

Directional controls(Left and right controls):

Following the traditional method of operation, the forward and backward flip controls the aircraft's acceleration and left and right turns. At first, the [90-degree flip function] was chosen, but I found it challenging to steer 90 degrees after the forward tilt, so I replaced it with a reverse angle.

For more precise steering control, the steering command "L:1"/"R:1" is sent directly when the flip angle is greater than 60 degrees, and "L:1"/"R:1" is sent when the flip angle is greater than 15 degrees and less than 60 degrees. " / "R: 1" for 150 milliseconds (basic.pause(150)), then continue with the command "L: 0" / "R: 0 " to stop the steering.

During operation, it was found that slight deviations in the Micro bit's flat position could lead to incorrect steering, so no steering command is sent or "L:0"/"R:0" is sent when the turning angle is less than 15 degrees.

Directional controls(Forward and backward acceleration control):

Later, I found that the forward and backward tilt would affect both turning left and right, affecting the working experience. I didn't want the user to feel "out of control" regarding the direction of the operation. So I adjusted it to front and rear control by pushing the button A . Orientation is the part of the game that requires the most attention from the user and therefore requires a high level of precision(<https://dl.acm.org/doi/10.1145/2808202>). Initially, front-to-back tilt was used to control the front-to-back acceleration; However, it was found that the user's attention was focused on the screen, which made it challenging to avoid affecting the left-right tilt when performing front-to-back tilt, thus affecting the accuracy of the directional control. This led to the need for buttons on the directional controls to reduce the influence between the front and rear control and left and right control.

At the same time, the floating joystick reduces the need to sweep the device, so the use of floating buttons is avoided as far as possible in the design of common keys.

Weapon Controls :

Weapon firing is the most important feature of this game. The possible ways to operate it are single tap design and long press continuous fire. At first, I chose the single tap design because it would enhance the interaction between the game and the user (click on the following Button A to fire the weapon once), but after experimentation, I found that it would distract the user and affect the game experience (as the ship accelerates forward and backward with a single tap, three single tap controls would make it more difficult to operate). Of course, this feature may be used to make the game more difficult in subsequent designs. To maintain the interaction between the joystick and the game and to increase the sense of combat, there will be sound and light effect feedback when the attack button is held down.

Pause:

Pause is achieved by placing the entire device down. The LED will show when paused. When disassembled into two grips, the pause is achieved by placing the V2 face down.

Handle design:

The detachable handle supports single or two-player games. When the grips are joined together, the left microbit controls left and right steering and weapon switching (logo on the

single player panel), while the right microbit controls forward and backward acceleration (hold button B to accelerate forward; hold Button A to accelerate backward). The microbit is mounted straight up in order to better match human button habits.

Feedback:

During our experiments, we found that we needed to avoid complex wireless communication as much as possible during the design process and to reduce the reliance on game data reception for the following reasons.

- Microbit cannot receive data from serial ports and wireless at the same time.
- Data from the game is sent faster than it can be read and processed by the serial port.
- Wireless communication between two Microbits can cause latency in manipulation.

The main focus of the user's attention is on the computer screen, so there are two main roles for the Microbit to give feedback: one is to provide information that the user cannot get visually from the screen, e.g., current weapon type, turn range, etc. The second is to increase the interaction between the hands and the game, e.g., sound cues when attacking, death cues at the end of the game, etc.

The following are the main descriptions of the feedback design.

- Left and right steering: when the angle is greater than 15 and less than 60 degrees, it is judged as small steering, led lights up the inner light (left turn lights up the left light, right turn lights up the right light); when the angle is greater than 60 degrees, it is judged as big steering, led lights up the inner and outer two lights (left turn lights up the left light, right turn lights up the right light).
- Attack: the buttons will have different beeps during the process depending on the weapon type, and the V2's LED display will show different icons depending on the weapon type.
- Weapon: Microbit V1 displays the A weapon icon (capital letter A) when switching to A weapon; Microbit V1 continuously displays the B weapon icon (capital letter B) when switching to A weapon.
- Game start: Microbit V1 emits the corresponding sound and light effects.
- Game over: both Microbits display the "Game over" string on the led, and the Microbit V2 emits the corresponding sound effect.
- Pause: both Microbit display the pause icon.

Work Cited

<https://dl.acm.org/doi/epdf/10.1145/2808202>.

APPENDIX :

Input	Microbit control keys
Thrust	Buttons of V1(Botton B accelerates forward and Botton A accelerates backwards.)
Turn Left	Microbit V2 flip angle to the right
Turn Right	Microbit V2 flip angle to the right
Heading	Unused: not really relevant to the operation of the game
Teleport	Unused: not really relevant to the operation of the game and the random position will cause the player to die for no reason
Primary Weapon	Botton A of V2 (hold down to fire continuously, release button to stop firing); logo of V2 (switch weapons)
Secondary Weapon	Botton A of V2 (hold down to fire continuously, release button to stop firing); logo of V2 (switch weapons)
Shield	Botton B of V2(Gets a shield of 200 milliseconds for a single click)
Vector x	Unused: not really relevant to the operation of the game
Vector y	
Position x	
Position y	
Weapon Recharge Factor	
Energy Recharge Factor	
Pause Game Set Value	Pause when microbit V2 is facing down, continue when facing up