

Product Report

Group 62

Year3_Design&Build_2020

Data of Report: 23th, October, 2020

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1. Project Overview

1.1 Training topic background

(1) Basic knowledge learning:

Common sense of safe electricity use, selection of basic components, development and status quo of electronic process technology, manual welding materials, tools and technical points, introduction to the latest development of current smart electronic products, product development and production processes, key technology explanations, and related new technologies Introduction and demonstration of new devices, etc.

(2) The main purpose of training

Install the Arduino IDE and be familiar with the Arduino development environment; understand the working principle and usage of the MEGA2560 R3 development board and each circuit module; design electronic keyboard related circuits according to the topic requirements and material list; learn the use of Portus software by yourself to simulate the designed circuit. Realize the functional design of the electronic keyboard, the design and comparison of implementation schemes, welding and assembly, electronic keyboard programming, hardware installation and commissioning, appearance design and installation

1.2 List of main materials

No.	Materials	Amount
1	MEGA2560 R3 development board and related instruction materials	1
2	USB download cable	1
3	Bread board	1
4	Button switch (with button cap)	20
5	Photoresistor (two kinds of 5528 and 5539)	20
6	Matrix keyboard	1
7	1602LCD module	1
8	Passive buzzer module	3
9	Voice module + speaker	1
10	Ultrasonic distance measuring module	1
11	Infrared remote control transmitting and receiving module (infrared emission + 38k receiving + remote control)	1
12	Several LEDs of various colors	
13	Several kinds of current limiting resistors	
14	Offline power supply devices such as batteries and battery boxes	
15	Dupont Lines	

16	2.54mm 40pin header	
17	0.5W speaker	1
18	Transistor SS8550	4

2. PROJECT PLAN

2.1 Project objectives

Basic requirements:

Design and make an electronic piano with no less than 8 keys, which can play a complete simple tune. There are LCD display prompts during the performance.

Advanced requirements:

- (1) Special effects can be switched, such as sustain, tremolo wheel, etc.;
- (2) Can play music automatically;
- (3) Can play double notes or chords;
- (4) Self-designed other functions (such as using photosensitive resistance to make photosensitive keys, etc.).

2.2 Ideas

2.2.1 Collaboration

According to the software preparation, hardware construction, documentation, packaging and other modules of the division; In addition to the division of labor, there is also group cooperation, including the discussion of function implementation, searching for information and testing are carried out in the collaboration.

2.2.2 From easy to difficult

First of all, the basic functions of the electronic organ are realized, that is, the keys of eight basic syllables are played, and then other functional modules are gradually added, such as lighting effect, ultrasonic ranging, infrared remote control, recording and other functions.

2.2.3 Modular programming

Divide modules according to functions, write programs according to modules, and minimize the interaction between different modules through function encapsulation and so on.

The modularization of the program is also reflected in the fact that different modules have separate control buttons, which can control the entry of functional modules and realize the button exit to the main module at the same time.

2.2.4 Energy conservation and environmental protection

In appearance design and production, the use of discarded paper boxes and other articles, waste utilization, energy conservation and environmental protection.

2.3 Module plan

Expected function	Main modules and materials
Basic body	MEGA2560 R3 development board, key switch (with key cap), USB download cable, breadboard, passive buzzer module, DuPont cable
Recording and audio playback	Voice module ISD1820, 0.5W speaker
Display and prompt	1602LCD module
Infrared remote control	Infrared remote control transmitter and receiver module (infrared transmitter + 38k receiver + remote control)
Lighting effect	Various color LED
Ultrasonic distance measurement	Ultrasonic Ranging Module
Trill mode	Arduino IDE
Tenuto mode	Arduino IDE
Multitone mode	Arduino IDE

2.4 Development environment

Arduino is an open source electronic prototyping platform. It is built on the open source simple I/O interface version, and has a Processing/Wiring development environment similar to Java and C language. It mainly contains two parts: the hardware part is the Arduino circuit board that can be used for circuit connection; and the software part is the Arduino IDE, the program development environment in the computer. Arduino can perceive the environment through a variety of sensors, and feedback and influence the environment by controlling lights, motors, and other devices. In this training, the Arduino IDE is used as the development environment to associate various functional modules to finally realize a suggested electronic organ with multiple functions.

2.5 Timetable

7 th September	8:00-12:00	Learn related basic knowledge and reference materials
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	14:00-21:00	Electronic keyboard basic body, ultrasonic distance measurement
8 th September	8:00-12:00	Lighting effects, LCD display
	14:00-21:00	Infrared remote control
9 th September	8:00-12:00	Tremolo effect
	14:00-21:00	Recording and audio playback, training documents
10 th September	8:00-12:00	Suspension effect, ppt production, appearance production, training document
	14:00-21:00	

3.PROJECT IMPLEMENTATION

3.1 Implementation process

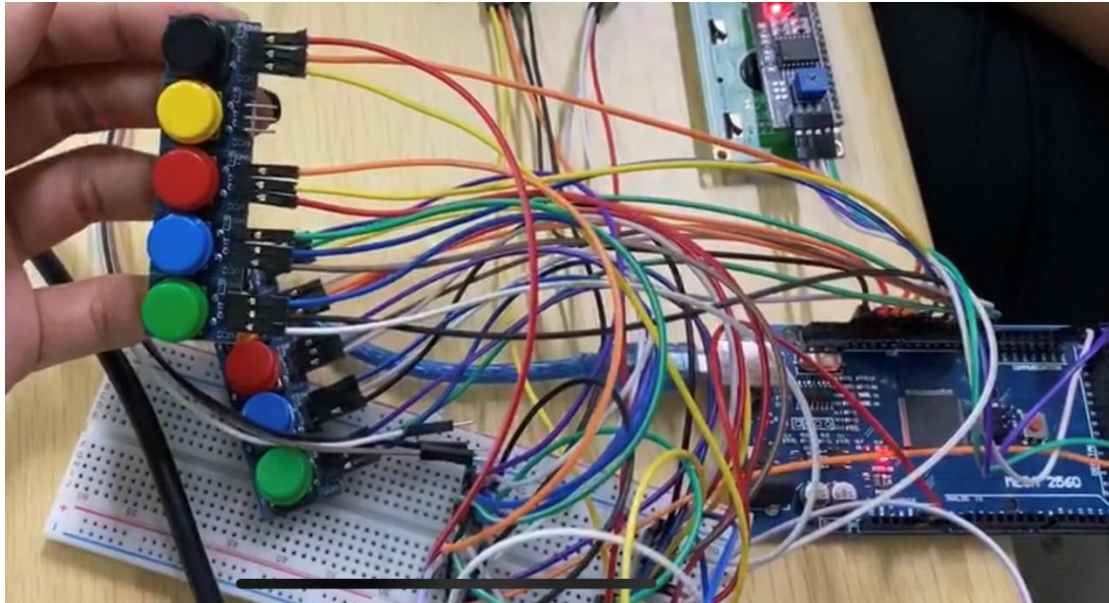
3.1.1 Study of relevant basic knowledge and reference materials

Learn about the Arduino IDE development environment through the provided reference materials, and through the network retrieval of information, the different functional modules included in the project have been studied as expected, and their basic functions and usage methods have been mastered.

 Arduino机器人制作入门教程	2017/6/25 9:08	PDF 文件	2,082 KB
 Arduino-入门到精通-例程3-PWM调光	2017/6/25 9:05	Microsoft Word ...	524 KB
 Arduino-入门到精通-例程6-按键控制	2017/6/25 9:05	Microsoft Word ...	517 KB
 Arduino-入门到精通-例程11-感光灯	2017/6/25 9:07	Microsoft Word ...	341 KB
 Arduino-入门到精通-例程19-红外遥控	2017/6/25 9:05	Microsoft Word ...	85 KB
 ARDUINO-升级版入门套件课程	2017/6/25 11:35	PDF 文件	4,026 KB
 林锋教你一步一步玩机器人(arduino)-基...	2017/6/25 9:09	PDF 文件	1,465 KB
 林锋教你一步一步玩机器人(arduino)-硬...	2017/6/25 9:10	PDF 文件	4,057 KB
 林锋教你一步一步玩机器人(arduino)-....	2017/6/25 9:10	PDF 文件	3,711 KB
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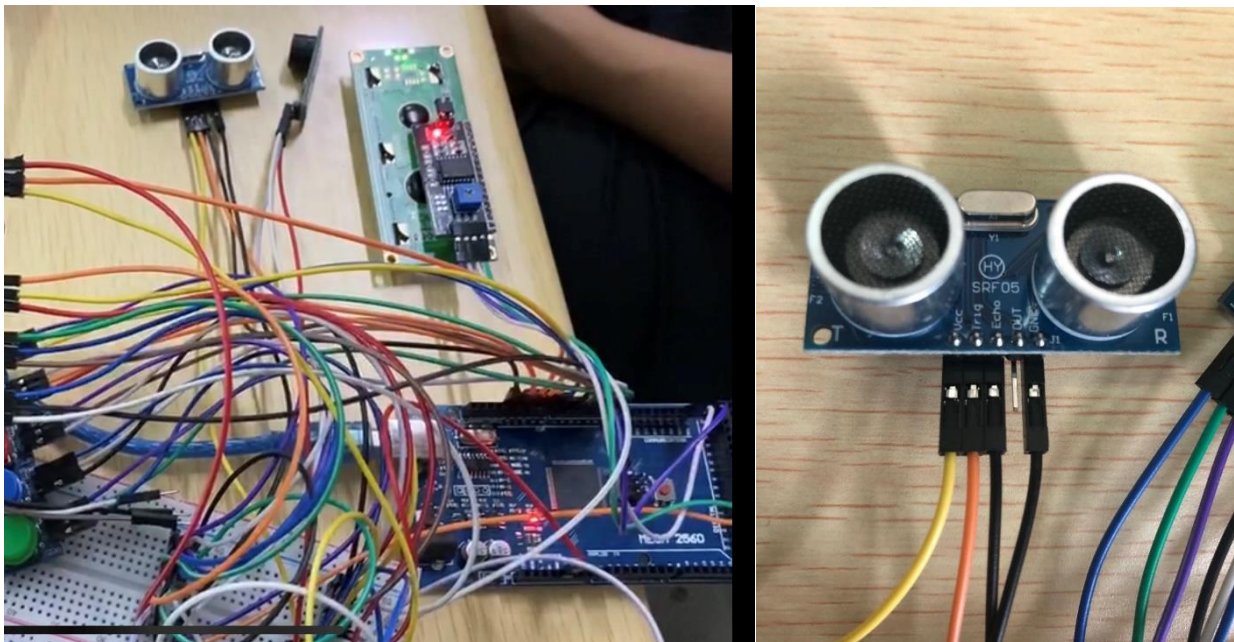
3.1.2 Basic body

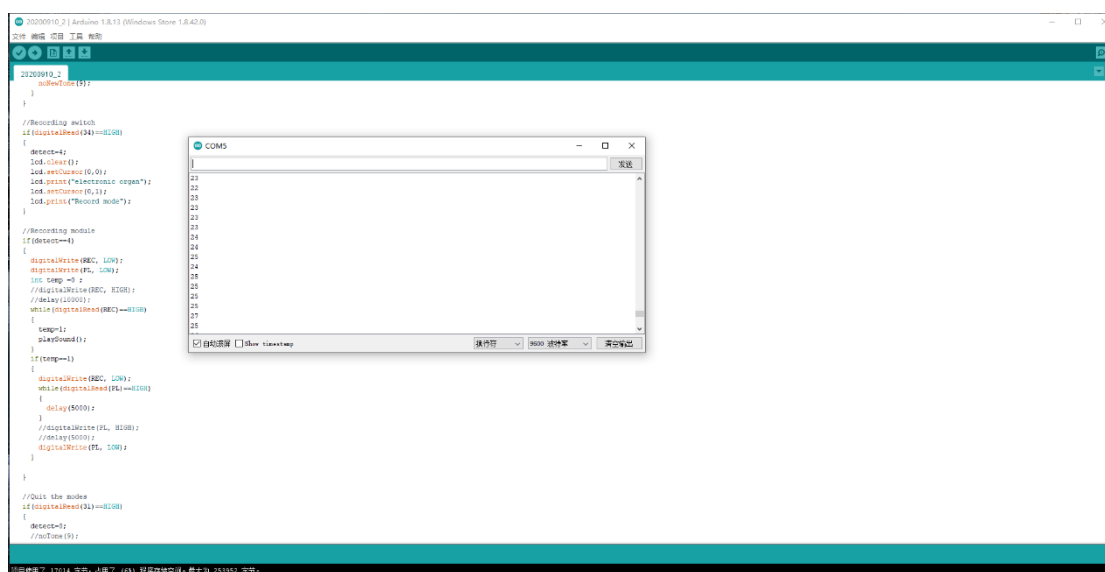
The materials used to make the basic body of the electronic keyboard are: MEGA2560 R3 development board, key switch (with key cap), USB download cable, breadboard, etc. First, use the USB download cable to connect the computer with the Arduino IDE development environment pre-installed to the Arduino circuit board and adjust the corresponding interface. After connecting, we choose the key switch (with key cap) as the key of the electronic organ in this product and connect it to the Arduino motherboard using DuPont wire and breadboard. In addition, the electronic keyboard produced this time also has a music playback function. We have pre-stored the two songs "Little Star" and "Big Fish" during programming, which can be selected and played through the exclusive buttons.



3.1.3 Ultrasonic distance measurement

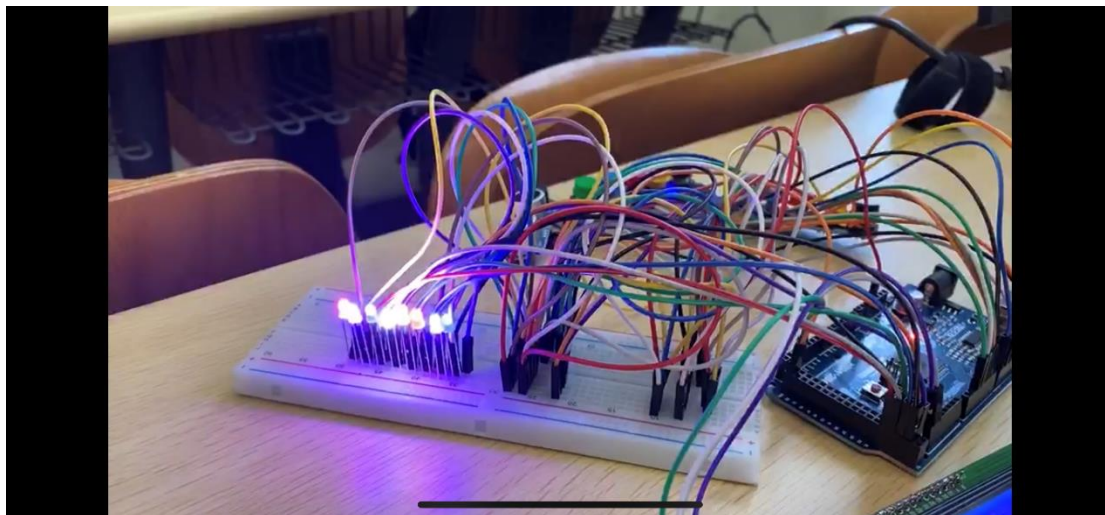
Due to the phased task (choose a sensor to practice using and complete a basic function), we first chose to add the ultrasonic ranging module to the main body of the electronic organ. HY-SRF05 ultrasonic ranging module can provide 2cm-450cm non-contact distance sensing function. The range accuracy can be 3mm. Connect it to the Arduino development board using DuPont cable (VCC: 5V power supply, GND: ground wire, TRIG: trigger control, signal input, ECHO: echo signal output).





3.1.4 Lighting effect

Use LEDs of various colors to add lighting effects to the keyboard: when the keys are pressed, there will be a light display, and different keys correspond to different LED lights. In the subsequent music playing function, the LED will also have its special lighting effects. (When playing "Little Star", all lights will flash according to the beat; when playing "Big Fish", all lights will remain bright until the end of the music.)



3.1.5 LCD display

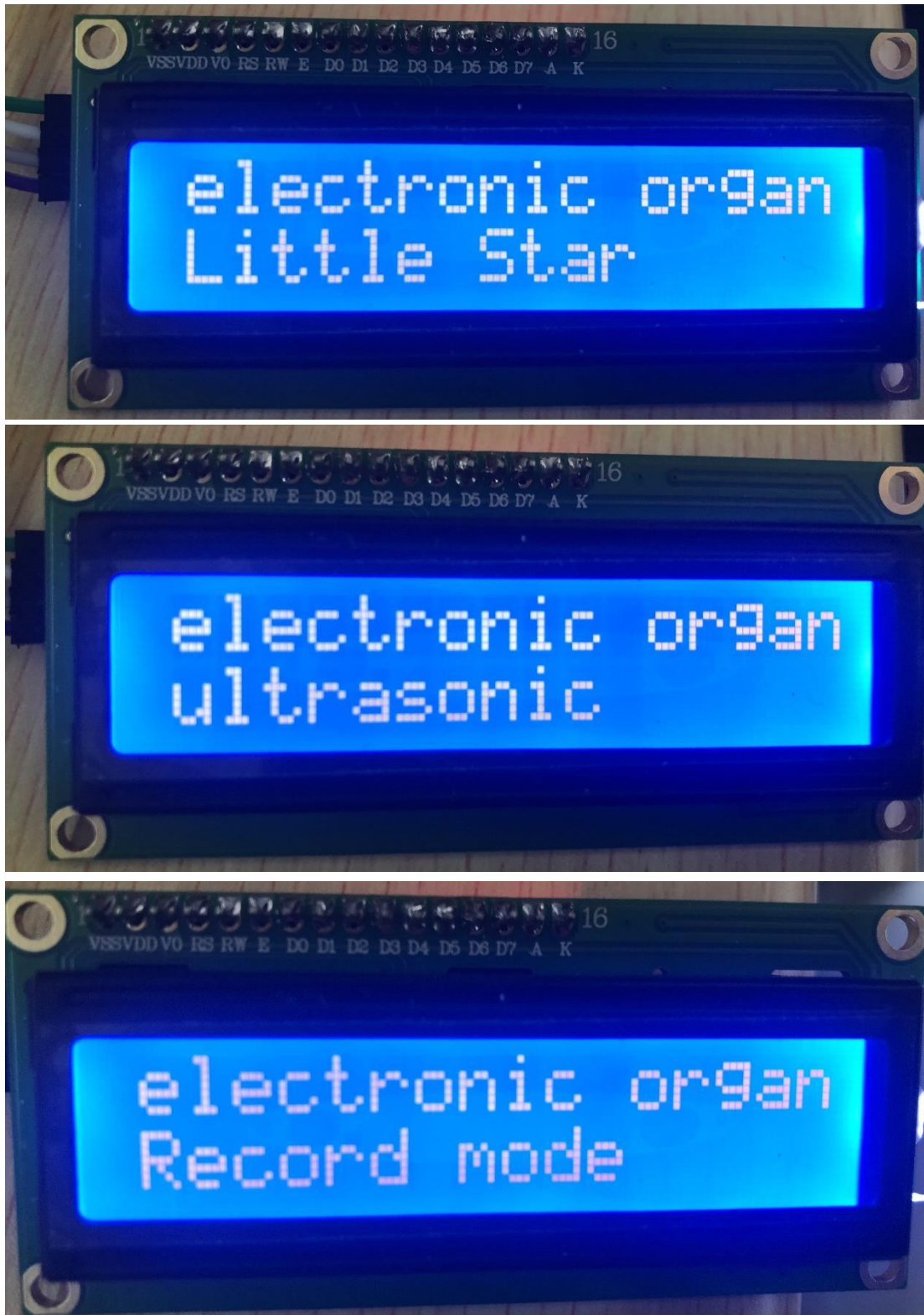
LCD1602 liquid crystal display is a kind of character type liquid crystal display module widely

used. Before connecting it to the keyboard, we first welded its parts.



After welding, we connect the LCD1602 liquid crystal display to the circuit. By using Arduino IDE to program it, the display screen can show different information and prompts under different conditions. For example, during the initial activation stage of the keyboard, the display will show a welcome statement; when the key is pressed, the display will show the note corresponding to the pressed key; and when the keyboard is playing a song, the display will show the song Name; when switching between different modes, the display will also show which mode the keyboard is currently in (for example: vibrato, ultrasonic).





3.1.6 Infrared remote control

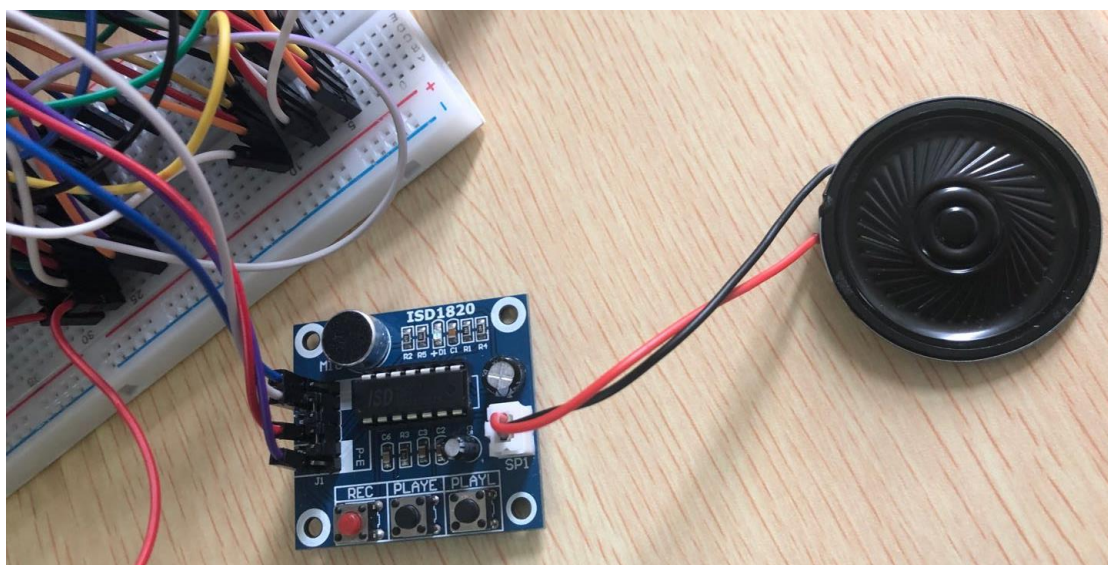
In order to realize the infrared remote-control function of the keyboard, we first connect the infrared receiver to the circuit. Then, through the window monitor function of the Arduino IDE, the window

value corresponding to each button of the infrared remote control is learned and recorded. Then according to the recorded value, the function of each button is arranged accordingly. After programming, the 1 to 8 keys on the infrared remote control correspond to the 8 tones of the piano keys in turn, and the LED lighting effects are also retained.



3.1.7 Recording and audio playback

In order to realize the electronic keyboard's recording and audio playback functions, we connect the voice module ISD1820 and a 0.5W speaker into the circuit (VCC: 5V power supply, GND: ground wire, REC: trigger control, signal input, PLAYL: signal output). Due to the original program of the module, the module will have a certain waiting time before playing the recorded audio, which may affect the user experience. Therefore, we use the Arduino IDE to adjust the main function of the module, so that when the PLAYL button of the module is pressed, the module will immediately play audio.



3.1.8 Tremolo mode

The plan needs to give the keyboard a special effect. After discussion, we finally chose to add a "tremolo effect" to the keyboard. Using the Arduino IDE, the keyboard sound in the "tremolo mode" will become a repeated loop of two different frequencies to achieve the effect of vibrato, and a button is provided for this mode as a mode switch.

3.1.9 Tenuto mode

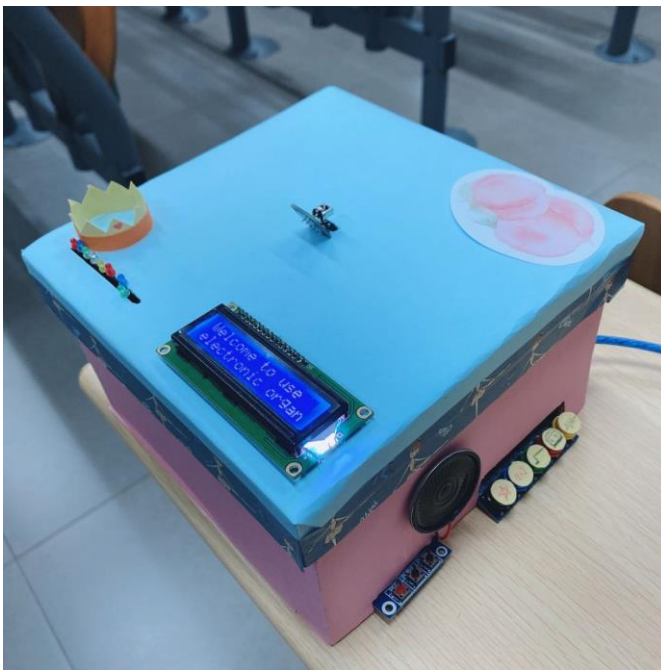
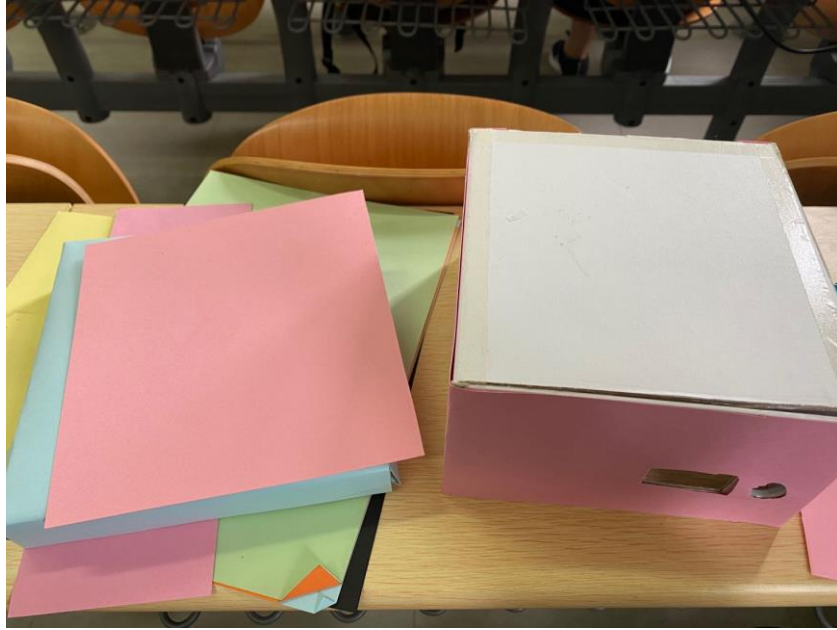
Continue to give special sound effects to the keyboard, this time I chose the sustain effect. The program is supplemented by the Arduino IDE to make the buzzer sound of the electronic keyboard in the sustain mode continue. Similarly, we also connect a key switch for this mode, providing users with the convenience of free choice, quick activation and shutdown.

3.1.10 Multitone mode

Due to the inability of the tone function to achieve multi-threading, the Tone library and the IRremote library (used by infrared remote control) do not coexist and other issues, dual tone was not implemented initially. But after adjusting the program through the Arduino IDE, the dual tone mode of the electronic keyboard was finally realized. When the electronic keyboard is in the dual tone mode, the user can press multiple keys at the same time to get the sound of the pressed keys overlapping. Similarly, we also connect a key switch for this mode, providing users with the convenience of free choice, quick activation and shutdown.

3.1.11 Appearance design and production

The overall appearance of the electronic keyboard is a cubic trend. Considering a better user experience, we have assigned the interactive parts of each module as follows: keyboard keys, ultrasonic ranging switch and main switch are located on the front of the keyboard; LCD display screen, infrared receiver and LED lights are located on the top of the keyboard; music The playback button, the vibrato mode switch, the recording mode switch and the sustain mode switch are located on the user's left plane facing the keyboard; the buzzer and the ultrasonic ranging component are located on the user's right plane facing the keyboard. The main materials used to make the appearance are cardboard and cardboard.



3.2 Problems encountered

3.2.1 Multitone mode

Due to the inability of the tone function to achieve multi-threading, the Tone library and the IRremote library (used by infrared remote control) do not coexist and other issues, dual tone was not implemented initially. After that, try to change the code structure and use the nested judging sentences in the loop structure to realize that after pressing the two buttons, it can be played

alternately in a short time. Because the time setting is very short, the auditory effect is approximately simultaneous.

3.2.2 Trill mode

The initial completion of the vibrato mode will cause the sound of the initial mode to also change to vibrato. Later, it is found that the overall structure of the code is unreasonable. The addition of a notone function in the judgment module causes the long-term key press process to be equivalent to repeated keystrokes, resulting in vibrato. Then it was solved by adjusting the Arduino IDE program structure.

3.2.3 Voice module automatically plays after recording

After the initial connection of the voice module is completed, it will automatically play the audio after recording (no need to press the play button PLAYL), and then set the judgment sentence. Set the voice module to perform recording when the recording button is pressed, that is, the adjustment of the voice module program function is completed. Optimization, so that the problem is solved

4. Project summary

4.1 Conclusion

In four days, through the Arduino IDE and the application and association of the Arduino motherboard and different functional modules, we finally successfully made a simple electronic piano. It not only has the most basic button sound function of the electronic keyboard, but also can satisfy the user to switch three sound modes (initial mode, vibrato mode, sustain mode). At the same time, it can also be used as a music player for pre-stored music playback, recording, and audio playback. In order to enhance the user experience, the electronic keyboard is also equipped with lighting effects and infrared remote control functions that can be combined with music. In addition, the use of the ultrasonic distance measurement module is a module that is not installed in a general electronic keyboard. The use of this module allows users to understand the scale through distance and listen to the continuous changes of tones through distance changes, or the user's personal usage and purpose.

4.2 Experience

After this training, we got real contact with the Arduino IDE and various functional modules and got the opportunity to associate each part by hand, and finally get a finished product with multiple functions and meeting design requirements. The familiar knowledge system and the corresponding unfamiliar content and components were used in the training process. We were able to not only put the knowledge we learned in the past into real practice for exploration, but also improve ourselves in the process of learning and applying modules. Ability to learn and understand unfamiliar content. While achieving practical results, we also discovered many deficiencies of our own. For example, when using the Arduino IDE development environment for programming, the design of the overall framework of the program is insufficient and the data structure is not optimized.

4.3 Teamwork

Name	Mainly responsible for
Miaoxuan Zhang	the software programming part, complete the main modules such as electronic keyboard music playback, LCD display prompt sentence module, lighting effect module, infrared remote control key, vibrato effect, recording and audio playback effect, as well as switching between different modes and pushing button programming. At the same time responsible for the production of PPT and presentation video, participate in group discussions, access to materials, etc.
Ye Hua	the connection and adjustment of hardware facilities: buttons, LCD display screens and other equipment; recording modules; lighting design and

	connection; appearance packaging design and production; information and literature inquiry.
Yunhang Sun	the circuit connection and adjustment of the buttons, LCD display, and ultrasonic ranging module; consult the relevant information of the hardware module, participate in group discussions, record the training process, and write and organize the report of this training practice.
Qinshan Sun	Code writing: Electronic organ keys, tenuto mode, multitone mode, ultrasonic mode, infrared remote control, etc. Design and make cad drawings. Make simulation proteus circuit. A small part of the hardware works. PPT writing.

5. Web Design Introduction

Our website design is mainly based on black and white, and the creative inspiration comes from the piano keys. D&P is an electronic musical instrument company such as electric-piano as core product, focusing on the development of high-quality electronic musical instruments. Therefore, we mainly adopt simple and elegant styles in web design which is used as the official sale website of our company. We are committed to making the website meet the various shopping needs of users while making users feel the convenience and efficiency of the website. Let users feel the highest sincerity of the company during the shopping process.

6. Web Appearance

We looked through some website like Yamaha to learn from their web design, functional design and so on. The entire website pays more attention to our products and uses a flat style to make the website look more friendly and efficient. At the same time, clear functional modules are divided which reduced redundant elements in order to make user keep more attention on the product and have a deep understanding of our products and services.

7.Main Pages

7.1 Home Page

As the company's main page, users can view company and product introductions for free. Before users register and log in, they can browse products at will to get product recommendations so that users can better understand the company. From the menu bar of Our Product and view the Product buttons on the first page users can check the products, which are designed to provide convenience for the customers.

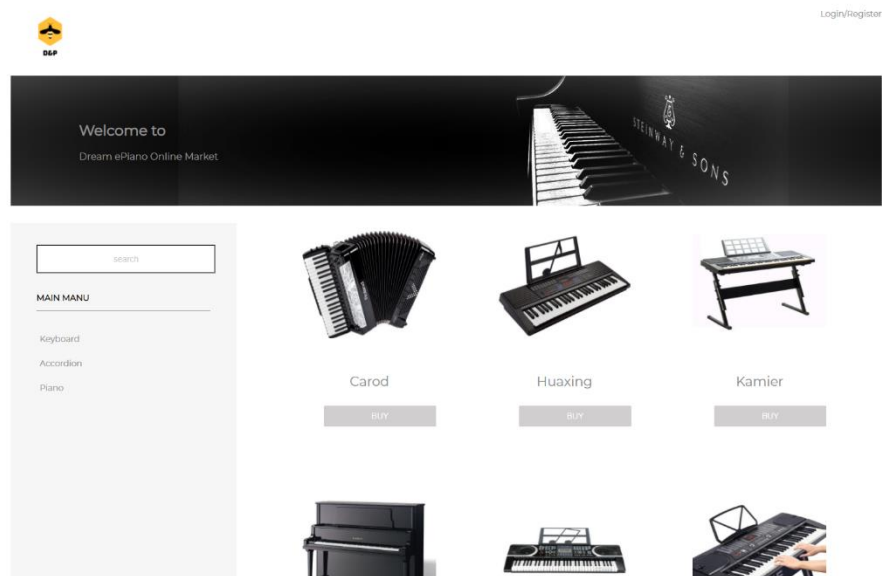
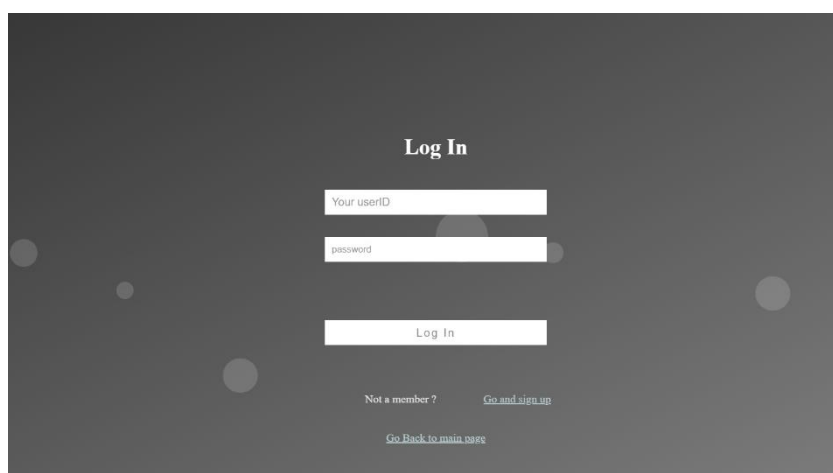


Fig 1 Home Page

7.2 Login & Register Page

If the user wants to add his favorite products to the shopping cart or directly



purchase, the page will prompt the user to log in or register.

Fig 2 Login Page

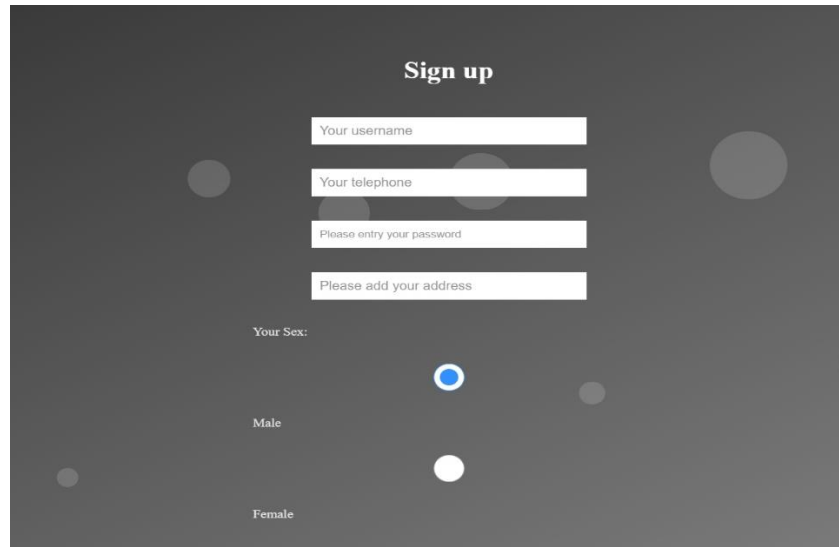
A dark gray sign-up page with the title "Sign up" at the top. Below the title are four white input fields: "Your username", "Your telephone", "Please entry your password", and "Please add your address". Below these fields is a section for "Your Sex:" with two radio button options: "Male" (selected) and "Female".

Fig 3 Sign Up Page

7.3 Product List Page

In addition to the recommended products on the homepage, each series has many products. Users can click the button to enter the details page, make a purchase or add to the shopping cart.

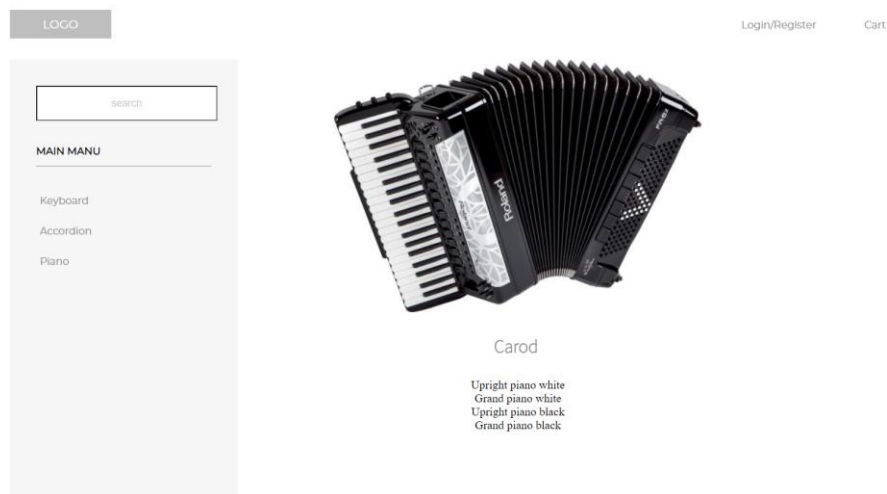


Fig 4 Product List Page

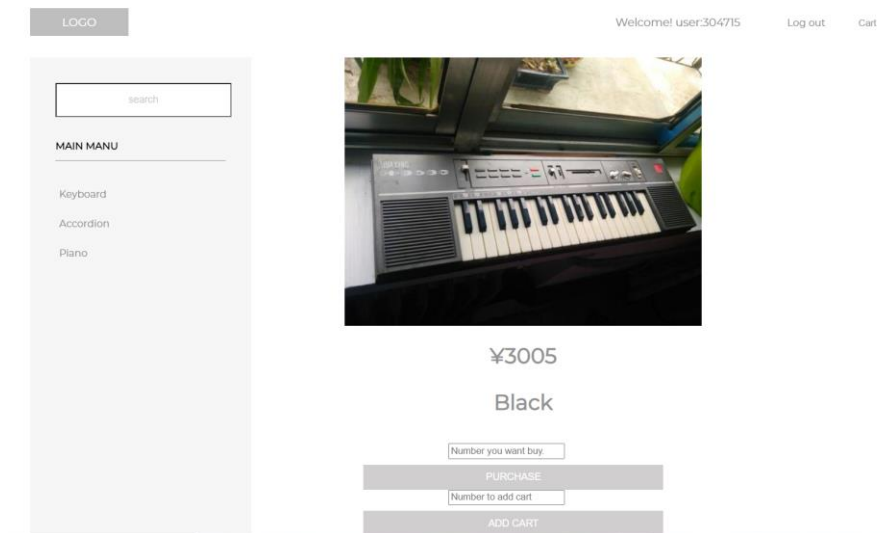


Fig 5 Product's Specific Information Page

7.4 Cart Page

There is a shopping cart button at the top of the page which allow users to view and edit the items in the shopping cart after logging in. The shopping cart page displays the name, quantity and price of the product in detail, so that the user can choose to submit an order for payment.



Fig 6 Cart Page

7.5 Order & Detail Order Page

After the user submits the order, the website will generate an order and a detailed order. On the order page, users can see the total price, time, and shopping address of the submitted order.

Welcome! user: 1537

OrderID	Total Price	Address	Date
173	12019.0	Haidian District, No. 10 West Tucheng Road	2020-10-11 12:55:57
201	66088.0	Haidian District, No. 10 West Tucheng Road	2020-10-10 16:01:21
225	66088.0	Haidian District, No. 10 West Tucheng Road	2020-10-10 15:59:28
656	3000.0	Haidian District, No. 10 West Tucheng Road	2020-10-10 16:41:19
1098	3004.0	Haidian District, No. 10 West Tucheng Road	2020-10-10 16:02:26
1132	3000.0	Haidian District, No. 10 West Tucheng Road	2020-10-10 16:42:53
1368	3000.0	Haidian District, No. 10 West Tucheng Road	2020-10-10 16:45:27
1951	4567.0	Haidian District, No. 10 West Tucheng Road	2020-10-21 21:34:54
1964	3000.0	Haidian District, No. 10 West Tucheng Road	2020-10-10 16:47:33
2084	12019.0	Haidian District, No. 10 West Tucheng Road	2020-10-11 12:55:52
2886	3000.0	Haidian District, No. 10 West Tucheng Road	2020-10-10 17:02:28
3019	3004.0	Haidian District, No. 10 West Tucheng Road	2020-10-11 13:16:00
3518	3000.0	Haidian District, No. 10 West Tucheng Road	2020-10-10 16:28:40
3883	12019.0	Haidian District, No. 10 West Tucheng Road	2020-10-11 12:56:53
4414	12019.0	Haidian District, No. 10 West Tucheng Road	2020-10-11 12:49:39
4782	66330.0	Haidian District, No. 10 West Tucheng Road	2020-10-08 16:53:40
5593	66000.0	Haidian District, No. 10 West Tucheng Road	2020-10-10 15:59:18
5939	33044.0	Haidian District, No. 10 West Tucheng Road	2020-10-08 16:51:45

Fig 7 Order Page

The user can jump to the detailed order page by clicking on the order number. The name, quantity, price and status (ordered, delivered, signed) of all the products purchased by the user at a time can be displayed.

Welcome! user: 1537

Detailed OrderID	Item Name	Numbers	Price	Status	ItemID
158	Coard_Upright_piano white	2	3000.0	ordered	10005
278	KaWai_ES1 white	1	3010.0	ordered	10015
389	huaxing_black	2	3005.0	ordered	10010

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Fig 8 Detail Order Page

8 General structure of our code

