with clear levels and reasonable structure. The design ideas and plans are complete, and the experimental results are correct, which shows that the student has a good professional and technical foundation and the ability to independently analyze and solve problems. It meets the requirements of undergraduate graduation design and is allowed to participate in the defense.

Rating (100 points X_1) **88**

Supervisor (Signature):

Date:

Graduation Project Reviewer Evaluation Form

Major: Electronic Information Engineering Student: Yuqi Hao

Topic: Design and implementation of escalator control system based on STM32

point piece	Level and score item Head (Full score for this item)	Comments point wait class A	B	C	D	each files have to point A	B	C	D	score
material material Comments read people 30%	1. Task completion status (10)	All done	Almost complete	Main part completed	Unfinished	9-10	7-8	5-6	≤ 4	**8**
	2. Basic concepts and theoretical arguments (20)	Clear and correct	Basically clear Basically correct	Still clear, still correct	Incorrect, not applied	18-20	15-17	12-14	≤ 11	**17**
	3. Calculation method and results (30)	Correct, more computer applications	Basically correct Small amount of applications	Not yet correct, not applied	Incorrect, not applicable	26-30	21-25	16-20	≤ 15	**25**
	4. Independent insights and application value (10)	Yes, Larger	Yes, general	Yes, No or None, General	None, None	9-10	7-8	5-6	≤ 4	**6**
	5. Instructions and drawings (20)	Clearly structured, correct, meticulous and neat, with correct foreign language abstracts	Basically correct, more serious, more correct	Still correct, still serious, basically correct	Many mistakes, carelessness, inaccuracy	18-20	15-17	12-14	≤ 11	**17**
	6. Difficulty of the topic and workload (10)	Difficult, full	Moderate, full	Easier, still full	Easy, not full	9-10	7-8	5-6	≤ 5	**8**

Reviewing teacher's evaluation opinion

Comments:

As a kind of traffic facility, escalator plays an important role in shopping malls, subways, hotels and other places in the city. With STM32F103C8T6 single-chip microcomputer as the core, the student designed an escalator control system by expanding the weight detection module, voice recognition module, infrared beam sensor module, DC motor drive module, sound and light alarm module, Bluetooth module , independent button module, display module, voice broadcast module and other module circuits. The system has functions such as operation control, number counting, emergency braking, overweight alarm, voice recognition, voice broadcast, data display, etc. The topic selection meets the professional training requirements, the document structure is reasonable, the level is clear, the format is standardized, and the design content meets the requirements of graduation design.

Rating (100 points X_2) **81**

Reviewer (Signature):

Date:

Graduation Design Defense Group Evaluation Form

Major: Electronic Information Engineering Student: Yuqi Hao

Topic: Design and implementation of escalator control system based on STM32

point piece	Level and score item Head (Full score for this item)	Comments point wait class A	B	C	D	each files have to point A	B	C	D	score
answer debate Commission member 30%	1. Report (20)	Concise, clear and focused	Basic clarity Not enough focus	Still clear, some mistakes	Unclear concept More errors	18-20	15-17	12-14	≤ 11	**16**
	2. Answers to questions (50)	Correct and skilled	Basically correct	Still correct, wrong	Basically incorrect	43-50	35-42	27-34	≤ 26	**39**
	3. Instructions and drawings (20)	Overall impression: Careful, neat and correct	More serious	Still serious	Not serious	18-20	15-17	12-14	≤ 11	**15**
	4. Independent insights and application value (10)	Yes, Larger	Yes, general	Yes, No or None, General	None, None	9-10	7-8	5-6	≤ 4	**7**

Opinions of the defense panel

Comments:

Able to complete the content and requirements specified in the graduation design assignment; able to basically apply the theoretical knowledge learned to solve the problems in the design; have the ability to work independently; the design plan and design are relatively reasonable, the workload is relatively full, and the conclusion is relatively reasonable; the paper writing is relatively standard; the defense ideas are relatively clear, the language expression is basically fluent, and the answers to the questions are basically correct; meet the school's undergraduate graduation design requirements. After full discussion by the defense team, it is agreed to pass the defense.

Rating (100 points X_3) **77**

Person in charge (signature):

Date:

<table>
<tr><td colspan="5">Minutes of the defense meeting</td></tr>
<tr><td>Time</td><td colspan="2">May 25, 2024</td><td>Place</td><td>2-419</td></tr>
<tr><td rowspan="7">Answer debate Small Group become member</td><td>Name</td><td>Job title</td><td colspan="2">Major</td><td>Professional</td></tr>
<tr><td>Yue Tan</td><td>Professor</td><td colspan="2">Control Science and Engineering</td><td>Electronic Information Engineering</td></tr>
<tr><td>Xiongjie Liu</td><td>Teaching Assistant</td><td colspan="2">Software Engineering</td><td>Electronic Information Engineering</td></tr>
<tr><td>Yaqi Deng</td><td>Associate Professor</td><td colspan="2">Signal and Information Processing</td><td>Electronic Information Engineering</td></tr>
<tr><td>Jie Xiong</td><td>Lecturer</td><td colspan="2">Circuits and Systems</td><td>Electronic Information Engineering</td></tr>
<tr><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td colspan="5">A brief record of the main questions raised during the defense and their answers:

1. There is a weighing module in the escalator, so how does it work?
A: First, use a pressure sensor to sense the gravity of an object and convert it into a voltage signal. Then use a voltage amplifier to amplify the voltage signal by 128 times. Next, use an AD conversion chip to convert the amplified voltage value into a digital signal. Finally, use a formula to convert the AD value into gravity.
2. Radiating tubes to measure the number of people in the design?
A: Since the separated infrared radiating tube has higher accuracy and anti-interference ability, it can more reliably judge whether there is someone passing on the escalator. Although two parts need to be installed as the entrance and exit, the positions can be reasonably arranged during design and deployment to avoid obstruction by objects, which helps to improve the safety and operation efficiency of the escalator.
3. What innovations are there in the design?
Answer: The design incorporates three emergency stop methods for the escalator: push-button emergency stop, voice stop and remote control, which greatly enhances the safety of the escalator. Compared with traditional escalators, the system can better determine whether there is someone on the escalator, so that the escalator will run faster if there is someone and slower if there is no one, saving more energy.

Conference Host:
Recorder:
Date:</td></tr>
</table>

Hunan City University Undergraduate Graduation Project

Comprehensive Score Evaluation Form

Major: Electronic Information Engineering Student: Yuqi Hao

Topic: Design and implementation of escalator control system based on STM32

Mid-term inspection Suggested grades	Instructor Suggested grades	Reviewing Teacher Suggested grades	Defense results	Comprehensive results	Equivalent level
80	88	81	77	82.6	good

Opinion of the College Academic Committee:

Person in charge (signature):

College (official seal) Date:

※ ※ ※ ※ ※ ※ ※ ※ ※
※ Graduation Project ※
※ Materials for the ※
※ Class of 2024 ※
※ (4) ※
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Graduate Project

Project Name	**Escalator control system based on STM32 Design and Implementation**
Name	**Yuqi Hao**
Student ID	**200620432**
Faculty	**School of Information and Electronic Engineering**
Major	**Electronic Information Engineering**
Instructor	**Associate Professor Qiuxiang Zhu**

May 22, 2024

Hunan City University Undergraduate Graduation Project Integrity Statement

I solemnly declare that the undergraduate graduation project submitted is the result of my independent research under the guidance of my instructor. There is no intellectual property dispute over the results. Except for the content cited in the text, this design does not contain any other work that has been published or written by any other individual or group. The individuals and groups who have made important contributions to the research of this article have been clearly marked in the text. I am fully aware that I will bear the legal consequences of this statement.

Signature of the author of undergraduate graduation project:

May 22, 2024

Table of contents

Chinese Abstract

Chinese Keyword

The Chinese abstract is consistent with the English abstract. So the translation is omitted here.

Design and Implementation of Automatic Escalator Control System Based on STM32

Abstract: With the development of the domestic economy, escalators can be seen everywhere. In order to achieve the free control of the escalator and the safety of the escalator passengers, the design of an automatic escalator control system is developed based on the STM32F103C8T6 microcontroller in this paper. Through the integration of various sensors and modules, the MX1508 is employed to drive two DC motors for ascending and descending the escalator. Infrared emitter-receiver pairs are used for passenger counting and adjusting the escalator's speed based on the passenger count to save energy and improve riding experience. The button module is used to stop the operation of the escalator in an emergency to protect the safety of passengers in the event of an accident. The gravity detection module is used to detect if the weight is overweight, and once the weight is overweight, triggering audio-visual alarms to prompt passengers to reduce load. The voice recognition modules are used to monitor distress sounds and halts the escalator automatically to ensure the safety of passengers. With the Bluetooth module, users can monitor and control the escalator's status in real-time, enhancing the system's intelligence and convenience. Test results demonstrate that the automatic escalator control system realizes functions such as escalator operation control, passenger counting, emergency braking, overweight alarm, automatic speech recognition, voice broadcast and data display, effectively ensuring the safe operation of escalators.

Key words: Automatic escalator control system; Microcontroller; Safety assurance; Passenger counting; Bluetooth remote control

Introduction

With the continuous acceleration of urbanization, the demand for transportation is growing. As an important part of urban transportation facilities, escalators are now increasingly used in shopping malls, airports, high-speed rail stations, subways, hotels and other places[1]. The traditional escalator operation mode has some problems, such as high energy consumption, uncomfortable riding experience, insufficient safety and reliability[2]. In this context, an escalator control system based on STM32 microcontroller is selected as the design topic.

As an important part of modern urban transportation facilities, escalators have gone through multiple stages of development and have been continuously innovating and improving in terms of technology and functions. In foreign countries, the first modern escalator was designed and manufactured by the American OTIS Company in 1920. It has a history of more than 100 years and only has basic transmission functions. In the mid-20th century, escalators gradually began to usher in technological innovation and development. Escalator manufacturers began to introduce electronic and automation technologies to make escalators more intelligent, but there are still certain safety risks. From the late 20th century to the early 21st century, with the development of the electronics industry and computer technology, escalators have been further improved. The introduction of technologies such as sensors and frequency converters has made escalators run more smoothly and energy-efficient, while strengthening safety control. In the 21st century, escalators began to develop in a more intelligent direction, and speed-controlled elevator technology was widely adopted by foreign elevator companies. This technology has strong comfort and has been widely used due to its many advantages[3] . In China, escalators began to enter the Chinese market in the 1980s and were first used in commercial streets. From the 1990s to the early 2000s, China began to independently develop escalators. The initial technology was relatively simple and mostly imported. In the 2010s, domestic escalator manufacturers began to innovate in control systems, safety technologies, energy efficiency, etc., and they were widely used in various building fields in China[4]. Independent research and development capabilities have been improved, not only producing a large number of escalators, but also starting to export to

foreign markets. As of the end of 2020, there were about 850,000 escalators and moving walkways in use in China[5]. At present, China focuses on using intelligent sensing, intelligent control, intelligent interaction and intelligent Internet of Things technologies to enable escalators to intelligently perceive, make decisions and make adaptive adjustments to changes in the external environment and passenger behavior during operation[6]. With the continuous innovation of technology and changes in market demand, escalators will continue to develop in a smarter, safer and greener direction, both at home and abroad.

In previous escalator designs, emergency stop buttons are usually set at the entrance and exit and in the middle of the escalator. However, for most people, they do not know how to operate when an accident actually occurs[7]. To address this problem, this design introduces voice control and remote control functions. When an accident occurs, the injured person or other passers-by can control the escalator to stop by saying specific keywords, and the staff responsible for monitoring the escalator can also press the button in the mobile phone APP in time to stop the escalator. According to research, when the escalator runs at high speed for a long time, it will cause the computer system to fail[8]. Therefore, the current escalator design uses infrared sensors at the entrance and exit to detect whether there are people on the escalator. If someone is detected entering at the entrance, the escalator will run at high speed. If everyone is detected leaving the escalator at the exit, the escalator will run at low speed, which saves energy and prevents system damage. This design also continues this function. According to the requirements of GB16899, when the width of the step is 1 meter, the braking load of each step of the escalator is 120 kg[9]. In this design, the weight of the entire escalator is used to simulate the weight of the escalator.

This project uses modern microcontroller technology to introduce intelligence and safety into the operation and management of escalators based on existing research to improve passengers' travel experience and ensure their safety. As a common means of transportation in people's daily lives, the operating efficiency, comfort and safety of escalators directly affect passenger satisfaction. By introducing an escalator control system, the following goals can be achieved:

(1) Improve operating efficiency and comfort: Through intelligent control, the operating speed can be automatically adjusted according to the number of passengers on the escalator,

reducing energy consumption and improving riding comfort.

(2) Enhanced safety: In the event of danger, anyone can press the emergency brake button to stop the escalator to avoid causing greater harm. The overload alarm function can also remind passengers to reduce the load and reduce the risk of accidents.

(3) Remote monitoring and control: Through the Bluetooth module, the operating status of the escalator can be transmitted to the mobile phone in real time. At the same time, the staff can control the escalator in the monitoring room without having to go to the site to control the start and stop of the escalator[10].

(4) Adapt to future development: With the continuous advancement of science and technology, people's demand for intelligent and convenient transportation is also increasing. Designing an escalator control system based on a single-chip microcomputer can not only meet current needs, but also provide a good foundation for future development.

To sum up, the design background of this project is to solve the problems existing in traditional escalators, introduce intelligence and safety into them, improve user experience, and contribute to the upgrading and improvement of modern urban transportation facilities.

1 Overall Design

1.1 Functional requirements

Specific tasks to be achieved by the escalator control system:

(1) DC motor drive module: Use MX1508 to drive two DC motors to simulate going up and down escalators (one forward rotation represents going up, and one reverse rotation represents going down).

(2) Infrared radiator detection module: Each escalator will count the number of people. If the number of people on the escalator is not 0, it will run at high speed. If the number of people on the escalator is 0, it will run at low speed.

(3) Button module: Each escalator has two buttons, which serve as emergency brake buttons. When pressed, the elevator stops running. When pressed again, the elevator runs normally.

(4) Gravity detection module: detects gravity and issues an audible and visual alarm when overweight.

(5) Voice broadcast module: reminds passengers of the current escalator status.

(6) Display module: can display the current escalator up and down, operation and stop status and other information.

(7) Bluetooth module: can send the escalator operation status to the mobile phone, which can start and stop the escalator and modify the weight threshold.

(8) Voice recognition module: When a danger occurs, the system can recognize special emergency keywords and stop the escalator.

1.2 Overall design plan

This design uses the STM32F103C8T6 microcontroller as the core controller to build an escalator control system that integrates data acquisition, processing, control and communication. The entire system consists of a central control part, an input part and an output part. The central control part is the core of the system. The input part is an infrared counter-radiation sensor module, a voice recognition module, a film pressure detection module, a button module and a power supply module. The output part is a DC motor drive module, an audio and light alarm module, a display module and a voice broadcast module. In addition, this design also has a Bluetooth module, which can transmit the data received by the microcontroller to the Bluetooth APP on the mobile phone, and can also send commands such as starting and stopping the escalator and modifying the weight threshold through the Bluetooth APP to control the entire system. The specific system block diagram is shown in Figure 1.1.

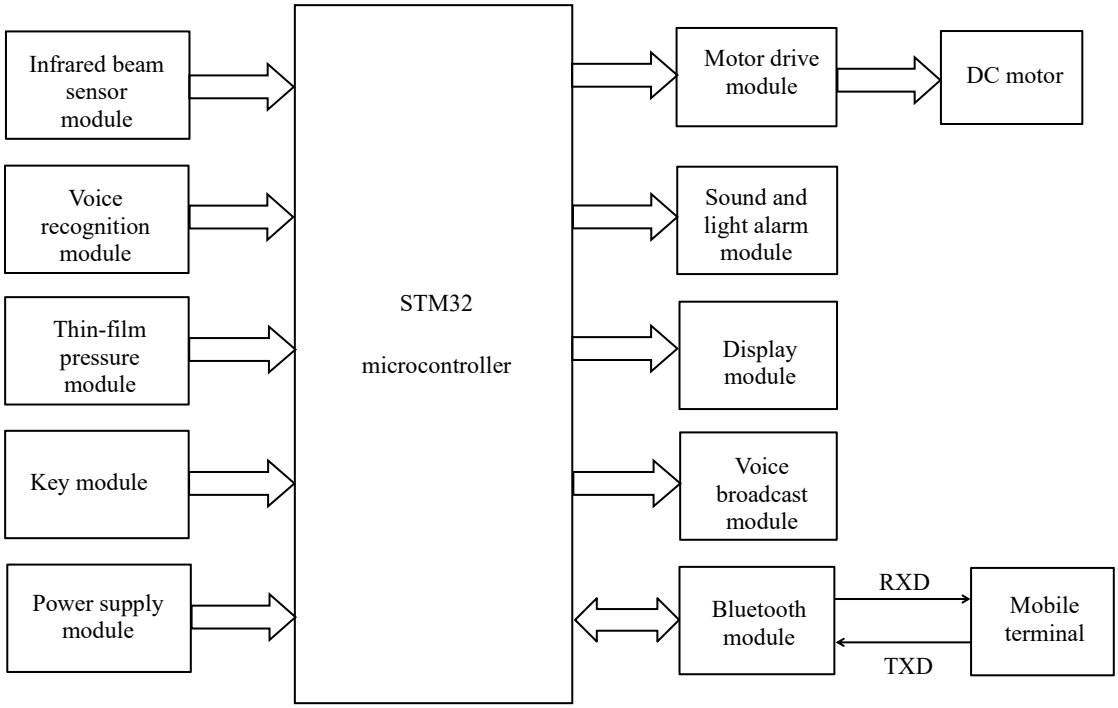


Figure 1.1 System block diagram

2 Hardware Design

2.1 Hardware circuit schematic diagram

The system hardware consists of a core control module, a weight detection module, a voice recognition module, an infrared beam sensor module, a DC motor drive module, an sound and light alarm module, a Bluetooth module, an independent button module, a display module, and a voice broadcast module. The overall circuit diagram of the hardware system is shown in Figure 2.1.

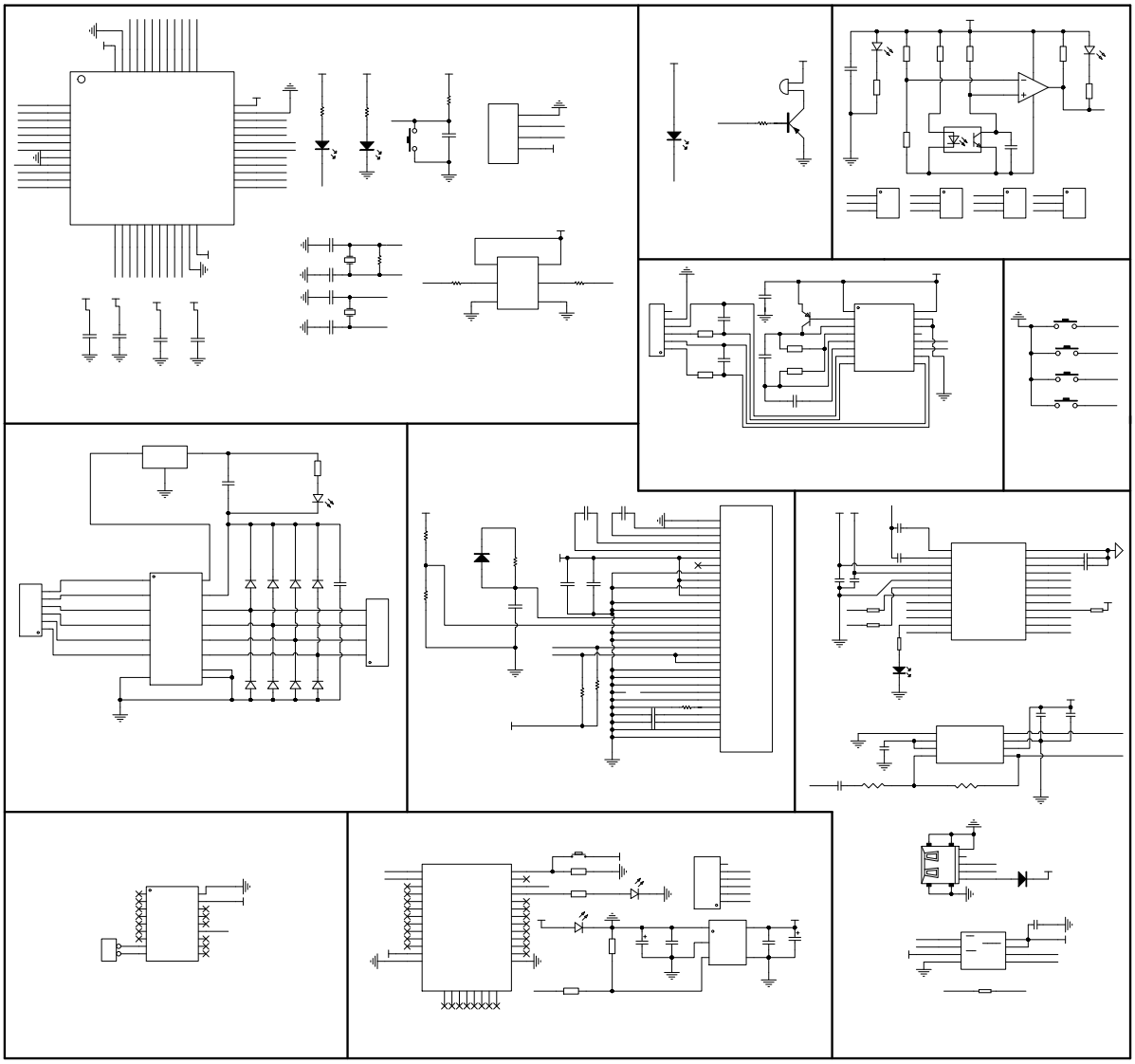


Figure 2.1 Hardware system overall circuit diagram

2.2 Schematic diagram of main hardware modules and related instructions

2.2.1 Core Control Module

The microcontroller is the core of the entire design system. This design uses the STM32F103C8T6 main control chip. The STM32F103C8T6 is a commonly used 32-bit microcontroller. The chip is based on the Cortex-M3 core, with a clock frequency of 72 MHz, multiple timers and ADC sampling channels[11], and has rich peripherals and powerful processing capabilities. The STM32F103C8T6 minimum system is usually composed of the STM32F103C8T6 chip, crystal oscillator, reset circuit, etc. The core board schematic is shown in Figure 2.2.

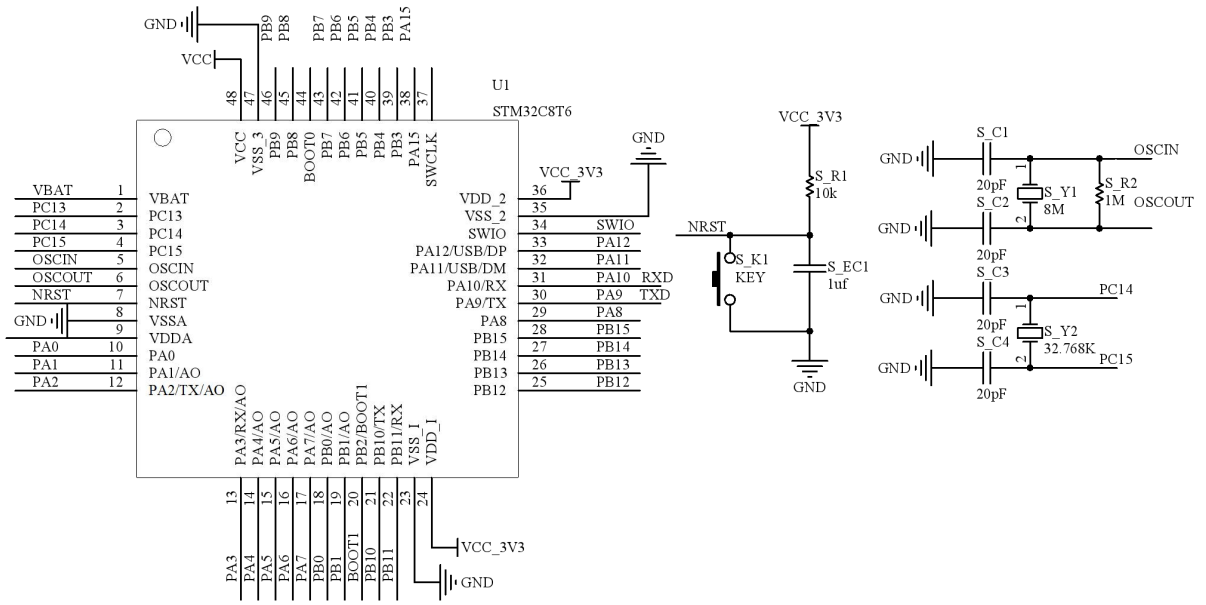


Figure 2.2 Schematic diagram of the core board

2.2.2 Weight detection module

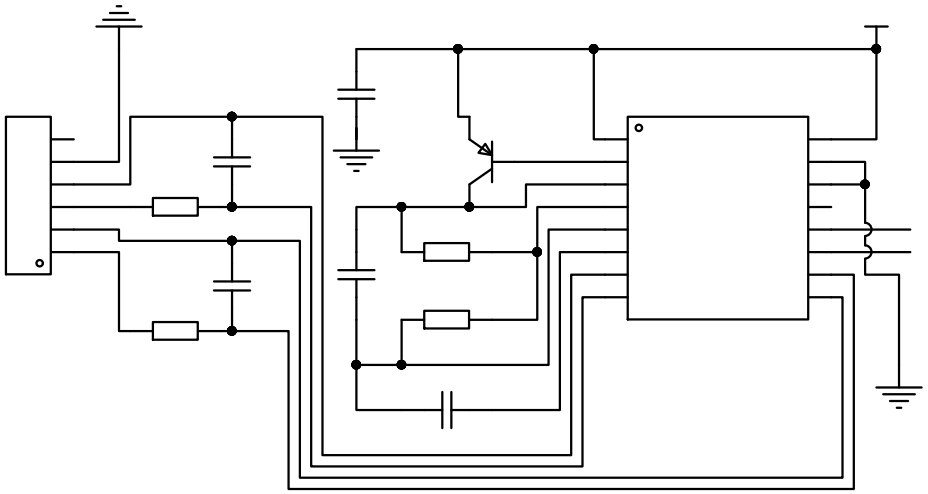
This design uses the HX711 module to measure weight, and can detect the weight of an object through an external sensor. The following is an explanation of the function and working principle of the HX711 weight detection module in this design.

Function: This module can realize two functions. The first one is weight detection. This module is used to measure the weight change of the external sensor and can detect the load or weight of the object. The second function is overweight trigger alarm. When the measured escalator load exceeds the set overweight threshold, the system will sound and light alarm and voice broadcast to remind passengers to wait.

Working principle: The HX711 module uses a differential measurement method to obtain the output signal of the sensor. The HX711 module contains a high-precision analog-to-digital converter (ADC). When the object to be measured is placed on the pressure sensor, the strain gauge bridge will deform and generate a weak signal. This signal is amplified by the amplifier and then converted into a digital signal, thereby generating more accurate and stable data, which is then transmitted to the controller through serial communication for data processing and display[12].

In this design, the DT pin and SCK pin of HX711 are connected to the PB6 pin and PB5 pin of the microcontroller, which are used to transmit data and clock signals respectively. By sampling the output data of HX711, the weight information of the object is obtained. When

the weight exceeds the set threshold, an audible and visual alarm will be triggered to remind relevant personnel. The circuit schematic diagram of the weight detection module is shown in Figure 2.3.



Schematic diagram of weight detection module circuit

2.2.3 Speech Recognition Module

Speech recognition module is a module used to obtain speech signals in the environment. It can be used to detect specific speech events and trigger corresponding operations. The following is an explanation of the function and working principle of the speech recognition module in this design.

Function: This module can realize the function of voice detection. By converting the collected voice signals into electrical signals, it can identify the fixed voice of help. When the voice of help is detected, the escalator will stop running.

Working principle: The speech recognition module usually collects speech signals through a microphone or other input device, and then performs error correction, completion and noise removal on the collected signals. Next, the processed speech signals are analyzed to extract parameters related to speech features. Finally, the extracted speech features are matched with the preset model. If the match is consistent, the signal is sent to the microcontroller for processing. The microcontroller will receive the signal through the PA4 pin. If a low-level signal is detected, the escalator system will automatically stop running to ensure the safety of passengers. The schematic diagram of the speech recognition module interface circuit is shown in Figure 2.4.

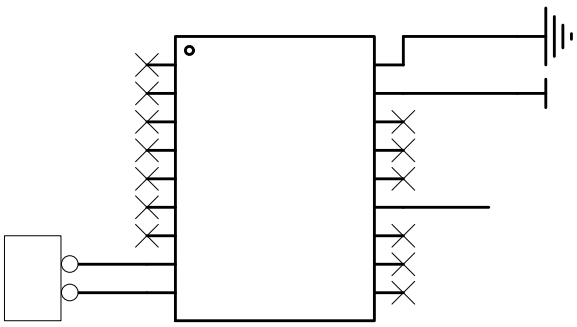


Figure 2.4 Speech recognition module interface circuit schematic

2.2.4 Infrared radiation sensor module

The separated infrared radiator is a sensor used to detect the passage of objects, usually composed of an infrared transmitter and an infrared receiver. The following is an explanation of the function and working principle of the separated infrared radiator in this design.

Function: This module can realize two functions. The first one is the number counting. The separated infrared radiating tube can detect the passing of objects and count the number of people passing through the radiating tube area. The second function is the operation control, which controls the running speed of the escalator according to the number of people. When the number of people is not 0, the escalator runs at high speed, and when the number of people is 0, the escalator runs at low speed.

Working principle: The separated infrared radiator consists of a transmitter and a receiver. The transmitter emits an infrared beam, and the receiver receives the beam emitted by the transmitter. When the infrared beam is blocked, the receiver will lose the signal, which will trigger the state change of the sensor. By monitoring the changes in the light signal between the transmitter and the receiver, it can be determined whether an object has passed.

In this design, four pins are used to connect two pairs of infrared radiators, each of which consists of a transmitter and a receiver. According to the state changes of these radiators, the microcontroller can determine whether the number of people is 0, thereby controlling the running speed of the escalator. By using separate infrared radiators for number counting and escalator speed control, more intelligent and efficient escalator operation can be achieved, providing a better user experience and energy saving. The circuit schematic diagram of the infrared radiator sensor module is shown in Figure 2.5.

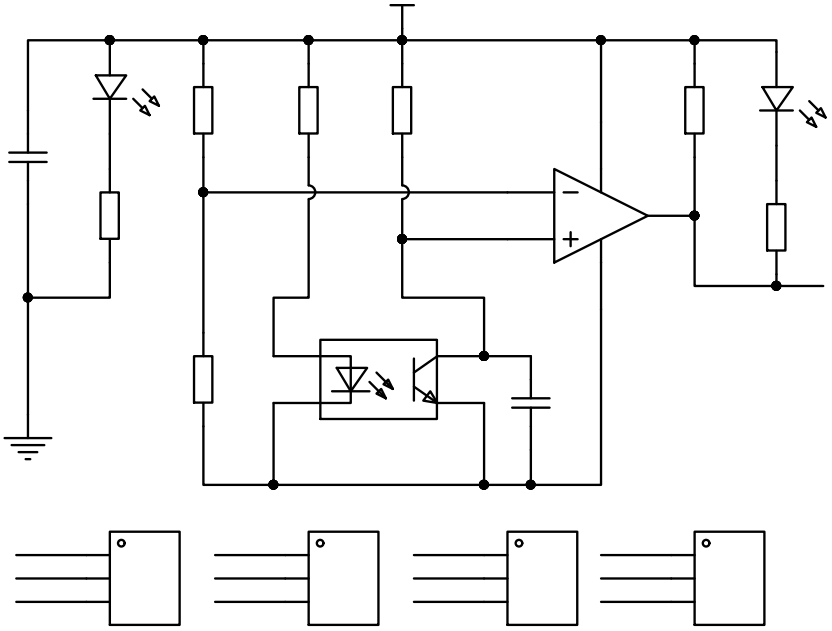


Figure 2.5 Schematic diagram of infrared radiation sensor module circuit

2.2.5 DC motor drive module

The drive module and DC motor play a key role in the escalator control system, and are used to realize the up and down operation of the escalator. The following is an explanation of the function, working principle and pin function of the drive module and DC motor in this design.

Function: The drive module is a circuit module used to control the DC motor. In this design, the drive module is used to change the running direction and speed of the escalator.

Working principle: The input pins A1, A2, B1, and B2 of the driver module receive control signals from the microcontroller, which are used to control the rotation of the motor. The output pins OA1, OA2, OB1, and OB2 are connected to the terminals of the DC motor to control the rotation of the motor by providing appropriate voltage and current.

In this design, the input A1 of the driver module is connected to the PB10 pin of the microcontroller to control the forward rotation of the motor. The input A2 is connected to the PB11 pin of the microcontroller to control the reverse rotation of the motor. The input B1 is connected to the PB12 pin of the microcontroller to control the forward rotation of the motor. The input B2 is connected to the PB13 pin of the microcontroller to control the reverse rotation of the motor. The outputs OA1 and OA2 are connected to the two terminals of a DC motor. By controlling the voltage and current of these two pins, the rotation of the motor can

be controlled. The outputs OB1 and OB2 are connected to the two terminals of another DC motor. Similarly, by controlling the voltage and current of these two pins, the rotation of the motor can be controlled.

By changing the state of the input pin in a timely manner, the forward, reverse, and stop operations of the motor can be realized, thereby controlling the up and down movement of the escalator, allowing the entire system to work efficiently and safely. The circuit schematic of the DC motor drive module is shown in Figure 2.6.

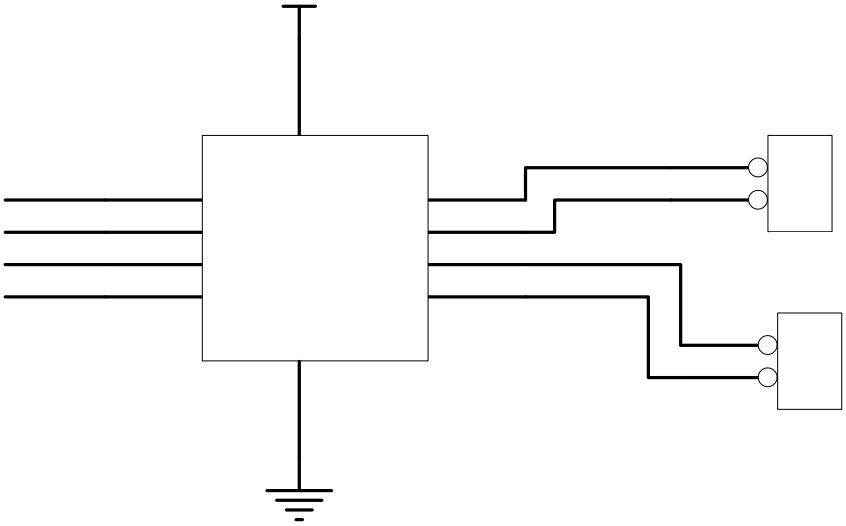


Figure 2.6 DC motor drive module circuit diagram

2.2.6 Bluetooth module

The Bluetooth module is divided into a mobile phone APP end and a single-chip microcomputer control end. The mobile phone APP end uses App Inventor to develop a graphical interface, and realizes data transmission through the configuration of the Bluetooth client. The timer can be set to refresh the interface to realize real-time data display of the APP receiving interface. On the APP end, functions such as setting thresholds, turning on and off escalators, and detecting the number of people can be realized. This is to transmit data to the single-chip microcomputer Bluetooth slave end through Bluetooth, thereby changing the parameter configuration of the single-chip microcomputer[13].

Function: The Bluetooth module is used in this design to realize remote monitoring and remote control of the escalator's operating status. It can send information such as the escalator's load status and number of people to the mobile phone, and allow users to remotely

start and stop the escalator through their mobile phones, providing a more convenient user experience and control method.

Working principle: The Bluetooth module can establish a Bluetooth connection between the microcontroller and the mobile phone, allowing the escalator control system to exchange data with the mobile phone.

The Bluetooth module can communicate bidirectionally with the microcontroller. The use of the Bluetooth module allows users to easily monitor and control the operating status of the escalator through a mobile phone, improving the intelligence and user-friendliness of the escalator system. The schematic diagram of the Bluetooth module circuit is shown in Figure 2.7.

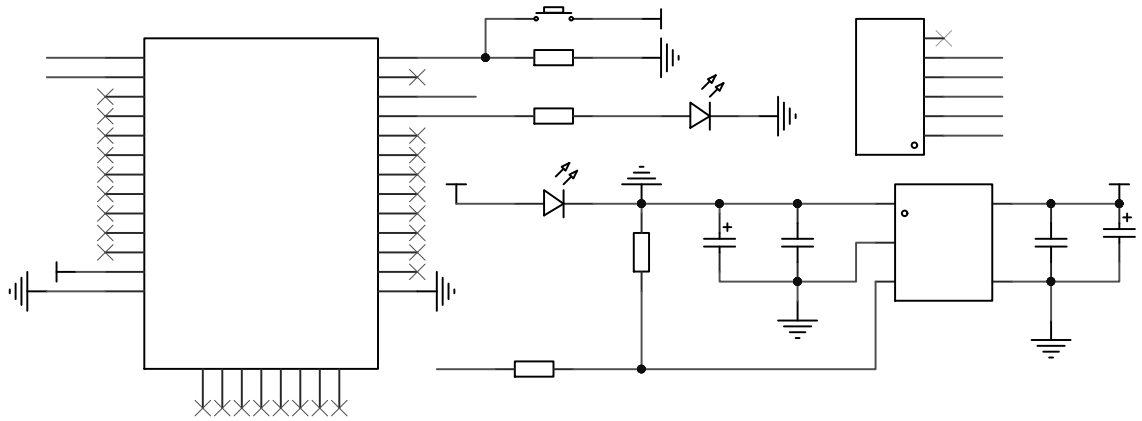


Figure 2.7 Bluetooth module circuit schematic

2.2.7 Sound and light alarm module

Function: The sound and light alarm is used to send warning signals to passengers under certain conditions to remind them to pay attention to safety. In this design, the sound and light alarm module will be used to detect gravity overload conditions. When overload occurs, sound and light alarms will be triggered to attract the attention of passengers.

Working principle: Sound and light alarm modules usually contain a sound generator and a light emitting diode (LED) or other light source. The sound generator produces a high-decibel sound signal to attract people's attention. This sound is usually regarded as an alarm signal in an emergency. The LED flashes or emits a strong light to increase people's attention to the alarm. In some cases, the flashing light source can convey different alarm conditions.

By controlling this module, the microcontroller can trigger an audible and visual alarm to communicate overweight conditions to passengers. This helps to improve passengers' safety awareness and ensure that they can take appropriate actions when encountering abnormal situations. The circuit schematic of the audible and visual alarm module is shown in Figure 2.8.

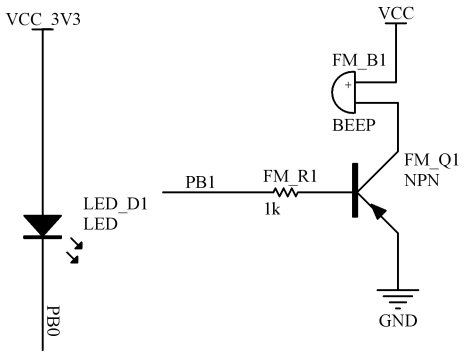


Figure 2.8 Schematic diagram of the sound and light alarm module circuit

2.2.8 Independent button module

Function: The independent button is used as an emergency brake button in this design to immediately stop the escalator. When the emergency brake button is pressed, the escalator will stop running; press the emergency brake button again and the escalator will resume normal operation.

Working principle: The independent button is a mechanical switch. When the button is pressed, the corresponding circuit inside the switch will be turned on. When the button is released, the contact of the button opens and the circuit is disconnected. In this design, when the emergency brake button is pressed, the corresponding circuit will be triggered, thereby controlling the operating state of the escalator.

Pin function: Button 1, Button 2, Button 3 and Button 4 are connected to the PB7, PB8, PB9 and PB15 pins of the microcontroller respectively. By connecting to these pins of the microcontroller, each independent button can pass the pressed state to the microcontroller, and the microcontroller can control the operation state of the escalator based on these inputs.

The independent button plays the role of emergency braking in this design, ensuring that the escalator can be stopped quickly in an emergency, thereby increasing the safety of passengers. The circuit schematic of the independent button module is shown in Figure 2.9.

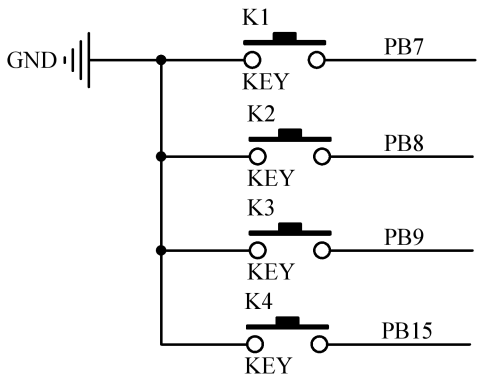


Figure 2.9 Schematic diagram of independent key module circuit

2.2.9 Display module

The display module of a system should be selected based on the module size required by the system, the difference between input power and output power, and functional factors. OLED has the characteristics of high brightness, suitable module size, high active power, and more power saving, so a 0.96-inch OLED display is selected as the display module of this design. When current passes through, the OLED display will display data[14]. The size of OLED is 0.96 inches, the pixel is 128*64, and it can clearly display characters and other information[15].

The display module in this design plays the role of displaying the current escalator weight limit, weight, status, number of people and other information, thereby providing passengers with more intuitive status information. The circuit schematic diagram of the display module is shown in Figure 2.10.

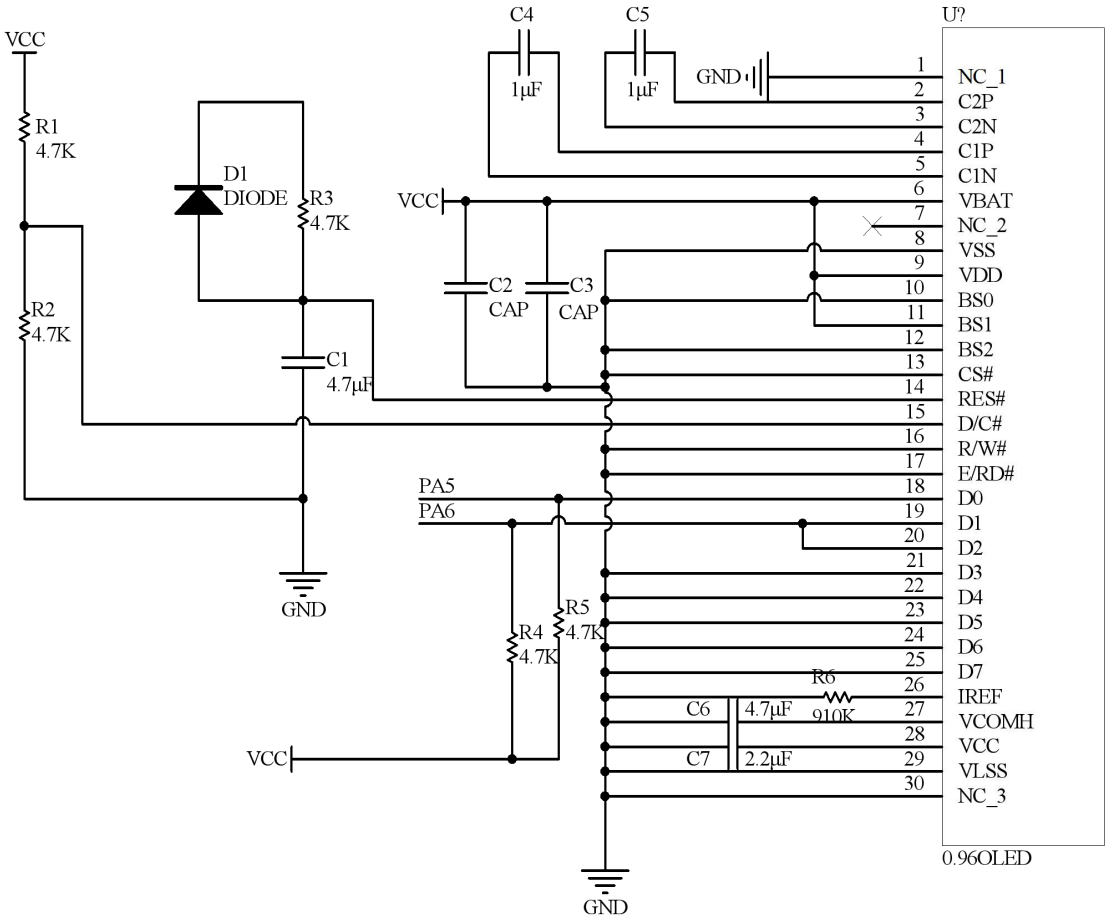
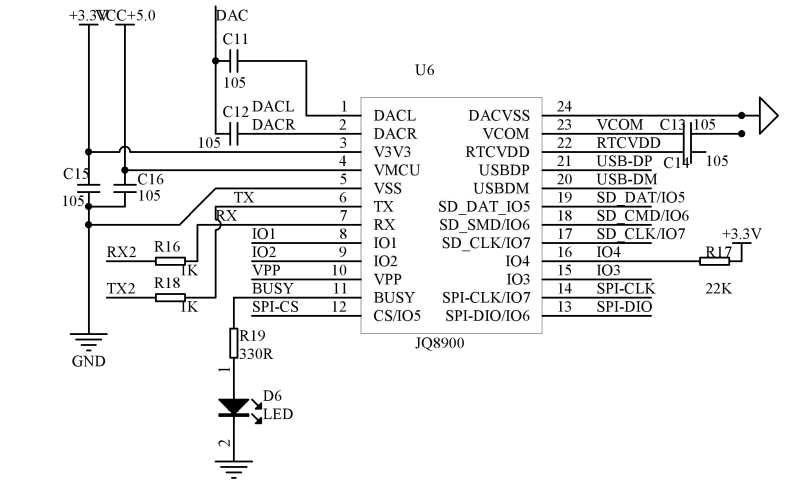


Figure 2.10 Display module circuit schematic

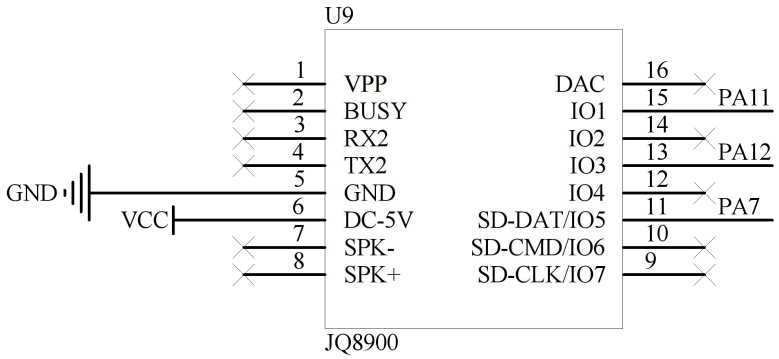
2.2.10 Voice Broadcast Module

The JQ8900 voice module is used as the voice broadcast module of this design. The voice reminder of overweight and escalator operation functions are realized by the JQ8900 voice broadcast module. The module has a built-in 3W power amplifier and 4MB of storage space, which is very suitable for the requirements of this project. The JQ8900 voice module uses hard decoding for audio, so the audio becomes more stable and clear. Connect the chip via a USB data cable and plug it into a computer. The computer will automatically identify the storage space and can flexibly change the voice content in the SPI FLASH[16].

Function: In this design, the voice broadcast module is used to broadcast overload conditions and uplink and downlink conditions to attract the attention of passengers. The circuit schematic diagram of the voice broadcast module is shown in Figure 2.11.



a) Circuit diagram of the main control chip of the voice broadcast module



b) Voice broadcast module pin circuit diagram

Figure 2.11 Schematic diagram of voice broadcast module circuit

3 Software Design

3.1 Main program flow and related instructions

In the main program, each module is initialized first. At this time, the escalator is in a low-speed running state. Then it enters the while main loop. In the main loop, it first enters the processing function. This function mainly judges that if the number of people on the escalator is not 0 under normal circumstances, it will run at high speed. If the number of people on the escalator is 0, it will run at low speed; next, it judges whether the emergency stop button is pressed. If it is pressed, the elevator stops running, otherwise the elevator runs normally; then it judges whether the high-decibel volume is collected. If the high-decibel volume is collected, the escalator stops and marks the current state as an accident. Otherwise, it runs normally and the state is normal. Then it judges whether the gravity is too high. If the

weight is too high, the sound and light alarm and voice broadcast warning, otherwise the sound and light alarm and broadcast are cancelled. Then enter the monitoring function. This function mainly obtains the measurement value by calling the corresponding drive function, and displays the measurement value on the OLED screen, such as the current escalator operation state, the number of people on the escalator, the current escalator load, etc., and transmits the monitored data to the mobile phone through the Bluetooth module; finally, it judges whether the Bluetooth command is received. If the Bluetooth command is received, it will make corresponding processing according to the command. The main flow chart of the escalator system is shown in Figure 3.1.

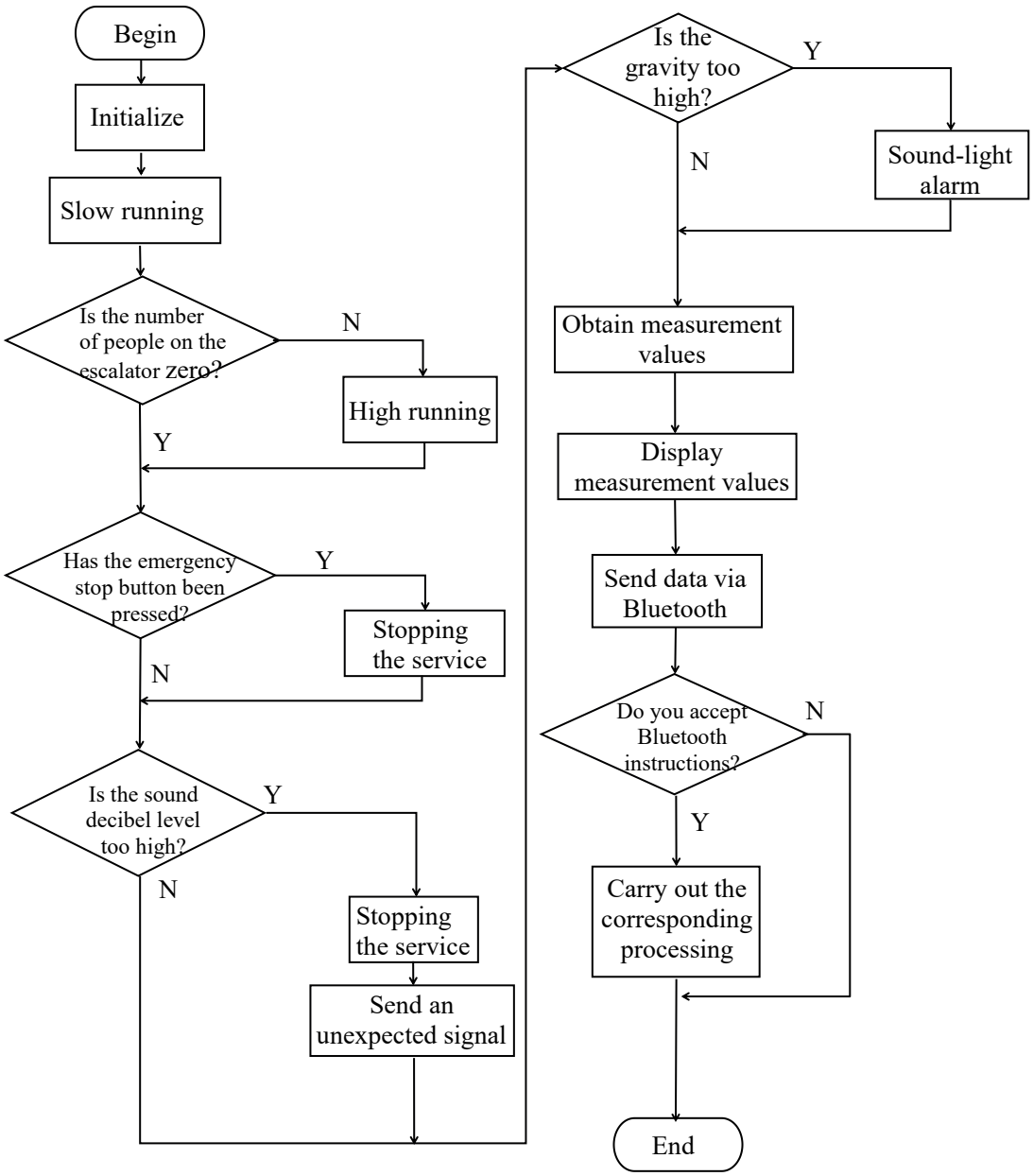


Figure 3.1 Main flow chart of escalator system

3.2 Driver program flow and related instructions for each hardware module

3.2.1 Weight detection module

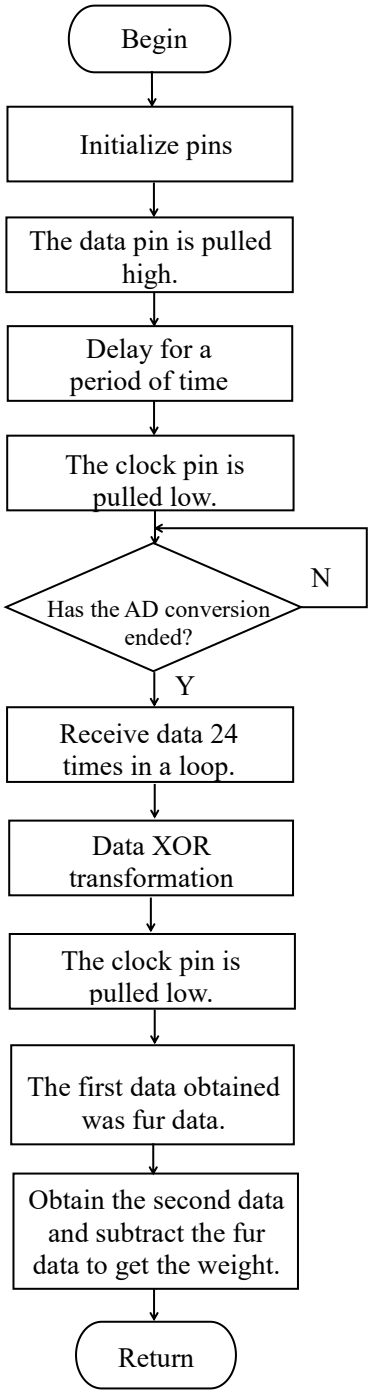


Figure 3.2 Weighing module flow chart

Before starting the AD conversion, first ensure that the pin is initialized and the data line is set to a high level, and then delay for a period of time. Start the conversion while keeping the clock pin at a low level and start reading the data. Then, after receiving 24 pulses, perform XOR processing on the data, and then pull the clock pin to a low level to end the conversion process. The first data collected is the fur weight, and the second data minus the first data is the final weighing weight. The weight detection module process is shown in Figure 3.2.

3.2.2 Speech Recognition Module

First, initialize the voice configuration, including initializing the timbre and volume of the voice broadcast sound, initializing the pin status, wake-up exit time, etc. Next, add voice recognition words. When a keyword is recognized, determine the recognition ID of the keyword, and finally select the corresponding pin according to the recognition ID to send a signal to the microcontroller. The flow chart of the voice recognition module is shown in Figure 3.3.

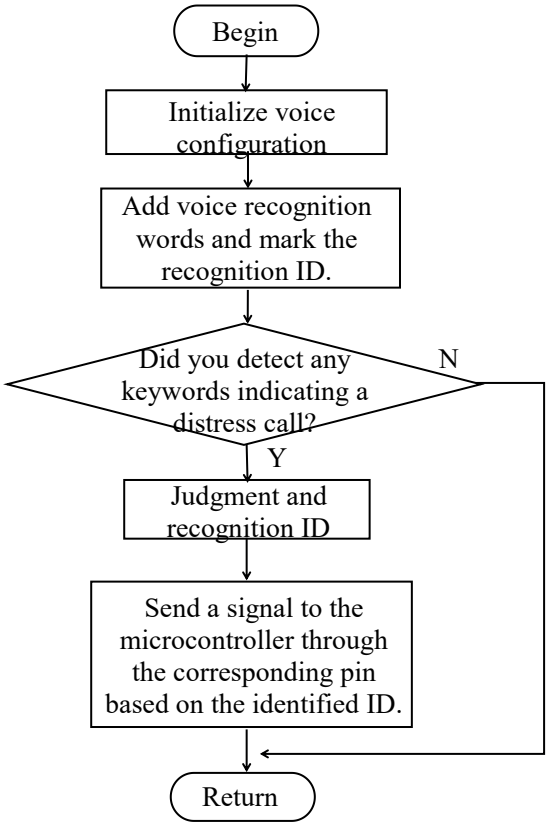


Figure 3.3 Flowchart of speech recognition module

3.2.3 Infrared radiation sensor module

First, initialize the external beam sensor pin. At this time, the pin is at a low level. Then determine whether someone is detected in the slot optocoupler. If there is someone, the module outputs a high level and transmits it to the microcontroller, and the number of people in the escalator system changes. Otherwise, the number of people in the escalator system remains unchanged. The flow chart of the infrared beam sensor module is shown in Figure 3.4.

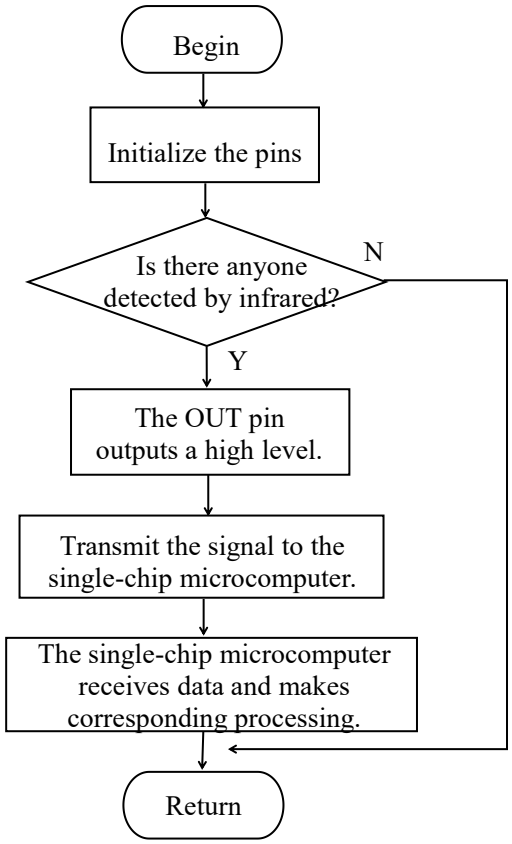


Figure 3. 4 Infrared radiation sensor module flow chart

3.2.4 DC motor drive module

First, initialize the pins and timer, define a cycle in the timer interrupt function, and

adjust the motor speed by adjusting the duty cycle of the high level within the cycle. The DC motor PWM debugging program sub-flow is shown in Figure 3.5.

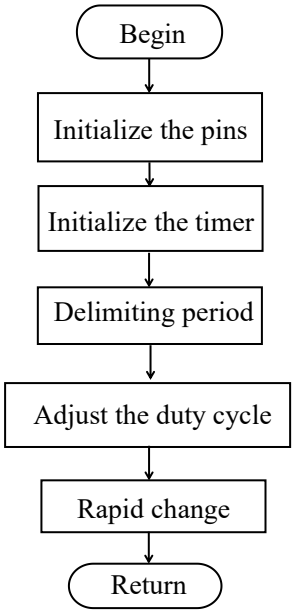


Figure 3.5 PWM debugging sub-flow chart

3.2.5 Bluetooth module

Set timer 1 to mode 2 to control the time period, and simultaneously configure the serial port to mode 1 for data transmission. Adjust the preset value of timer 1 to achieve stable communication at 9600 baud rate. Then start timer 1, turn on the serial port interrupt and the general interrupt to ensure system response. After the serial port is initialized, an interrupt is triggered every time new data is received, read data from SBUF, and clear the flag bit to prepare for receiving a new round of data. If data needs to be sent, call the send data function, just assign the data to SBUF, and then clear the send interrupt flag. The Bluetooth module flow chart is shown in Figure 3.6.

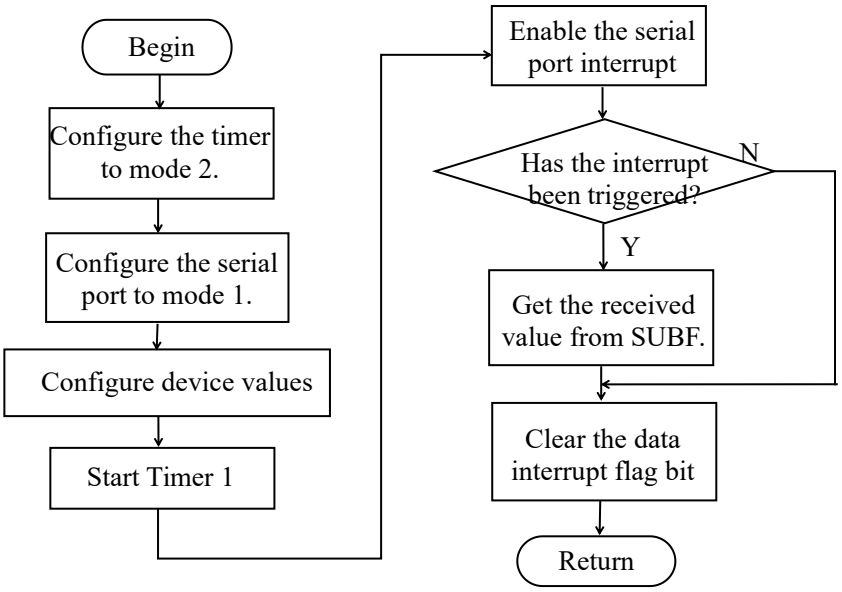


Figure 3.6 Bluetooth module flow chart

3.2.6 Independent button modules

First, define the button pin and initialize the pin state. Then determine whether the mode flag is 0. If it is 0, it indicates that the current state does not support the continuous press mode, otherwise it supports the continuous press mode. The mode used in this design does not support the continuous press mode, so it directly determines whether the button state flag is 1 and whether the button is pressed. If both conditions are met at the same time, the system executes a 10 millisecond delay to avoid the contact jitter problem, and then returns the button state flag to 0. Next, determine whether the button is pressed again. If the button is pressed, return the corresponding button key value. If the button state flag is not 1 or the button is released, check again whether the button is pressed. If the button is not pressed, set the button state flag to 1, and finally return to 0. If the button has been pressed, return to 0 directly. The independent button program sub-flow is shown in Figure 3.7.

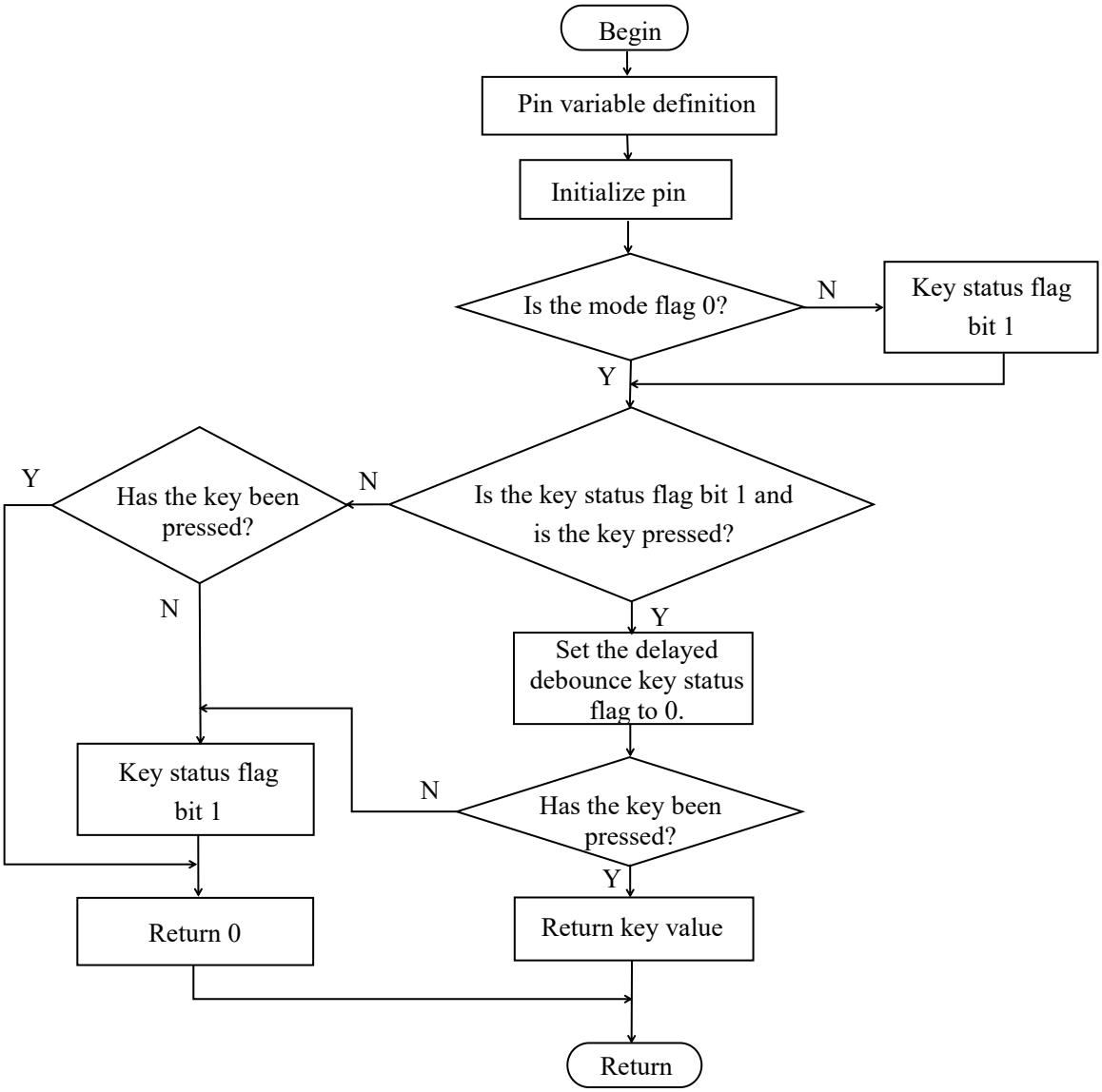


Figure 3. 7 independent key sub-flowchart

3.2.7 Display module

First, set the slave address, and then initialize the pins and commands, such as display mode, display offset, etc. After the initialization is completed, directly use the write data function to call the already written font array, and finally display the data. The display module flow chart is shown in Figure 3.8.

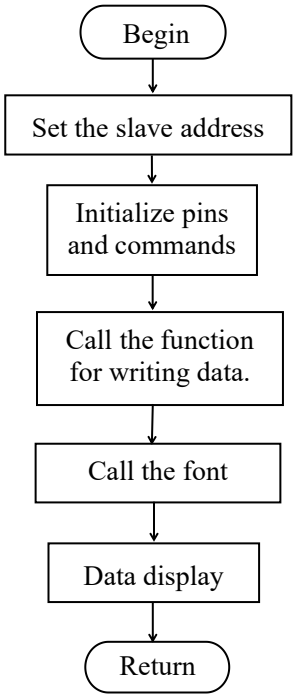


Figure 3.8 Display module flow chart

3.2.8 Voice Broadcast Module

First, initialize the IO pins, then determine whether the IO pins receive the microcontroller signal. If the signal is received, different voices are played according to the signals received by different IO pins. The voice broadcast flow chart is shown in Figure 3.9.

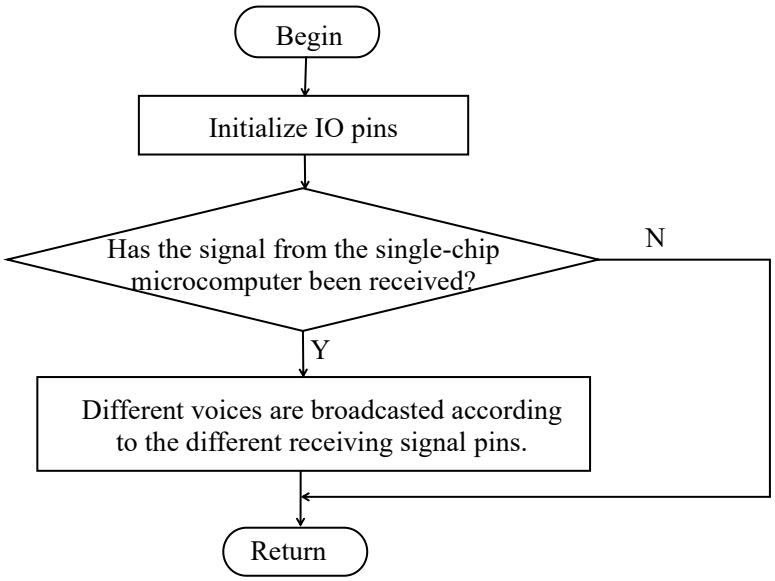


Figure 3.9 Voice broadcast flow chart

4 Test Results and Analysis

The physical test of the escalator control system design based on STM32 is shown in Figure 4.1. It can be seen from the physical test diagram that this design is mainly based on the STM32F103C8T6 microcontroller and its minimum system as the core, which controls the normal operation of the entire system. Around the core board are distributed weight detection modules, voice recognition modules, voice broadcast modules, infrared beam tube modules, DC motor drive modules, OLED display modules, sound and light alarm modules, Bluetooth modules, independent button modules, etc. This design adds a power module to meet the voltage requirements of some modules and ensure the normal operation of the escalator. This test is mainly to test whether each module can stably and reliably achieve the expected functions: whether the escalator can complete the weighing detection monitoring function, the button and the up and down number control escalator start and stop and running speed function, the voice broadcast function, the mobile phone remote monitoring and control of the escalator weight limit, start and stop function, and the screen display function.

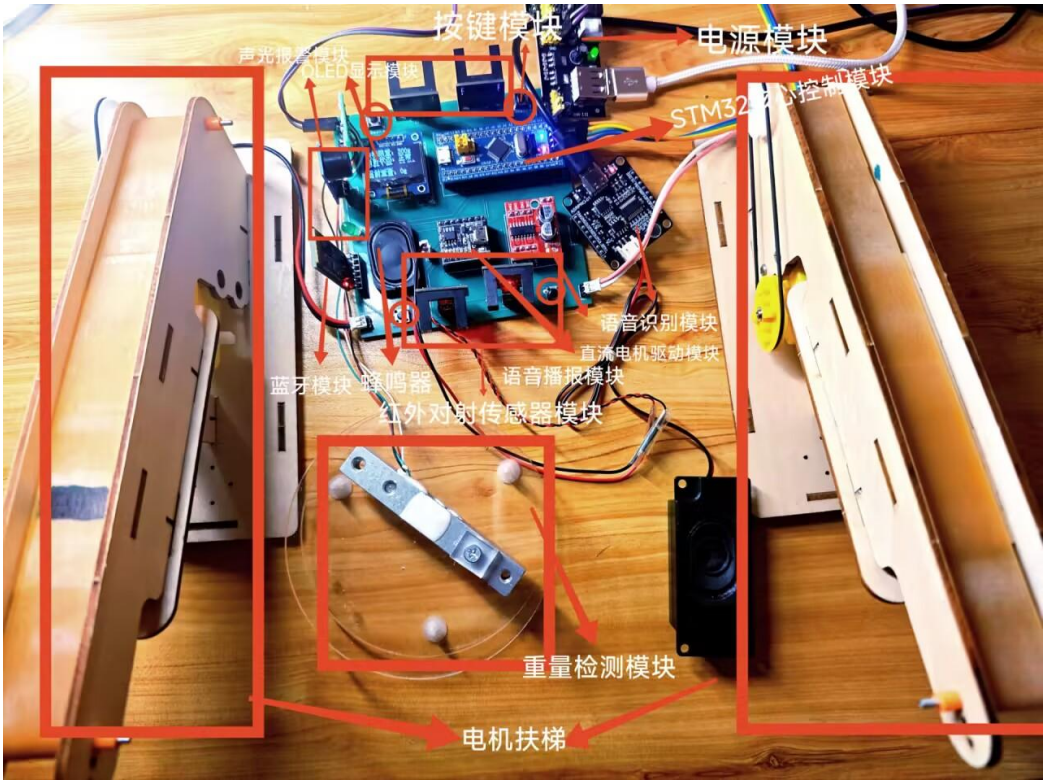


Figure 4.1 Physical test diagram of escalator control system design

4.1 Weighing and physical testing

The escalator designed this time can detect the current weight of the escalator in real time through the gravity detection module, and display it in real time through the OLED screen, with the weight value accurate to the unit. This test uses weights and other heavy objects to replace the weight of the people on the escalator. The initial overweight threshold is 300g. When the weight of the weight on the weighing module exceeds 300g, an audible and visual alarm and voice broadcast will be issued to remind that it is overweight. In order to verify the accuracy of the weighing module, it is necessary to calibrate and verify it with weights. As shown in Figure 4.2, when weighing a 100g weight, the displayed weight is 100g. After avoiding the weighing error, the test was started. Three different weight tests with non-overweight and overweight data were conducted under different weight limit thresholds. The threshold was set to 100g for the first time. A 49g weight was placed on the weight detection module. The escalator system did not sound or light alarm or overweight voice broadcast, and the escalator operated normally. When the weight was changed to 149g, the screen displayed overweight, and the escalator system sounded or light alarm and overweight voice broadcast to remind the people who were about to get on the escalator to wait. Similarly, when the threshold was set to 300g and 500g, the same phenomenon was shown when the weight was placed on the weight detection module below the threshold and above the threshold respectively. Table 4.1 records the influence of different weighing weights on the overweight state under different weight thresholds. The weight display and sound or light alarm test diagram are shown in Figure 4.3. It can be seen from Table 4.1 and Figure 4.3 that the weighing module has an accurate grasp of the weight data and can accurately determine whether it is overweight or not under different overweight thresholds and make corresponding judgments.

Table 4.1 Effect of weighing weight on overweight status

Overweight threshold (g)	Measured weight (g)	Call the police
100	49	N
100	149	Y

300	149	N
300	348	Y
500	340	N
500	530	Y

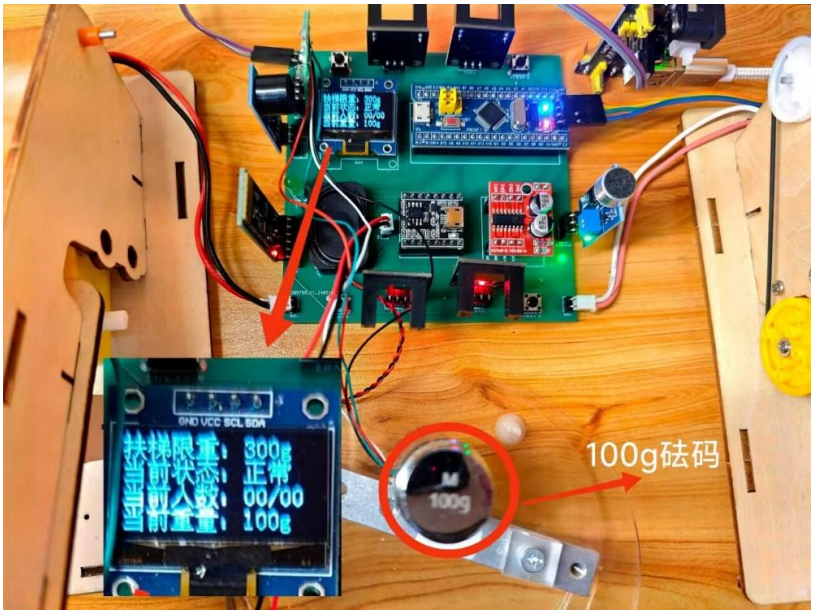
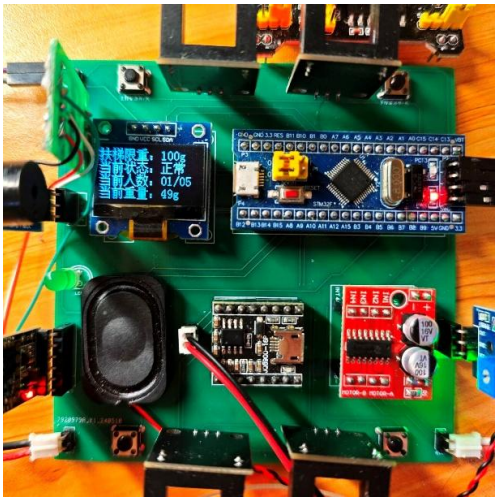
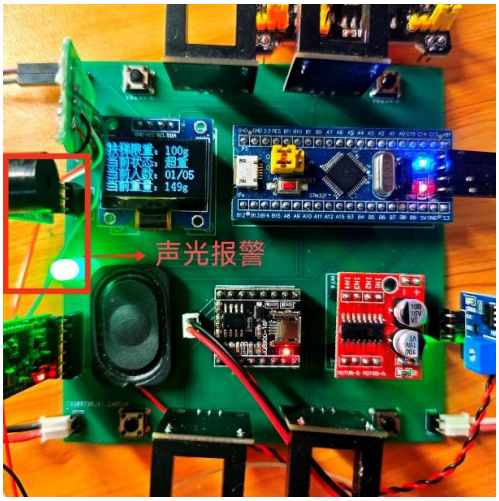


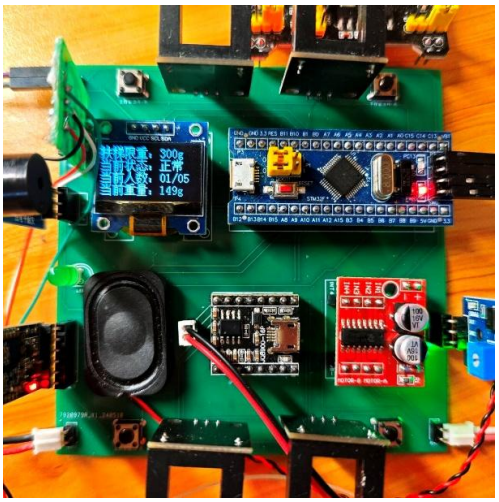
Figure 4.2 Weighing verification test diagram



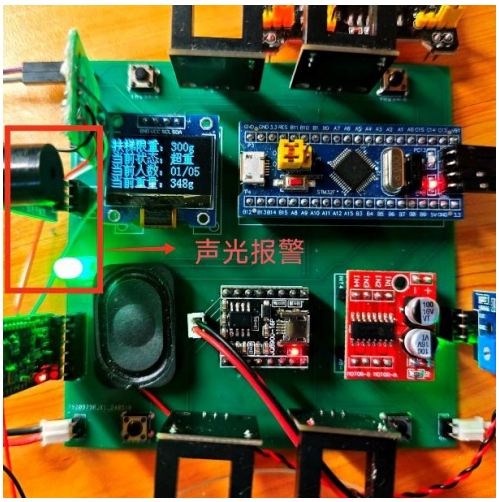


a) Test image of the vehicle under the 100g threshold without overweight

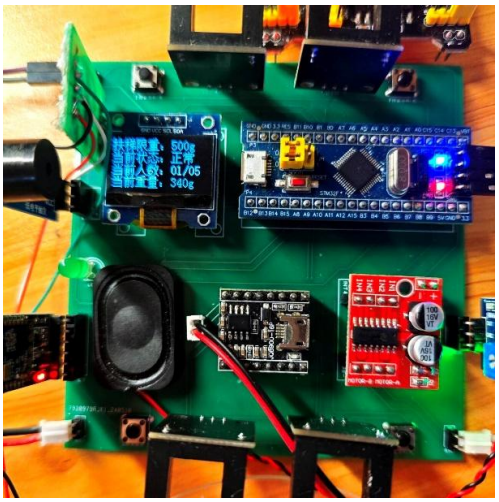
b) Test image of the vehicle under the 100g threshold with overweight



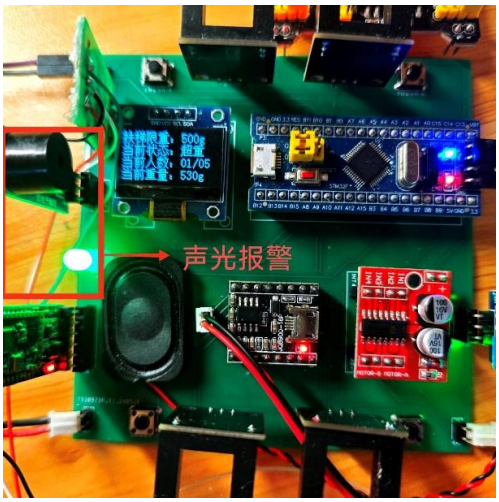
c) 300g threshold value without overweight test picture



d) 300g threshold value overweight test picture



e) Test image of the product with a weight below the 500g threshold value and not overweight



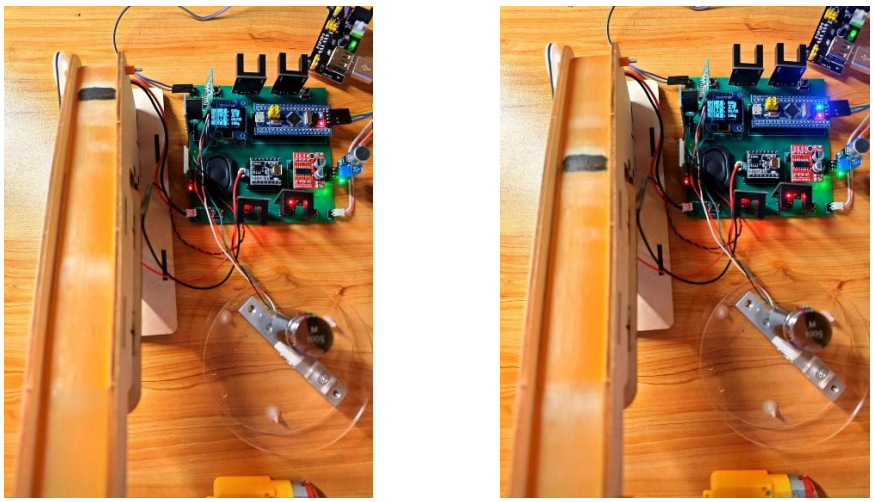
f) Test image of the product with a weight below the 500g threshold value

Figure 4.3 Weighing test actual test diagram

4.2 Escalator Physical Test

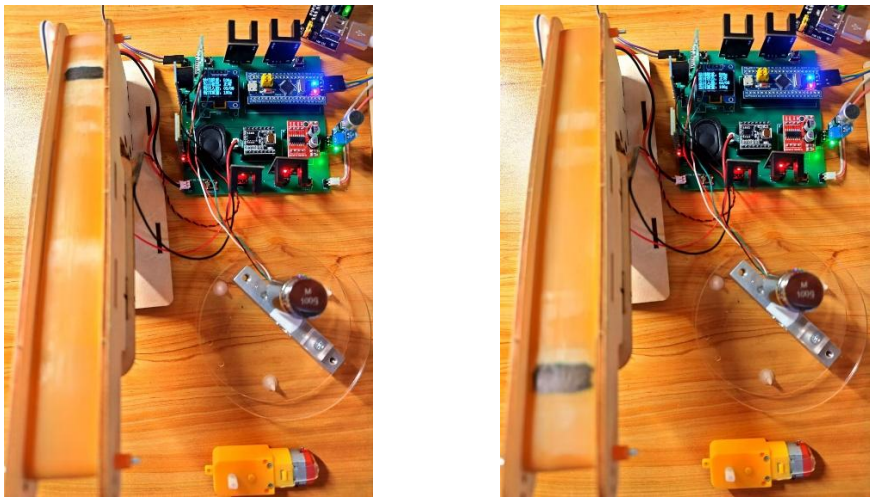
The escalator designed this time detects the entry and exit of people on the escalator through two pairs of infrared counter-radiation sensor modules. On the same side, one infrared counter-radiation sensor records the number of people entering the upward escalator, another infrared counter-radiation sensor records the number of people leaving the upward escalator, and the other pair records the number of people entering and exiting the downward escalator. In order to more intuitively and accurately display the speed of the escalator, draw a black horizontal line on the escalator track. By observing the movement of the horizontal line, you can intuitively see the operation of the escalator. First, power on the entire system. At this

time, the escalator is turned on by default. The escalator on the left goes up and the escalator on the right goes down. Both escalators move at a low speed. The escalator operation diagram in the low-speed state is shown in Figure 4.4. It can be seen that after three seconds, the position of the black horizontal line on the track changes from Figure (a) to Figure (b). When the upper left infrared counter-beam sensor detects an object passing through, it will add 1 to the number of people going up, and at the same time broadcast "escalator up, pay attention to safety" and display the number of people on the escalator at this time on the screen. At this time, it is detected that the number of people on the escalator is not 0, and the left escalator runs faster, as shown in Figure 4.5. By comparing Figure 4.4 and Figure 4.5, it can be analyzed that at the same time, the escalator is faster when there are people entering than when there are no people. When the lower left infrared counter-beam sensor detects an object passing through, it will reduce 1 to the number of people going down. If the number of people going down is 0, the escalator automatically returns to the low-speed running state. Similarly, the right down escalator detects people entering the escalator through the lower right infrared counter-beam sensor, and detects people leaving the escalator through the upper right infrared counter-beam sensor. When the number of people going down is not 0, the down escalator runs at high speed, otherwise it runs at low speed. The test diagram is shown in Figure 4.6. The four emergency start and stop buttons of this system are installed at the up and down entrances and exits. By pressing the two buttons on the left, the left escalator can be started and stopped. Similarly, pressing the two buttons on the right can control the start and stop of the right escalator. This module can well record the number of people in the up and down escalators and make corresponding adjustments to the escalator running speed.



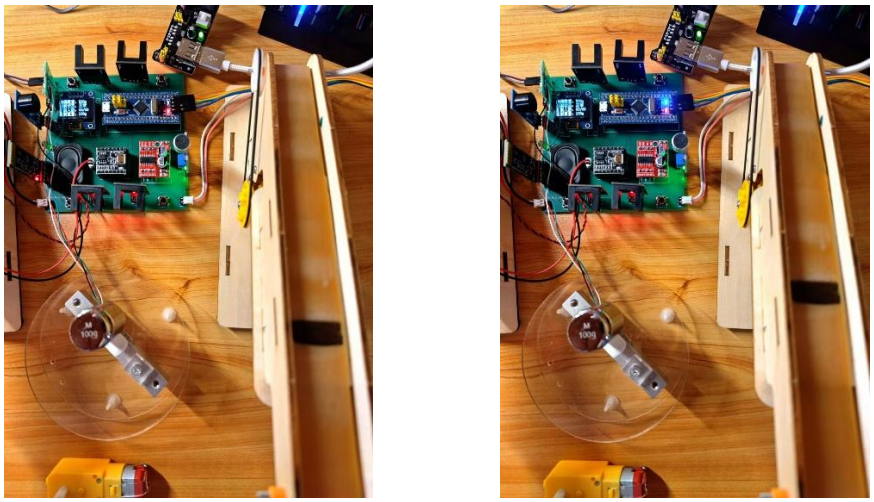
a) Initial position of the black line at low speed b) End position of the black line at low speed

Figure 4.4 Escalator operation test diagram at low speed of upward escalator



a) Initial position of the black line at high speed b) End position of the black line at high speed

Figure 4.5 Escalator operation test diagram at high speed of upward escalator



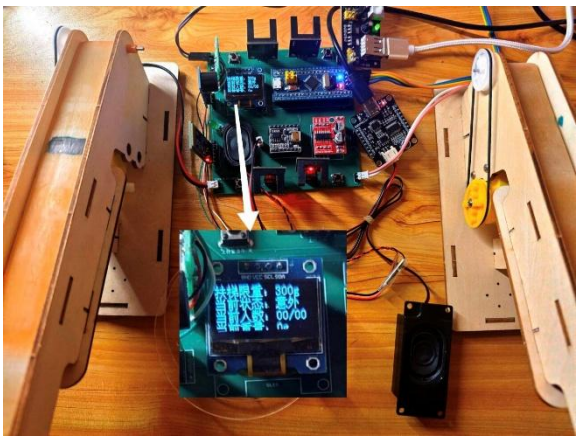
a) Initial position of the black line at low speed b) End position of the black line at low speed

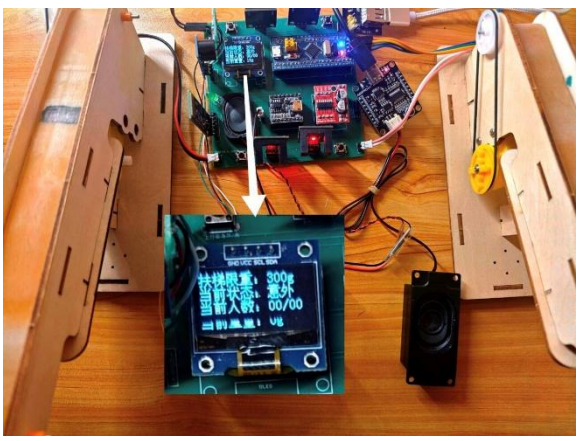
c) Initial position of the black line at high speed　　d) End position of the black line at high speed

Figure 4.6 Downward escalator operation test diagram

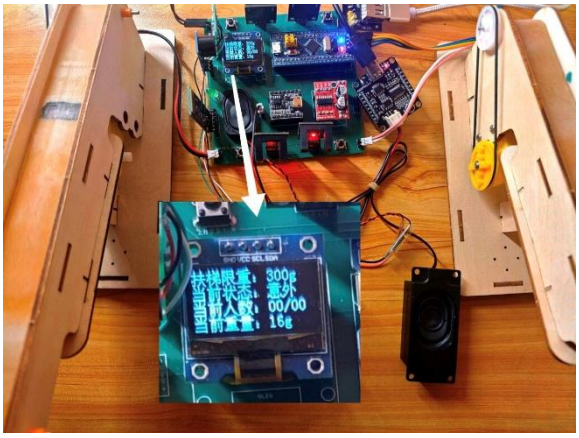
4.3 Speech Recognition Physical Test

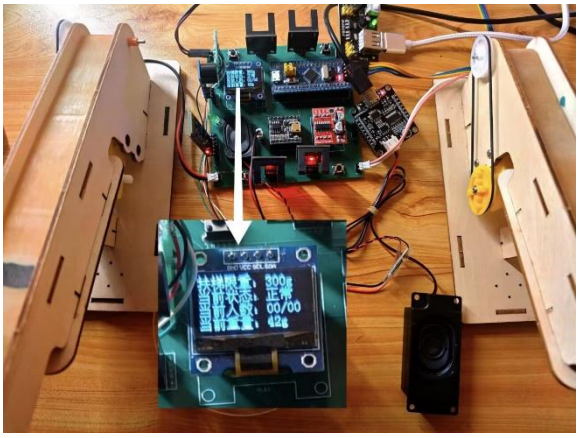
This design uses a voice recognition module. When a specific distress voice is collected, the escalator will automatically stop and modify the current escalator status. Specific distress voices include specific words such as "help", "something happened", and "the escalator is broken". The actual test diagram is shown in Figure 4.7. When the person in need of help sends out voice calls for help such as "help", "something happened", and "the escalator is broken", the escalator status changes to an accident, and the escalators on both sides stop running. When speaking normally, the escalator runs normally. After the voice recognition module collects the distress voice and causes the escalator to stop running, pressing any emergency button or pressing the Bluetooth APP button can restore the escalator to normal. The test results show that the voice recognition function is normal. When a distress voice is detected, the escalator can be stopped and the escalator status can be changed in time.





a) Diagram of the impact of voice "life-saving" on the system b) The impact of voice “failure” on the system





c) The impact of the voice “escalator is broken” on the system d) Impact of non-keyword speech on the system

Figure 4.7 Speech recognition physical test diagram

4.4 Bluetooth module test

First, on the web APP Inventor, write and arrange the buttons and text information of the Bluetooth control interface, then write the program logic, compile and export the Bluetooth control software, and then download the software through the mobile phone to debug the relevant functions. The Bluetooth assistant interface is shown in Figure 4.8.

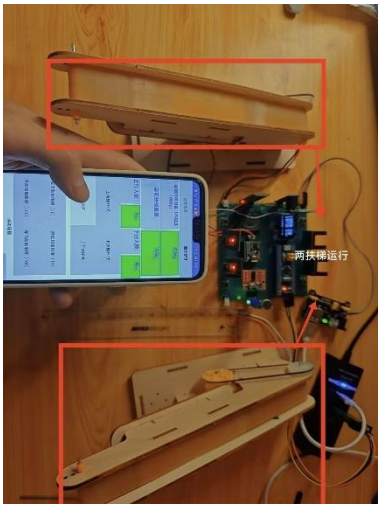
This Bluetooth module test are: 1) Whether the escalator can be started and stopped, and the overweight threshold can be increased or decreased through the Bluetooth function of the mobile phone; 2) The Bluetooth software displays the current number of people going up and down the escalator system and the current passenger weight in real time. When the number of people and weight exceed the set value, the panel will change from green to yellow. 3) How far is the limit distance of the system function controlled by Bluetooth. First, connect the mobile phone Bluetooth to the Bluetooth module. After the connection is successful, the Bluetooth APP panel can display the current escalator weight limit, current weight, and the current number of people going up and down the escalator. There are also 8 buttons with different functions, namely, escalator on/off, escalator on/off, up and down escalator on, up and down escalator off, increase overweight limit (10), reduce overweight limit (10), increase overweight limit (100), and reduce overweight limit (100). There is a text sending button at the bottom of the interface, which can represent 8 different buttons by sending AH. After the Bluetooth module is successfully connected to the mobile phone, the interface displays the

current default weight limit of 300g, the current escalator weight, and the number of people going up and down. Press the Up/Down Escalator On button in the interface, and the two escalators start running. At this time, the escalator function test is carried out, and the results are consistent with the test results in 4.2 above. Similarly, when the Up/Down Escalator Off, Up Escalator On/Off, and Down Escalator On/Off buttons in the interface are pressed, the correct phenomenon will appear. When the Increase Overweight Limit (100) button in the interface is pressed, the escalator weight limit displayed on the interface is increased by 100g, and when the Decrease Overweight Limit (100) button is pressed, the escalator weight limit displayed on the interface is reduced by 100g. The Bluetooth APP button function test diagram is shown in Figure 4.9. At this time, the weighing monitoring function test is carried out, and the function can be realized normally. When the number of people going up or down exceeds the set 12 people, the corresponding panel will change from green to yellow to remind the mobile phone end personnel, and when the current escalator weight exceeds the escalator weight limit, the panel will also turn yellow. The Bluetooth assistant interface display test diagram is shown in Figure 4.10. Table 4.2 records the impact of the distance between the mobile terminal and the escalator system terminal on Bluetooth communication. The test results show that the Bluetooth control function, Bluetooth data receiving function and Bluetooth APP panel display function tests are all normal. In the absence of obstructions, the maximum distance of the mobile phone Bluetooth control escalator system is 24 meters, and the response time of the Bluetooth module is extremely short within the 24-meter straight-line communication distance. When the mobile phone is more than 24 meters away from the escalator system, Bluetooth communication will not be normal.

Table 4.2 Effect of distance on Bluetooth communication

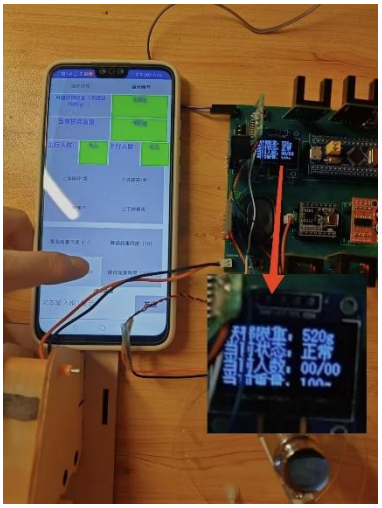
Distance (m)	Response time (s)	Is the communication normal?
10	0.5	Y
20	0.5	Y
twenty three	0.5	Y
twenty four	1	Y
25	Not Responding	N

Figure 4.8 Bluetooth Assistant Interface



a) Bluetooth controlled escalator running function diagram

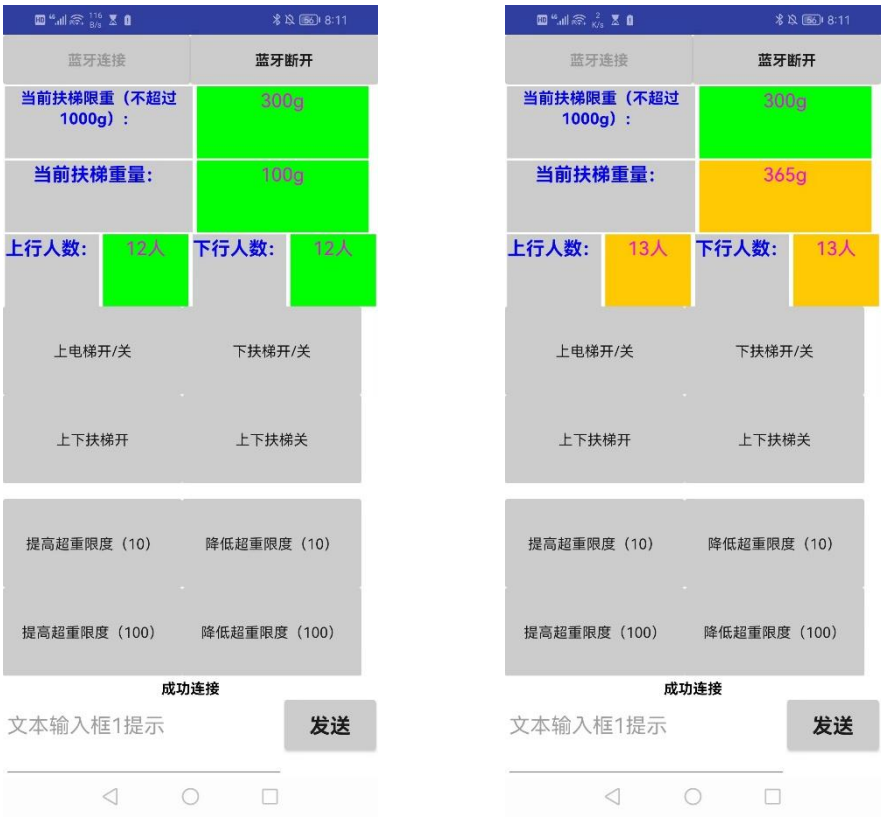
b) Bluetooth controlled escalator stopping function diagram



c) Increase the overweight threshold function map

d) Reduce the overweight threshold function map

Figure 4.9 Bluetooth APP button function test diagram



a) Bluetooth Assistant interface is not overweight b) Bluetooth Assistant interface is overweight

Figure 4.10 Bluetooth Assistant interface displays test image

Conclusion

This design is based on the STM32F103C8T6 microcontroller and develops an escalator control system to improve the operating efficiency, safety and user experience of the escalator. By integrating a variety of sensors and modules, the escalator's automatic control and multiple safety protection functions are realized. The system has features such as drive module, people counting, emergency braking, gravity detection, voice recognition and Bluetooth remote control, providing comprehensive management and monitoring for the daily operation of the escalator.

In terms of hardware implementation, the MX1508 driver module is used to drive the escalator up and down, the separated infrared radiator is used to count the number of people, the weight detection module detects gravity, the voice recognition module performs specific voice recognition, and the Bluetooth module realizes remote control. Independent buttons are used for emergency braking to ensure that the escalator can be quickly stopped in an

emergency.

Through the Bluetooth module, users can conveniently monitor and control the operating status of the escalator remotely, which improves the intelligence and user-friendliness of the system. In addition, the system design also takes into account safety factors, such as overweight alarm, sound and light alarm, etc., to ensure the safety of passengers and equipment. In short, this design provides a useful demonstration and guidance for the upgrade of modern urban transportation facilities, and also provides inspiration for the development of the future intelligent transportation field.

References

[1] Q. Tang. Analysis of PLC single chip control of escalator[J]. Information Construction, 2016, (4): 296.

[2] Z. Chen, H. Tan, S. Li. Design of an escalator with adaptive entrance and exit passenger status[J]. China Elevator, 2022, 33(12): 62-64.

[3] L. Zhang. Automatic escalator electronic control system based on microcontroller[D]. Hangzhou: Zhejiang University of Technology, 2016.

[4] M. Wei. Research on PLC single chip control of escalator[J]. Today's Manufacturing and Upgrading, 2022, (9): 62-65.

[5] W. Shu, H. Ouyang. Discussion on technical standards for intelligent perception and autonomous safety management of escalator passenger behavior[J]. Quality and Standardization, 2021, (10): 39-43.

[6] Z. Shen. Application research and development thinking of intelligent escalators[J]. China Elevator, 2020, 31(22): 29-35.

[7] S. Zhang. Research on wiring method for emergency stop control of subway escalator[J]. Modern industrial economy and informatization, 2018, 8(16): 27-29.

[8] Y. Huang. Fault handling based on power failure of subway escalator[J]. Technology and Market, 2017, 24(8): 48-49.

[9] Z. Chen. Reasonable configuration of escalator host according to efficiency curve and load characteristics[J]. Mechanical and electrical engineering technology, 2014, 43(3): 103-108.

[10] F. Dai. Design of a high-safety escalator operation control system[J]. China Elevator, 2020, 31(17): 25-27.

[11] K. Li, Z. Lei, J. Zhang. Position sensorless brushless DC motor vector control system based on STM32[J]. Electronic Design Engineering, 2024, 32(9): 75-79.

[12] D. Zheng, P. Li, S. Gong, et al. Design of intelligent electronic scale based on lightweight convolutional neural network [J]. Journal of Chongqing Electric Power College, 2023, 28(5): 18-21.

[13] Y. Shang, S. Pan. Design of solar-powered clothes drying system based on STM32[J]. Automation and Instrumentation, 2024, (4): 87-91, 96.

[14] Z. Yu, X. Yue. Design of field vehicle-mounted intelligent monitoring equipment based on STM32[J]. Internet of Things Technology, 2024, 14(4): 12-14, 19.

[15] H. Feng, W. Ren, R. Li, et al. Design of intelligent desk lamp control system based on STM32[J].

Journal of Baicheng Normal University, 2024, 38(2): 65-75.

[16] P. Fan, G. Min. Design of smart medical advice bracelet based on STM32[J]. Internet of Things Technology, 2024, 14(5): 136-139, 143.

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Four years in college is an important stage for a person's growth and development. Looking back on these four years of experience, I have deeply realized many life truths and growth experiences. First of all, four years in college is a process of self-cognition. Through learning, practice and communication, I gradually understand my strengths and weaknesses, interests and abilities. I learned how to discover and tap my potential, how to overcome my shortcomings and defects, and constantly pursue personal improvement and improvement. Secondly, four years in college is a process of self-management and self-discipline. In an environment of independent living and learning, I need to learn how to manage my time, energy and behavior, and how to make and follow my own plans and plans. These processes have cultivated my self-discipline and sense of responsibility, and also made me cherish and use my time more, and pursue an efficient and meaningful life. In general, four years in college is a stage full of challenges and opportunities. Through continuous learning, practice and reflection, I gradually realized my goals and directions, and also had a stronger belief and self-confidence. I hope that in the days to come, I can continue to maintain my love and pursuit of life and learning, continue to grow and progress, and become a more outstanding and meaningful person.

Finally, I would like to thank all the teachers and classmates for their guidance and help in the past four years. They taught me professional knowledge, how to study, and how to be a good person. It is because of them that I have made significant progress in all aspects. I would like to express my sincere gratitude to them and wish all the teachers to cultivate more and more outstanding talents and have students all over the world!

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G · Gridda Paper Testing Report [Simplified Version]

Gezida

Report ID: e17d0ac5c14c4b248cff775cd29091d4

Documents submitted for inspection: Final draft_Hao Yuqi

Author: Hao Yuqi | Inspection unit: Hunan City University | Inspection time: 2024-05-24 21:26:35

Comparison index library | 1989-01-01 to 2024-05-24

Academic journal library	Newspaper resource library	Undergraduate thesis shared library	Grid Data Public Knowledge Base
Dissertation library	Internet resource library	Patent library	Institution's self-built database
Conference paper library	Grid multivariate library (formulas, source code, tables, etc.)		

Test results

Total similarity ratio: 13.44% (total similarity ratio = duplication rate + citation rate)

Duplicate check indicators: self-writing rate 86.56% duplication rate 6.66% citation rate 6.78% (including self-citation rate 0.0%)

Format detection indicators: main body complete

Other types of test results: after removing citations, the total similarity ratio is 6.66%; the total similarity ratio of the same school and class is 0.0%

Similar fragments: duplicate fragment 16, same class fragment 0, reference fragment 11

Indicator name	school requirements	Indicator detection results	System judgment
total similarity ratio	Not more than 25%	13.44%	conform to
Citation rate	Not less than 0%, not more than 25%	6.78%	conform to
Compared with the same school	Not more than 25%	0.0%	conform to
Total word count of the paper	No less than 200 characters/words	15,744 characters	conform to
Format detection	Subject integrity	Subject integrity	conform to

Other test results:

Indicator name	Identify quantity	System judgment
code block detection	0	--

Replication rate index source

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G • Gezida Paper AIGC Test Report

Gezida

Report ID: e17d0ac5c14c4b248cff775cd29091d4

Documents submitted for inspection: Final draft_Hao Yuqi

Author: Hao Yuqi | Inspection unit: Hunan City University | Inspection time: 2024-05-24 21:26:35

Test results

Suspected AIGC risk level: None

Suspected AIGC fragments: 9

Suspected AIGC segments = high-risk segments + medium-risk segments + low-risk segments

fragment summary list

serial number	Submit fragments for inspection	Suspected AIGC probability
1	To sum up, the design background of this project is to solve the problems existing in traditional escalators, introduce intelligence and safety into them, improve user experience, and contribute to the upgrade and improvement of modern urban transportation facilities.	middle
2	The sound acquisition module is used to acquire sound signals from the environment. It can be used to detect specific sound events and trigger corresponding actions. Below is an explanation of the function, working principle, and pin functions of the sound acquisition module in this design.	middle
3	A separate infrared radiator is a sensor used to detect the passage of objects. It typically consists of an infrared transmitter and an infrared receiver. Below is an explanation of the function and operating principle of the separate infrared radiator in this design.	middle
4	In this design, four pins are used to connect two pairs of infrared radiators, each consisting of a transmitter and a receiver. Based on the state changes of these radiators, the microcontroller determines whether the number of people on the escalator is zero, thereby controlling the escalator's speed. By using separate infrared radiators for both counting people and controlling escalator speed, more intelligent and efficient escalator operation is achieved, providing a better user experience and energy savings. The schematic diagram of the infrared radiator sensor module is shown in Figure 2.5.	middle
5	Function: In this design, the Bluetooth module enables remote monitoring and control of the escalator's operating status. It transmits information such as the escalator's load and number of passengers to a mobile phone, and allows users to remotely start and stop the escalator via their phone, providing a more convenient user experience and control method.	middle

Academic journals: (0.82%) Dissertation: (0.28%) Undergraduate thesis sharing library: (5.56%)

Citation snippet sources

Academic normative citations (6.78%) Self-citation (0.0%) Other citations (0.0%)

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Graduation Project Guidance Record

Project	**Design and Implementation of Escalator Control System Based on STM32**
Name	**Yuqi Hao**
Student ID	**200620432**
Faculty	**School of Information and Electronic Engineering**
Major	**Electronic Information Engineering**

Supervisor **Qiuxiang Zhu** **Education** **PhD**

Fill in time **2024 Spring** **Semester**

Hunan City University Academic Affairs Office

Graduation Project Guidance Schedule

The First Guidance Record	Students shall determine the topic of graduation design and complete the assignment and opening report according to the schedule. The guidance record is as follows: 1. According to the training plan and requirements of electronic information engineering, combined with the professional knowledge learned, I plan to carry out the graduation project on the topic of "Design and Implementation of Escalator Control System Based on STM32"; 2. After determining the topic, actively conduct literature research and retrieval around the topic, clarify the design ideas, determine the design plan, and formulate the design tasks for each stage; 3. Propose the functions and parameter requirements to be realized by the design and clarify the significance of the design; 4. Complete the assignment and proposal report strictly in accordance with the format of the college's graduation project. Supervisor's Signature: Student Signature: Date: Date:

The Second Guidance Record	Guiding students in writing the first draft of their graduation project includes: 1. The basic structure of the design text: abstract, introduction, overall design plan, hardware design, software design, test results and analysis, conclusion, references, acknowledgments, appendix, etc. 2. The basic structure of a software development text: abstract, introduction, system development theory, requirements analysis, system design, system implementation and testing, conclusion, references, acknowledgments, etc. 3. Provide guidance on the abstract and conclusion of the graduation project: Ideas for writing an abstract: what will this design do, how will it be done, and what functions will it achieve; Ideas for writing conclusions: what has been done in this design, how well it has been done, and what are the shortcomings; the conclusion is a summary of the design, not a design experience or a summary of the writing process; 4. Guidance on writing English abstracts: Write a corresponding English abstract based on the Chinese abstract, requiring correct translation of professional vocabulary and concise and fluent sentences; 5. Guidance on paper format, especially formatting requirements for tables, figures and references. Supervisor's Signature: Student Signature: Date: Date:

The third Guidance Record	Second draft revision comments, the design text is guided on the basis of the second draft: 1. Modify the English abstract of the design text. The sentences must be concise and fluent, and the translation must be correct. 2. Design introduction: It should state why this design is made (the significance of the design), the current design ideas, existing problems and the advantages of this design; 3. The layout format of the design text shall be modified according to the school's requirements; 4. References should be marked when cited in the text; 5. Specific explanations are required for the diagrams and procedures in the appendix in the text; 6. The format of the program flow chart is not standardized; the size ratio of the hardware circuit diagram is somewhat out of balance; 7. Modify the conclusion. The conclusion is a summary of the entire design, and the language should be concise and refined; 8. Tables in the paper must be in three-line tables, and should be on the same page as much as possible; 9. Some paragraphs are more colloquial, so read through the entire text for further revision; 10. The table of contents needs to be automatically generated and must be consistent with the title of the main text. Supervisor's Signature: Student Signature: Date: Date:

The Fourth Guidance Record	The student designed an escalator control system with STM32F103C8T6 microcontroller as the core and peripheral circuits. The system has been made into a physical object and passed the test. The test results show that it has achieved the expected effect. After several revisions, the text written is fluent in language, reasonable in structure, clear in level, correct in content, and the design content meets the requirements of professional training. It has reached the level of undergraduate graduation design, and the final version basically meets the requirements of bachelor's degree thesis defense. Supervisor's Signature: Student Signature: Date: Date: