Project Deliverable D:

Initial Prototype Analysis and Test Results

Submitted by

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Date: 03/05/2021

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Acronym	Definition
LED	light-emitting diode
CNY	Chinese Yuan
CAD	Canadian Dollar

1 Introduction

During these two weeks, the two members of our team worked together to finish the task ahead of schedule. We have basically realized the connection of hardware, the voice recognition based on keywords, the Bluetooth signal transmission between the two devices, and the alarming function after receiving the signal. At the same time, we also actively contact our client by email and video-conferencing, and we are making plans to improve our products according to customer feedback.

2 Description of the global concept

2.1 Hardware

As the two members in our group have no knowledge and experience of both mechanical drawing and 3D printing, we do not understand the Cadence for industrial drawing. After the discussion among the members, we finally decided to buy the shells of the two devices from the network.

2.1.1 Bell unit

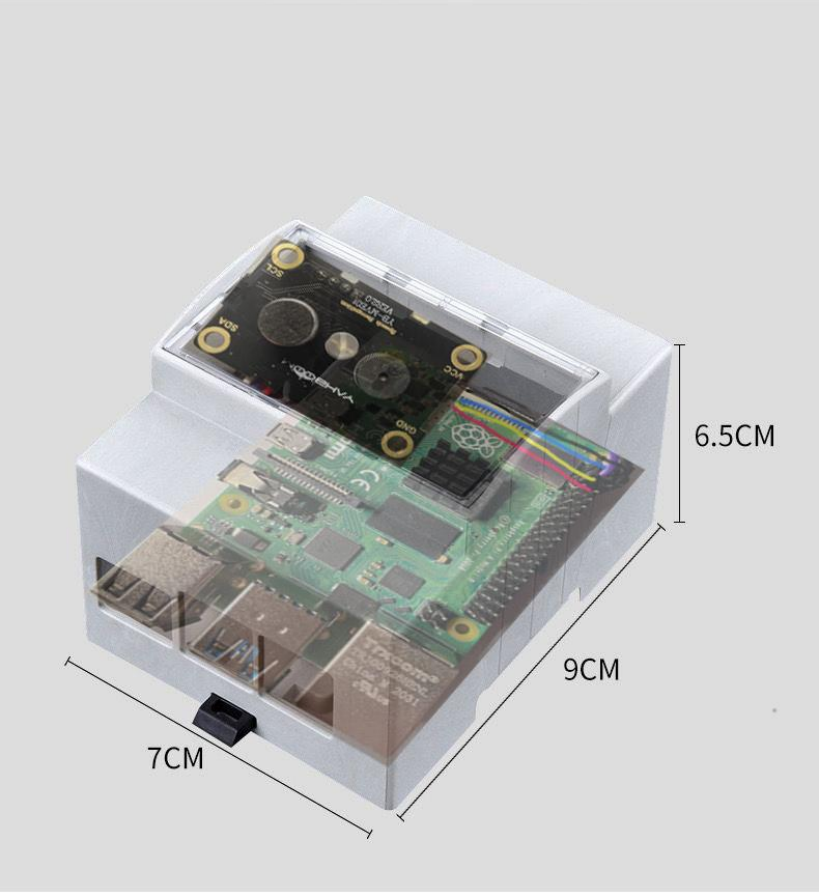


Figure1: Model of the bell unit

The product shown above is a schematic model made with Photoshop. We have achieved the internal connection between the speech recognition chip and the raspberry pi 4b, and now we are waiting for the shell to be shipped and installed.

First of all, the reason for adopting the shell is to take into account its semi-open shape, which makes it convenient for the microphone of the speech recognition chip to contact the outside of the device. This will greatly improve the accuracy of speech recognition. Secondly, considering that its price is only 2 dollars, which is very affordable.

In the choice of development board, we chose raspberry pi 4b as the CPU of the main unit of night call bell. Because it has strong processing ability, it can quickly process sound files and recognize keyword. Considering the following plastic package, we installed a heat dissipation sheet on the board to ensure the continuous operation of the device.

The speech recognition chip comes with a microphone and a buzzer, which greatly facilitates our wire connection. At the same time, the chip itself has the audio drive that the development board does not have, which greatly decrease the difficulty of our work. Also, the chip can receive an external voice signal through its microphone and converts the voice chip into machine code. We can realize voice control by comparing keywords with the accepted machine codes. In addition, the voice chip and the motherboard are connected by I2C protocol, which is a two-wire parallel communication mode. It is stable and efficient and does not need additional knowledge. You

only need to know the address of the data bus and how to input and output from the bus to communicate between modules.

Finally, in the choice of power supply, we use the type-c interface of 5V3A to power the main version. At the other end, we choose a general-purpose socket that can be used from 100V to 240V. This meets the customer's requirement "no additional and external devices need to be connected like computer".

2.1.2 Portable unit

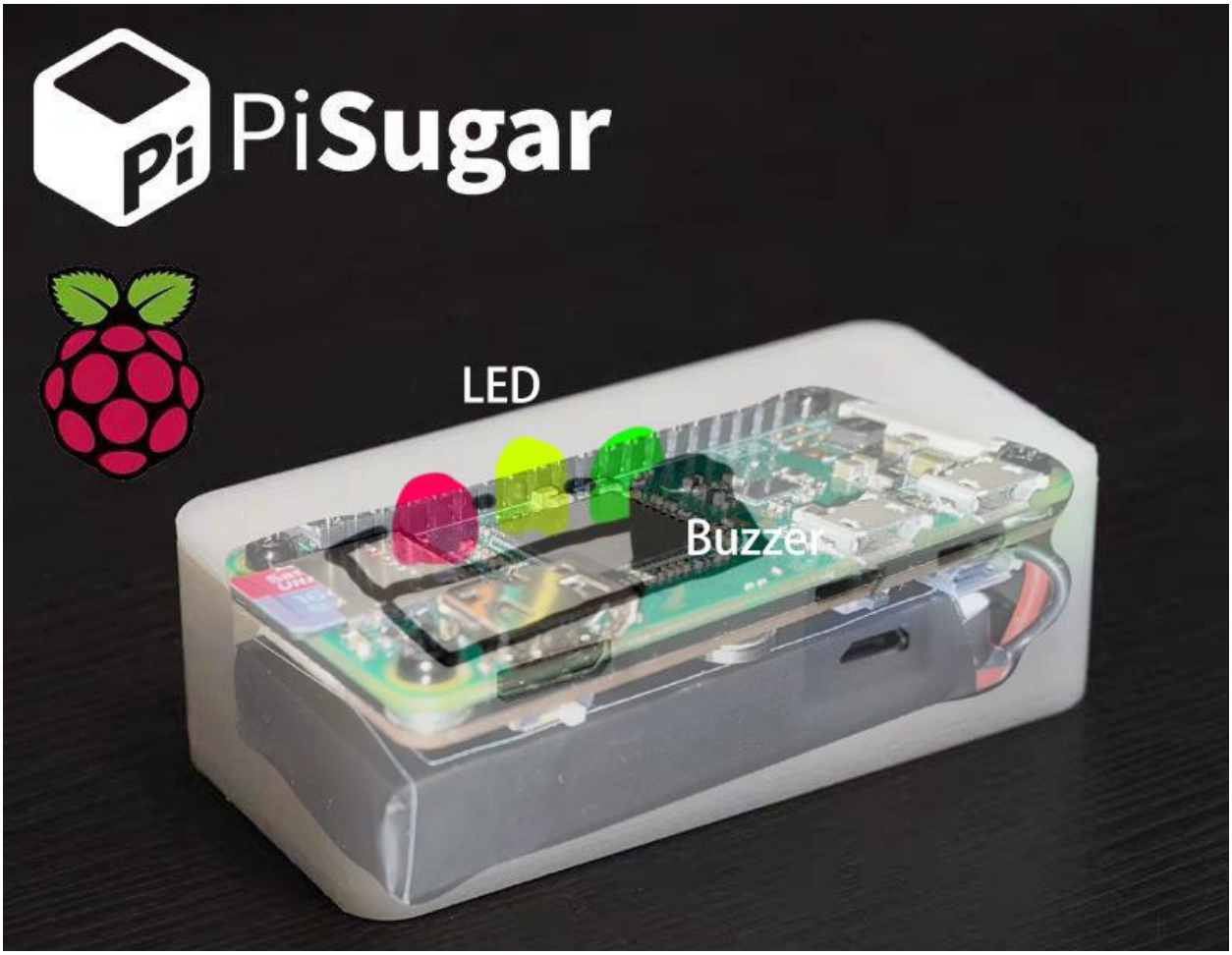


Figure2: Model of the portable unit

The picture above is also a model generated by Photoshop. We are still waiting for receiving the package; however, we have already gotten the battery model now.

In terms of packaging and power supply, we have adopted the scheme provided by PiSugar. They provide a 1200mAh battery that is directly connected to the motherboard through a row pin. The battery has its own processor, which can control the stability and safety of the charge

and discharge of the power supply. At the same time, it can also ensure the smooth operation of the raspberry pi motherboard when switching between USB power supply and battery power supply, and ensure that the motherboard will not be shut down or reboot. At the same time, the battery is magnetically connected to his own board, leaving a gap for the raspberry pi's ceramic antenna to make its Bluetooth connection and signal reception more stable. This plastic package is specially designed by PiSugar for the combination of the battery and the motherboard, which ensures that the size is the same, which makes our device more durable, you know, the device is to be carried around. In addition, we have contacted PiSugar, and asked them to replace the plastic cover with a 40-pin outlet so that our jumper wires can connect with the LED and buzzer out of the device.

At portable unit, we chose raspberry pi zerow as the development board. First of all, it is one of the smallest development boards in the raspberry pi family, and it is only the size of chewing gum. This satisfies the portability and lightweight of customer requirements. Secondly, among the same size raspberry pi development boards (such as raspberry pi nano), its processing ability is the strongest. Finally, the w in zerow represents that the development board has its embedded Bluetooth module and WIFI module, while zero does not carry these two modules.

In order to realize the warning function, we connect a tricolor LED and a buzzer through a pin arrangement. During the implementation of the code, we can adjust the switch and duration of the light and buzzer at any time. If the customer doesn't want the device to be too noisy, we can reduce the buzzer's buzzer time by modifying the code.

2.2 Software

2.2.1 Voice recognition

In the speech recognition program, we called three modules which are “os” for running system instructions, “smbus” for coping with data bus, “time” for controlling time.

Then, we defined four functions to realize the data transmission between motherboard and the voice recognition chip.

The first one is “AsrAddWords”. This function is to process the voice signal input from the microphone, and convert it into Unicode, then input the Unicode back to the corresponding address of the chip through the data bus.

The second one is “RGBSet”. This function is to control how the chip embedded LED works. It has three input variables which are “R” for red, “G” for green, “B” for blue. By mixing the lightness of these colors, we could get any color we want.

The third one is “I2CReadByte”. This function is used to establish and control the connection between motherboard and recognition chip. We use it to control all the data input and output from of chip.

At last, we also define a function for “Keywords”. We set our preferrable keywords and sent them from I2C to the chip. Fortunately, this chip has over ten registers to storage these keywords

which means we only need to set keywords as the first time we use this bell. Thus, we add an "if" to check if there are new keywords loaded. If there is no new keyword, we don't have to call this function. It will save a lot of boot time.

2.2.2 Bell unit as client

In this file, we called three modules, which are "bluedot.btcomm" for Bluetooth communicating, "os" for system instruction and "time".

We added a loop before sending trigger signal to make sure the bell unit is still connecting with the portable unit be using the system instruction "bluetoothctl".

We only define one function in this program which is "Trigger_signal". It determines what string will be sent to the server when keyword is recognized.

2.2.3 Portable unit as server

In this file, we called four modules, which are "bluedot.btcomm" for Bluetooth communicating, "os" for system instruction, "RPi.GPIO" for controlling pins and "time".

Also, we added three sentences for detection to make sure the portable unit is still connecting with the bell unit be using the system instruction "bluetoothctl".

In the main loop, the server will continuously be waiting for the signal from its client until it receives something from it. Then it will distinguish if the received signal is the string “trigger”. If the string is actually “trigger”, the code will call GPIO to control the work of LED and buzzer.

2.2.4 System flowchart diagrams

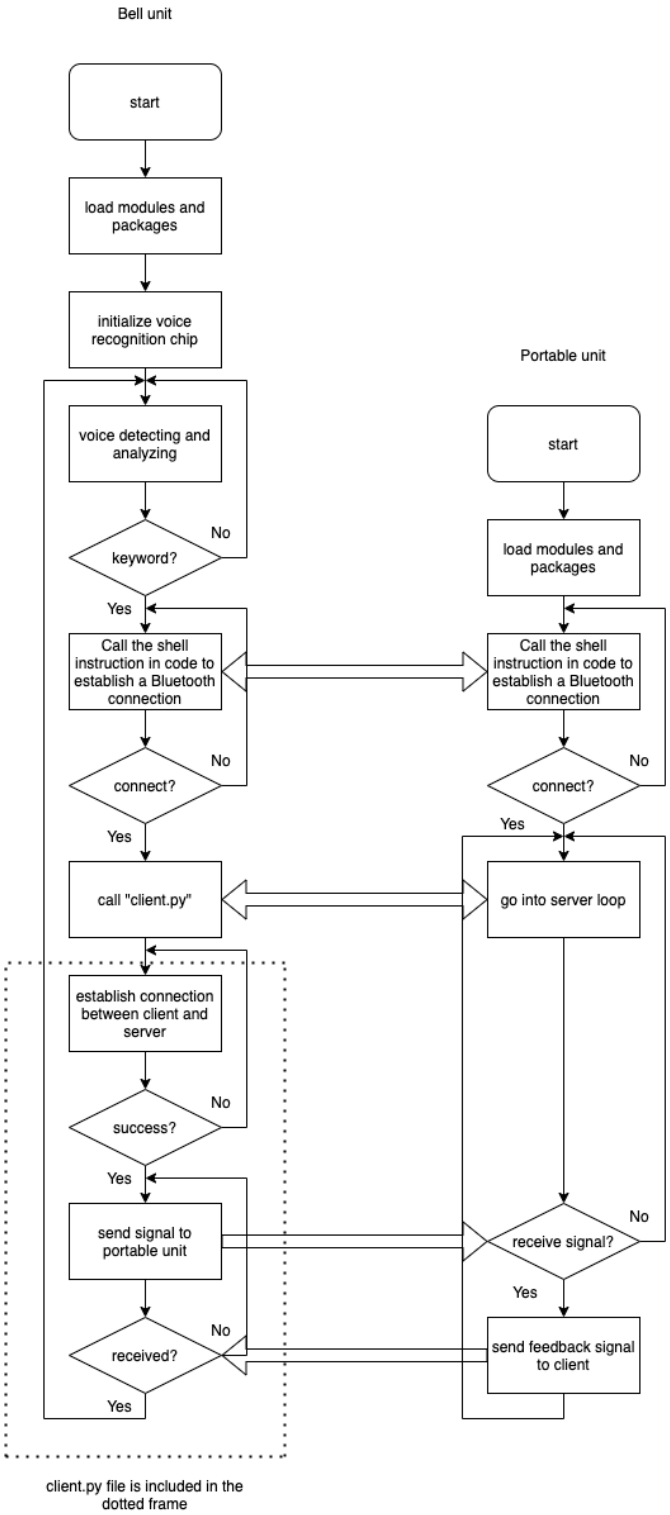


figure3: Flowchart of the whole process

3 Prototype and testing

3.1 Prototype

The complete operation demonstration of our prototype has been shown in the class, so we will not repeat it here.

3.2 Testing

	Conditions	**Testing results**
1	Can the signal strength be maintained within ten meters?	Yes. Even if there is a wall between and ten meters apart, the signal strength can be maintained well.
2	If one unit shuts down suddenly, will this unit automatically connect itself to another unit via Bluetooth when it is rebooted?	Yes. Raspberry pie itself has the function of Bluetooth automatic search and automatic connection. At the same time, we added codes to check the connection status and maintain the connection. The automatic connection after switching on and off can be guaranteed.

3	What happens when the bell unit sends a signal when the Bluetooth connection is disconnected?	The LED light of the bell unit will remain red, indicating that the signal still fails to reach the portable unit, and the bell unit will continue to search and connect with portable unit. As soon as the connection is restored, the signal will be sent out immediately.
4	How long does the battery capacity last for the portable unit?	After two tests, we could say that it can be maintained for nearly 5 hours after being fully charged.
5	How is the accuracy of voice recognition of this prototype?	Eight out of ten tests are successful and relatively standard pronunciation is required. We also need to make adjustments and optimizations in this respect.

Table1: Testing table

4 Revised project plan

	Summary of desig	2021/02/15	2021/02/17	
8	Detailed design(pro...	2021/02/18	2021/03/19	7FS
9	Hardware setting up	2021/02/18	2021/02/25	
10	Software coding	2021/02/26	2021/03/08	9FS
11	Testing	2021/03/09	2021/03/11	10FS
12	Client meeting 3rd	2021/03/12	2021/03/12	11FS
13	Improving	2021/03/15	2021/03/19	12FS

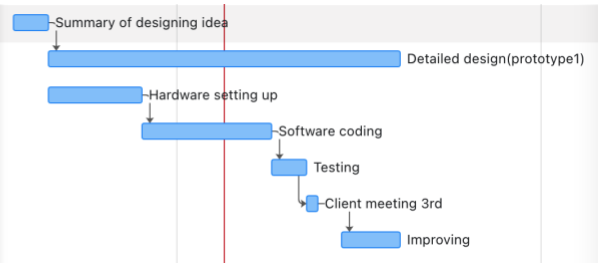


Figure4: Revise plan

According to the previous plan, we have completed the task ahead of schedule, so we have appropriately revised the follow-up plan to make the arrangement more appropriate and have more time.

5 Bill

	Item	Number	Cost	Weblink
1	raspberry pi 4b	1	46.67	https://m.tb.cn/h.4PxixGI?sm=4134d5
2	AC/DC Adaptor	1		
3	SD card(16g) for 4b	1		
4	heat sink	1		
5	voice recognition chip	1	23.24	https://m.tb.cn/h.4lrLQmp?sm=d89a7b
6	plastic package for 4b	1	3.12	https://m.tb.cn/h.4P1xnlX?sm=f86b9e
7	raspberry pi zerow	1	18.74	https://m.tb.cn/h.4lrKgmj?sm=a5fb5a
8	SD card(16g) for zerow	1		
9	tricolor LED	1	1.56	https://m.tb.cn/h.4O90jHk?sm=a769c4
10	buzzer	1	0.41	https://m.tb.cn/h.4lroQ63?sm=ddd0d9
11	PiSugar rechargeable battery	1	25.19	https://m.tb.cn/h.4PxRFSo?sm=ee7021
12	PiSugar 3D printing package	1		
13	jumper wire	40	0.37	https://m.tb.cn/h.4lrpgWO?sm=d08092
	TOTAL		119	

Table2: Bill of all items

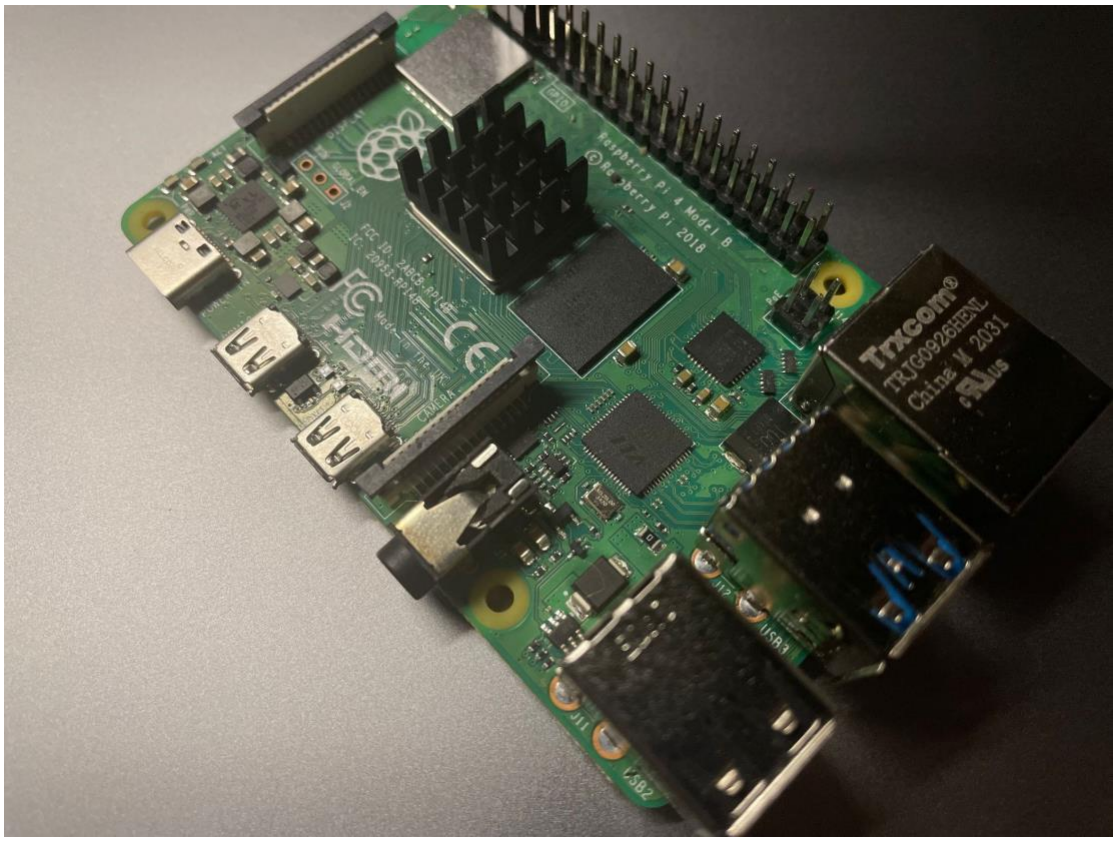
It is hereby stated that all the above components are purchased on Taobao, a Chinese e-shopping platform, and the prices of the products are converted from CNY to CAD.

6 Conclusion

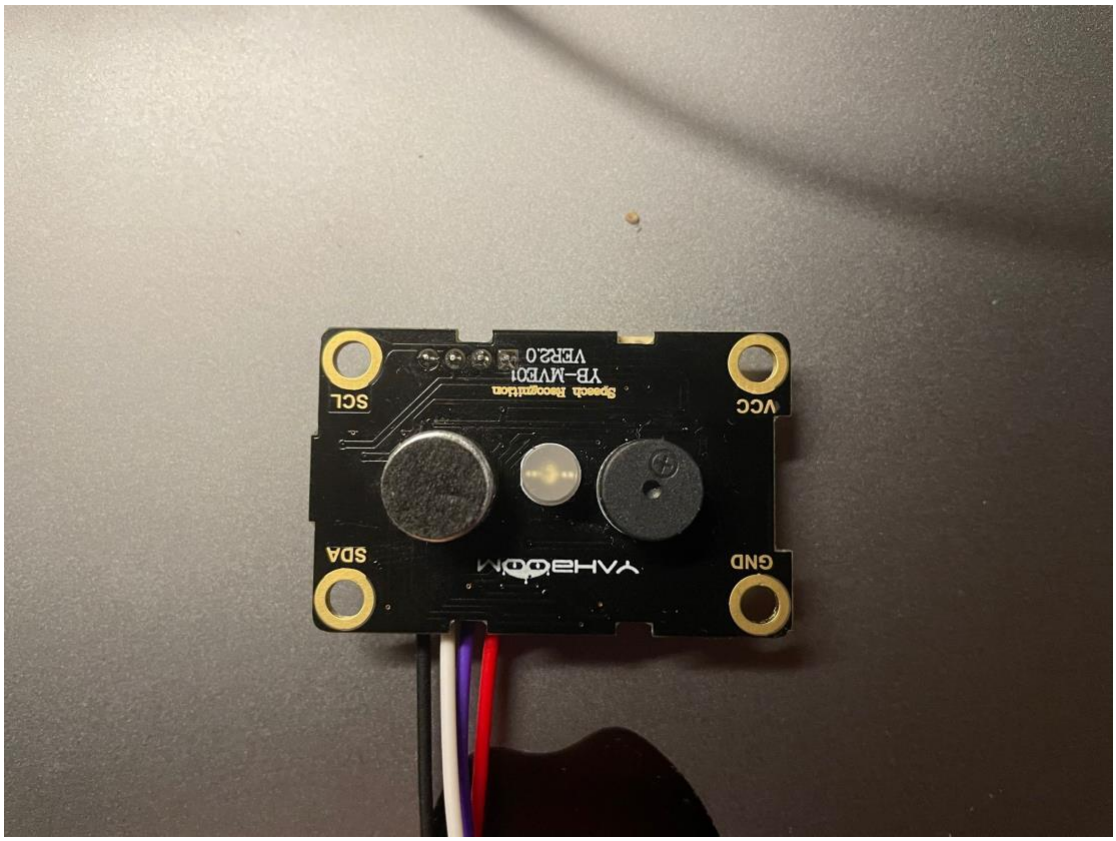
Through the disdain efforts of the team members, we finally realized the expectations and functions of the product successfully. The next thing we need to do is to optimize and adjust the product according to the customer's feedback to increase its accuracy and reliability. At the same time, the biggest challenge we face is how to reasonably place the jumper wires in their plastic shells and improve the reliability of the wire connection.

Appendix A

Appendix A.1 raspberry pi 4b

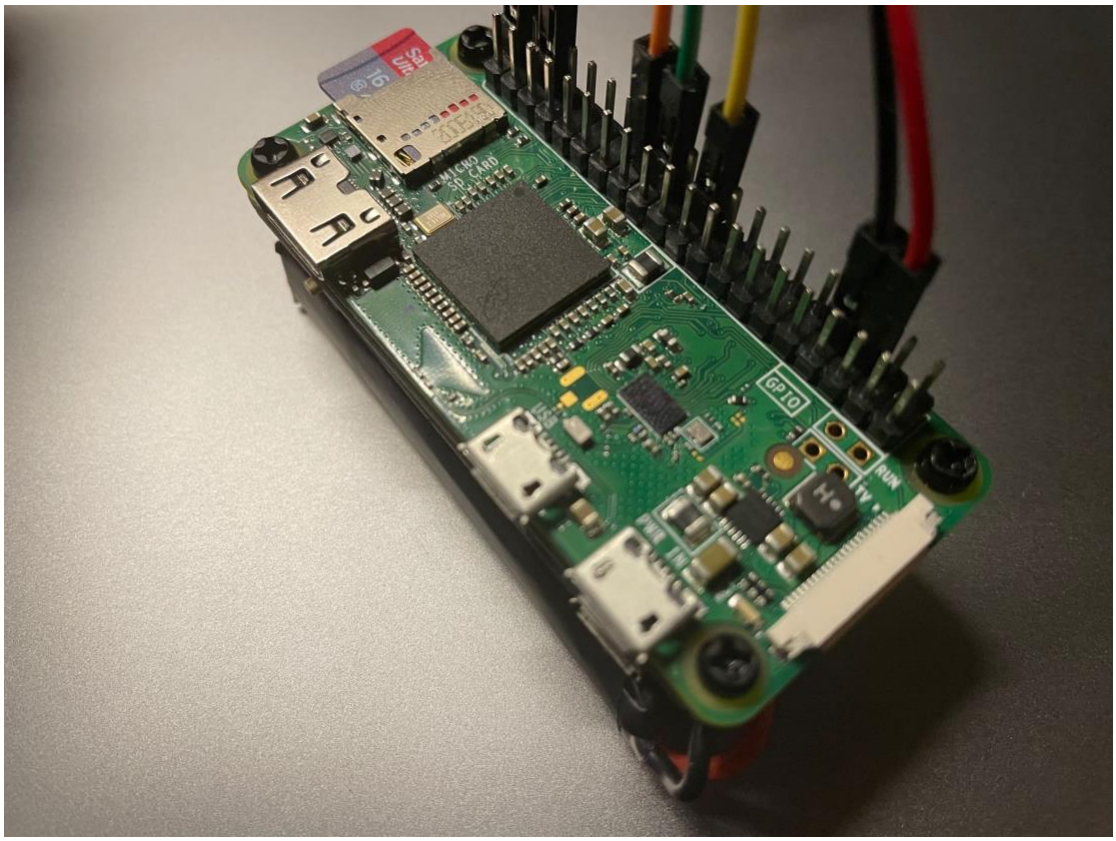


Appendix A.2 YB-MVE01 voice recognition chip

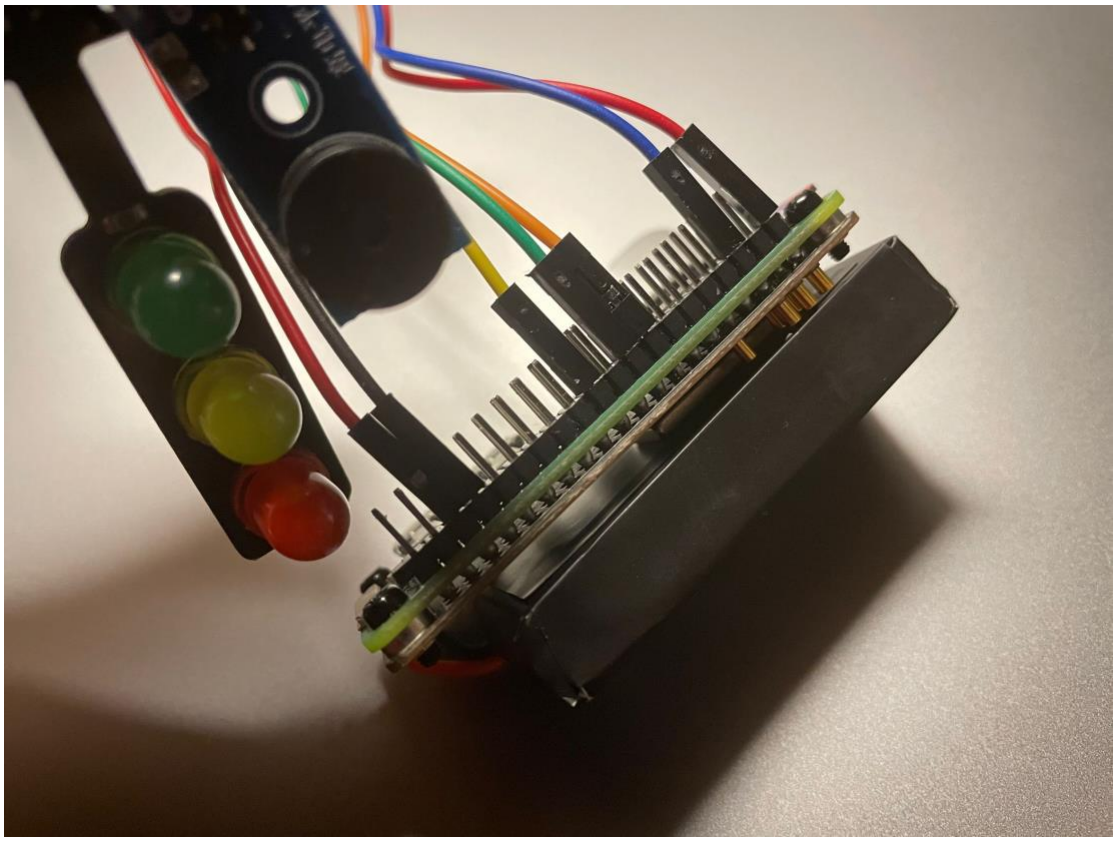


Appendix A.3 power of the bell

Appendix A.4 raspberry pi zerow



Appendix A.5 LED and buzzer



Appendix A.6 rechargeable battery module