Project One Reflection

for

Human-Computer Interaction (CPS 3601)

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Content

Introduction

In the Human-computer interaction course of the 2021 fall semester, we studied the UX design principles, software application evaluation under the guidance of Dr. Tiffany. Focus on Project one, our team implemented a software and hardware integrated interactive mapping system. The main functions of this system include travel footprint tracking, global geographic information display, and voice control. The system has three different input patterns, haptics click, touch screen control (computer, mo mobile-phone, tablet), and voice control. The output of this system also includes both hardware and software forms. In this reflection paper, I will give the whole project architecture in the flowchart firstly. In the second segment, I will explain the hardware implementation flow based on the Arduino development board. In the third segment, I will present the main interface and the series of functionalities based on Unity 3D and the voice control system based on Unreal Engine 4.

Keywords: Human-Computer Interaction, UX design, Interaction Design, Arduino, Serial Communication, Unity 3D development, Unreal Engine 4

Project Architecture

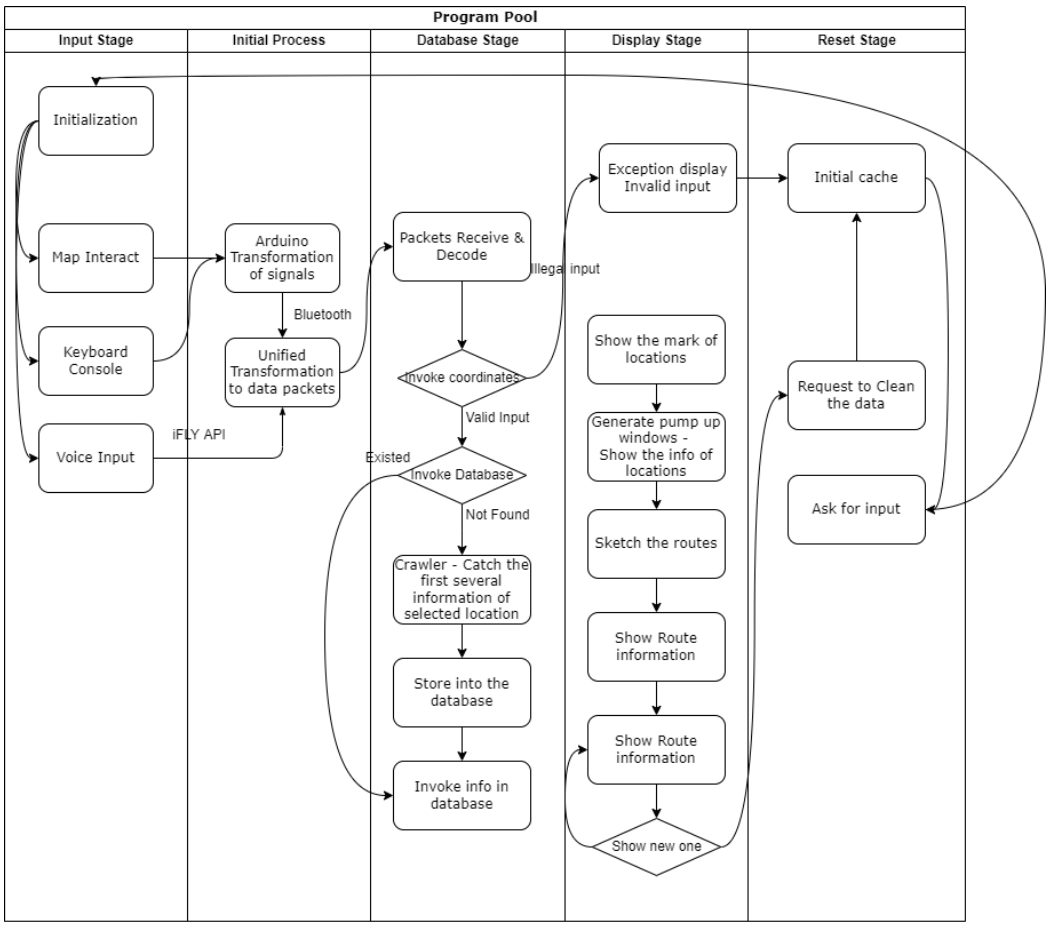

Fig.1. Project Overall Architecture

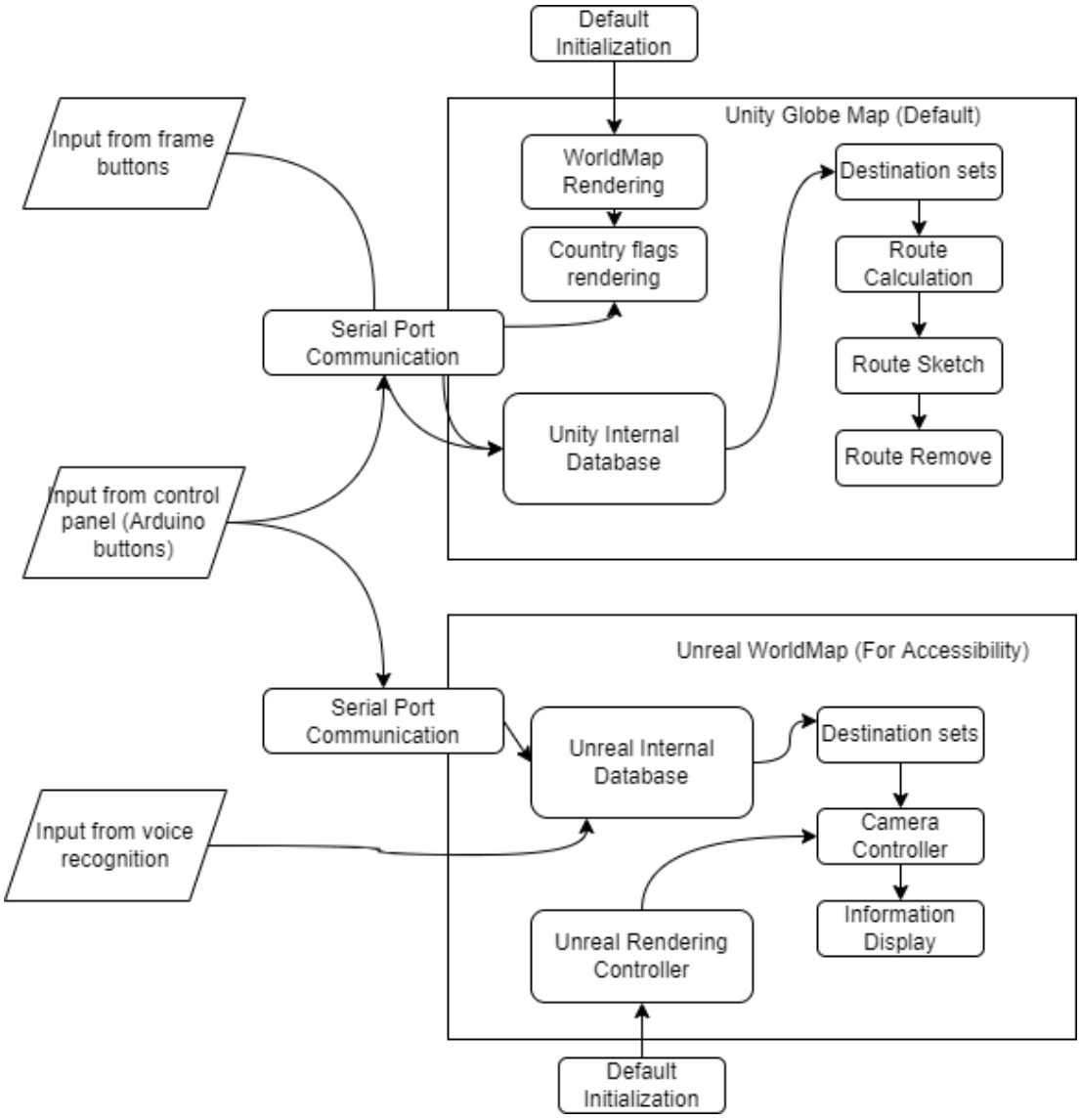

Fig.2. Project Process Flowchart

Hardware Implementation

All hardware implementation of this project are developed based on the Arduino UNO R3 board. In this segment, I will show the results from all required materials, circuit design, c language programming, and final results.。

I. Material List

Arduino UNO R3 developemtn Board	x 1	200 RMB
Breadboard	x 1	20 RMB
2.54mm Dupont Wires (Male to Male, Female to Female, Male to Female)	x N	10 RMB
Push Button	x N	15 RMB
LED diode light	x N	5 RMB
World Map (Hard cardboard, coated paper)	x 1	5 RMB

Fig.3. Hardware Material List

R3 board is the main device, and other devices are accessories to complete tasks with the board.

II. Circuit Design

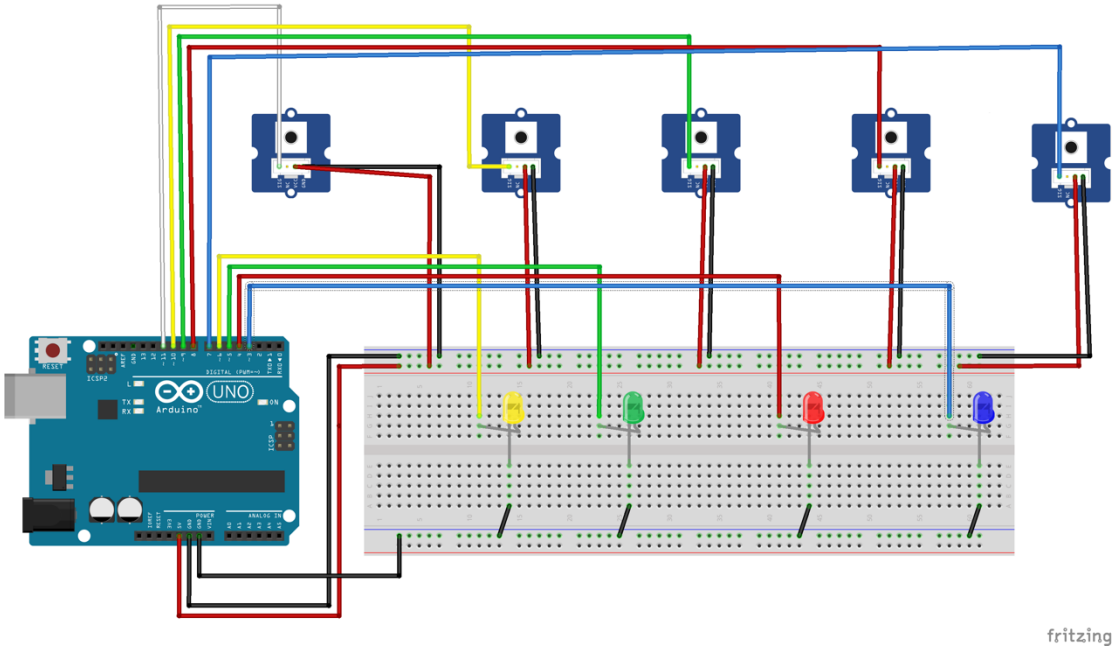

Fig.4. Circuit Connection Diagram

Figure 4 is draw by Fritzing, there are three main functions. One is to click the button to light up the corresponding LED. The second is to click the button to transmit the specified signal to the software interface through serial communication (Unity serial

port monitoring event). Third, the reset button (reset), which is always on. All LED lights are off. Through circuit design, the three tasks are combined without conflict. The details are shown in Figure 4.

Ensure that the N wires are connected to the board. On the side of the breadboard, connect the two long vertical rows of wires with red and black wires to provide 5-volt power and ground. The other color wire represents the pin port links for the signal inputs and outputs. Attach the buttons and led lights in sequence. As a specific example, when you press the button, the corresponding LED shows the footprint and transmits signals to the PC using the Arduino board and serial port (COM5).

III. C Programming

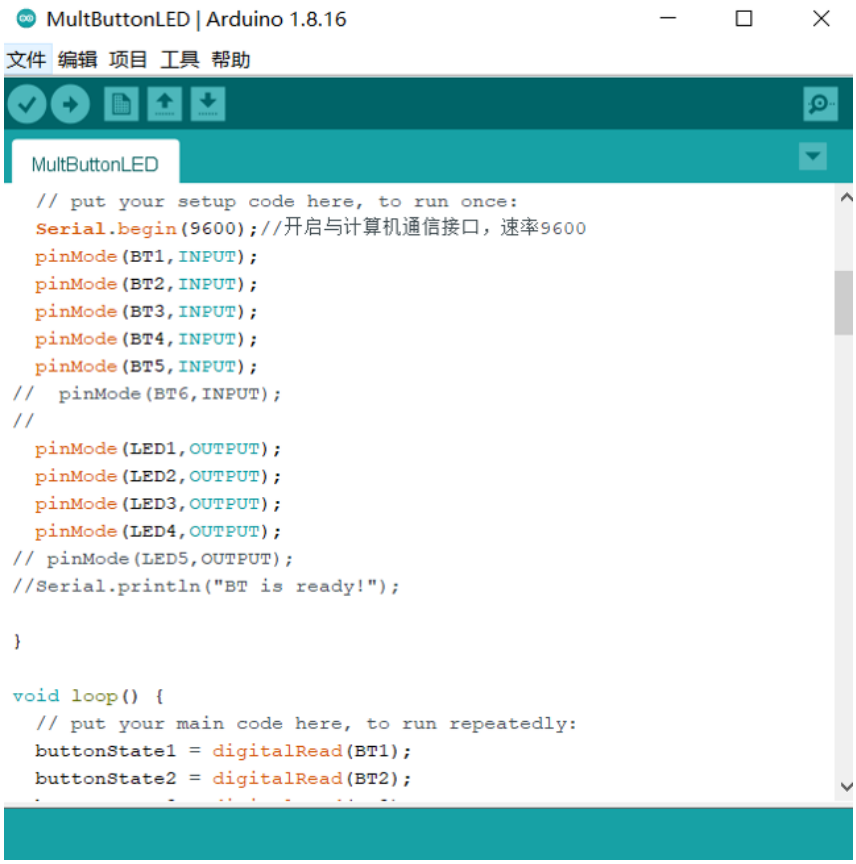

Fig.5. Snapshot of Serial Communication Code

The above picture 5 shows that it is the core part of the code. The serial communication is programmed by C language. In our first SetUP(), we configure the environment. Set the input or output to use the corresponding Pin, and secondly, call the serial communication package. When the Arduino board is connected to the PC, we

get the port name (normally COM3, 4, 5) through the device manager. Third, we set the serial monitor event in the software part (Unity and Unreal Engine4). Reading the signal of the hardware part and the software interface makes corresponding interactions, realizing the real human-computer interaction.

IV. UX Design

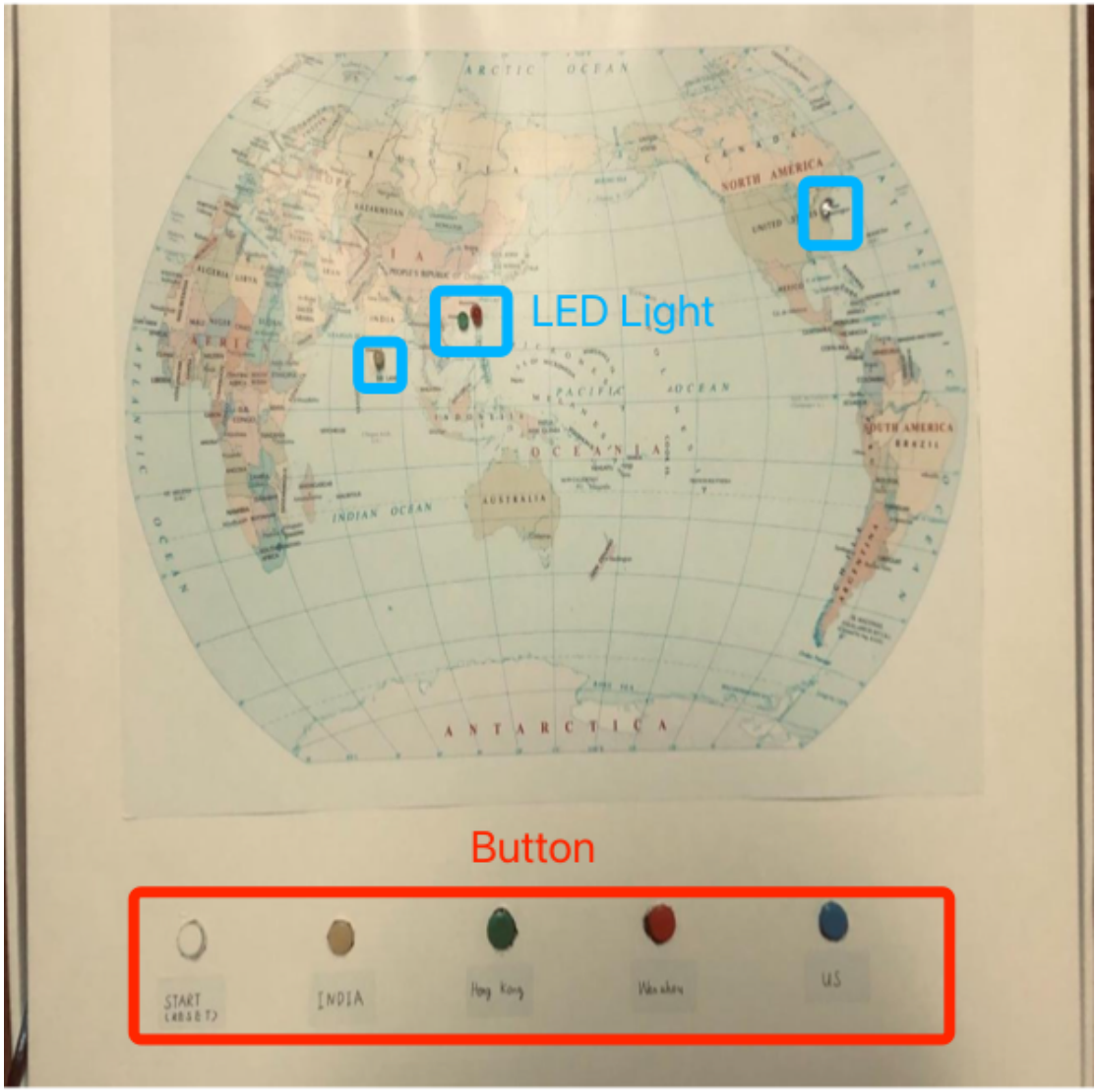

Fig.6. Hardware Prototype Part of Map System

In the physical design part, I adhere to the "less is more" design principle [1][2][3][4]. In the prototype, there are only 4 LED lights and 5 buttons for interaction. They are only used to send signals and display footprint functions, but I hide the Arduino board In the box, it is not visible (black box). This design also allows me to easily expand the function later, or reprogram and design the Arduino board or even the circuit without affecting the basic UI.

Software Implementation

I. Unity 3D

We use Unity 3D to develop the main interactive interface of the software part. The realization form is an interactive 3D earth digital model, which can be directly touched on the screen for location selection, the field of view conversion, zooming, and other actions. The specific realization function is to show the basic geographic information of the earth. In terms of technical implementation, first, download free earth geographic coordinates and cloud data from the *GoogloMAP* [5]API to build a 3D earth digital model. In the next step, there will be more aviation flight route planning algorithms, which will be transformed according to the geographic coordinates (latitude and longitude) in the digital model and displayed on the main interface.

Fig.7. Interface of Earth Digital Model by Unity 3D

We have implemented many functions on this digital earth model through the Unity engine, as shown in Figure 7. first, the real-time conversion of latitude and longitude. Simulate the accurate GPS coordinate positioning method and perform precise positioning through the crosshair interlaced by longitude and latitude. Second, the globe rotates freely or in random-view mode. We simulate the real starry sky background and let the globe move toward the earth's rotation, which perfectly simulates the real

situation. Since we call the touch screen interface, users can drag the globe to any area with their fingers and then zoom. Third, for detailed country and province information, we have access to the national information database publicly available on the Internet so that users can inquire about different information in different countries in the world. The fourth point, flight simulation, and route location display. According to the route simulation algorithm, we can draw the flight trajectory between the city and the city and display it dynamically. The flight trajectory is combined with the Arduino hardware part. Click different buttons, and the digital model of the earth will highlight the corresponding area on the globe to realize data linkage.

II. Unreal Engine 4

We also made a digital model of the earth on UE4 through the same data set, but unlike the unity engine, we only need to call the Audio plugin here to achieve voice control. The main interface is shown in Figure 8.

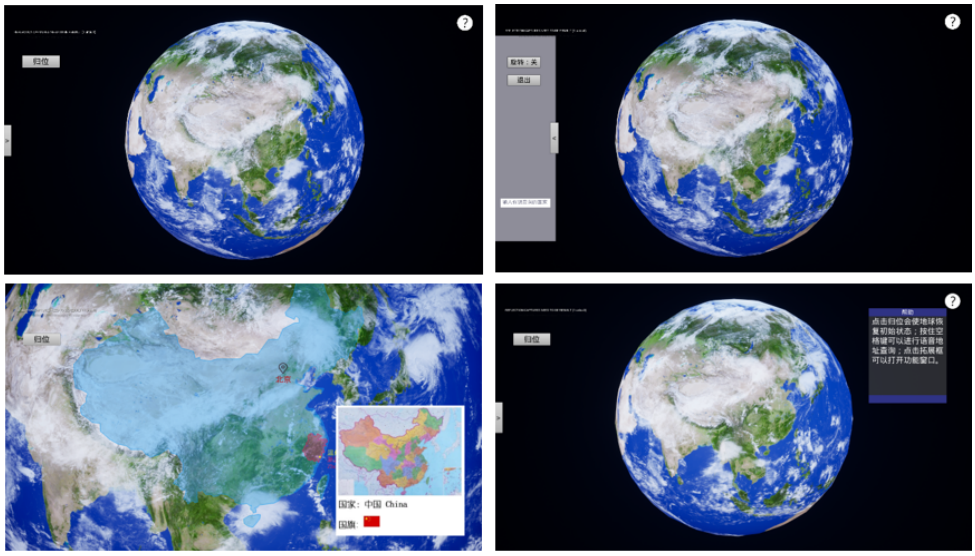

Fig.8. Interface of Earth Digital Model by UE4

In the technical implementation part, we first create a voice plugin file under the root directory of the file and then install the downloaded voice recognition plugin as a plugin. Because this is an offline plugin, you still need to configure the voice plugin through APPID. The code config process is shown in Figure 9.

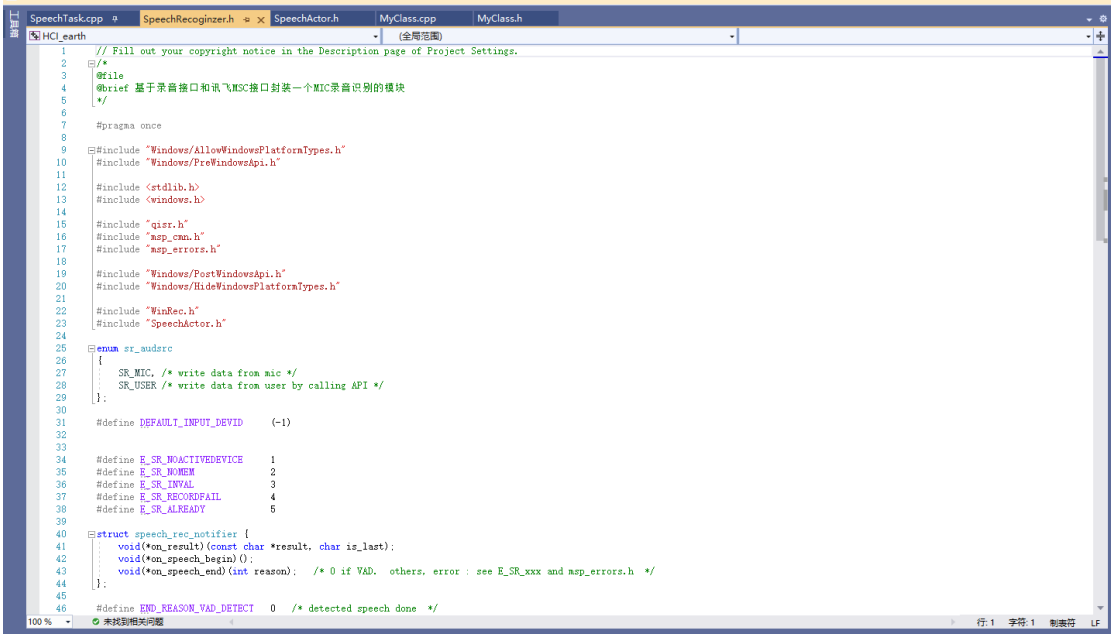

Fig.9. UE 4 Voice Plugin Configuration File

Conclusion and Future Work

In the end, I summarized the human-computer interaction course of this semester. In the development of project1, I found out the massive potential of the combination of software and hardware. It seems that interactive design seems simple, but there are many design concepts and methods, just like us. The "less is more" viewpoint that this project insists on requires a lot of calculations to determine the minimum number of components required to be displayed in the actual hardware.

For future work, we can see that regardless of the hardware and software, our design on the part of UX design is still too rough, which has a time relationship. However, in project2 if some Graphic Design students join, there may be a surprising result.

Reference

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