

PORTFOLIO

Qi Rui

Thanks for reviewing my portfolio!

[Game | Project](#) [ECHO](#) [Father and Son](#) [Seal Cutting Display System](#)

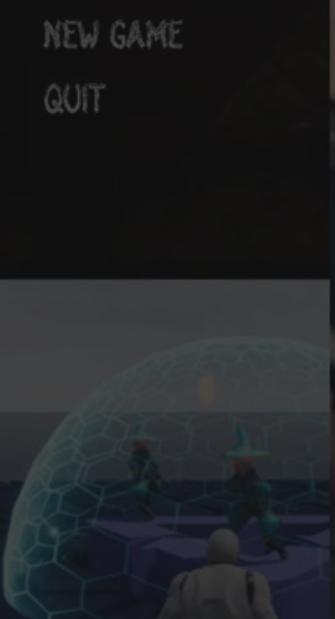
[Demo Collections](#) [Material Art](#) [UE demo](#)

[Interpolation Demonstration Tool](#)

[Essay](#) [Kishotenketsu Theory in Game Design](#) [Game Analysis--Cuphead](#)

Game Project

Qi Rui





Platform | Mobile

Date | 2020

Tools | UE4 – Maya – Substance Painter/Designer – Photoshop – Adobe Illustrator

Level Designer / 2D Artist

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- Click on <https://aliciarui.github.io/> to access all my previous works online.
- Web links for this project: <https://aliciarui.github.io/echo.html>
- Web links for gameplay video:
https://www.bilibili.com/video/BV1wv411t7zC/?spm_id_from=333.999.0.0&vd_source=ab84f2592ba10c98c2c85ee23b42b361

Project Summary

- A 3D puzzle adventure game uses time travel as the core mechanism to tell the story of a boy rescued from domestic violence. The game was developed by 9 P.M. studio.

Roles and Responsibilities

- My main role is the level designer and 2D Artist.
- Designed the basic structure of the game scene and integrated it with the game narrative.
- Built white models of scenes based on modeling software and engine and iterated to improve details.
- Set up meetings with other game designers to repeatedly discuss core gameplay, character, level, and scene design.
- Designed the icon logo for the game and made part of the illustrations.
- Worked closely with the programmer and 3D artists to ensure the process moved forward smoothly.
- Also responsible for part of the documentation.

What I learned

- Learned a lot about working in a team to design games and express ideas and creativity.
- Learned some good game design principles and methods.
- Learned about graphic design techniques.



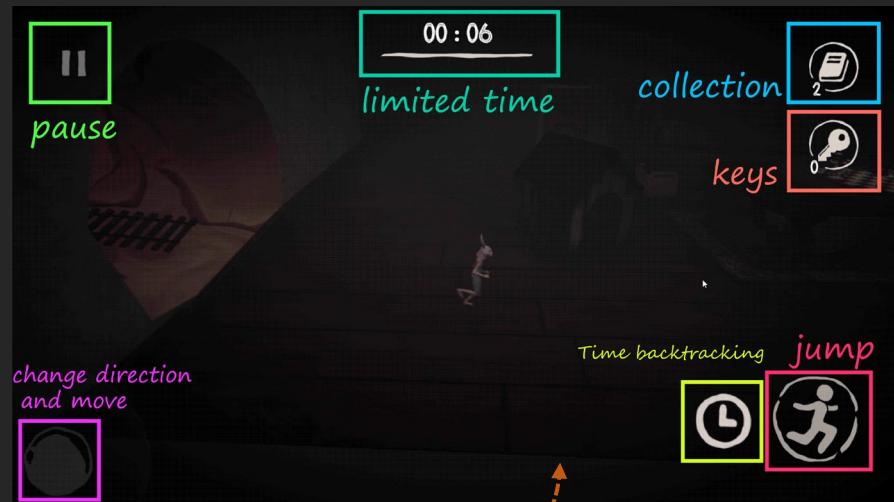
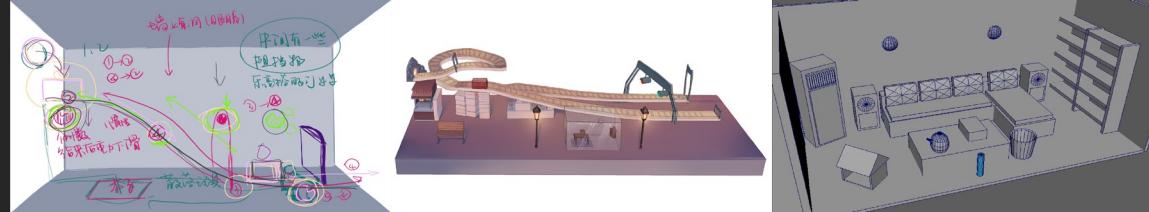
- This is an original indie game classified as a puzzle game called ECHO
- The protagonist John, is a boy who suffers from domestic violence but is eager for love and care. His miserable childhood forces him to wear bunny headgear to isolate and protect himself. On his way on the adventure, Jannie's voice becomes his guide. Although Jennie cannot stay by his side and has to call from a distance, her love is the salvation of John's life.

Core Mechanic Design

- Core Mechanic | Time Backtracking
- The protagonist has the ability to time backtracking, allowing the object to return to its original state within a specified time. After the duration of time backtracking, the object will return to its original form(state). Since the duration of time backtracking is limited and will increase as the protagonist gets through the challenge, the skill of time backtracking has the function of timing and is a type of growth attribute.
- There are three different situations when you can use time backtracking in the game.
 - 1) To change the position of the object
 - 2) To change the form(state) of the object
 - 3) To count time

Phase1

Level Design



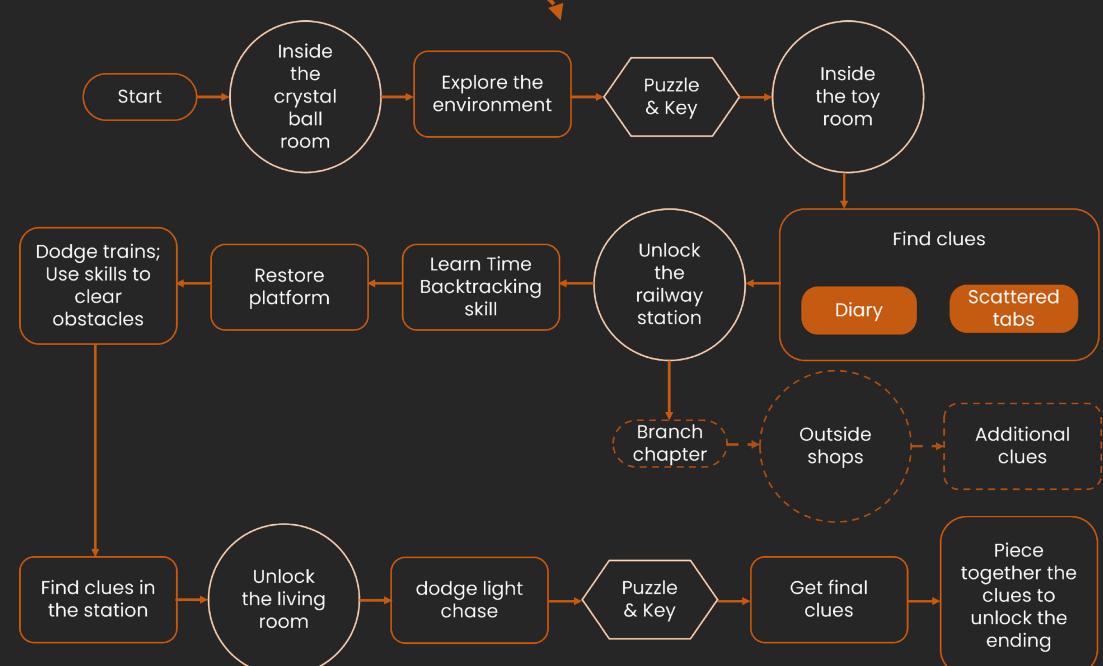
Interface Design

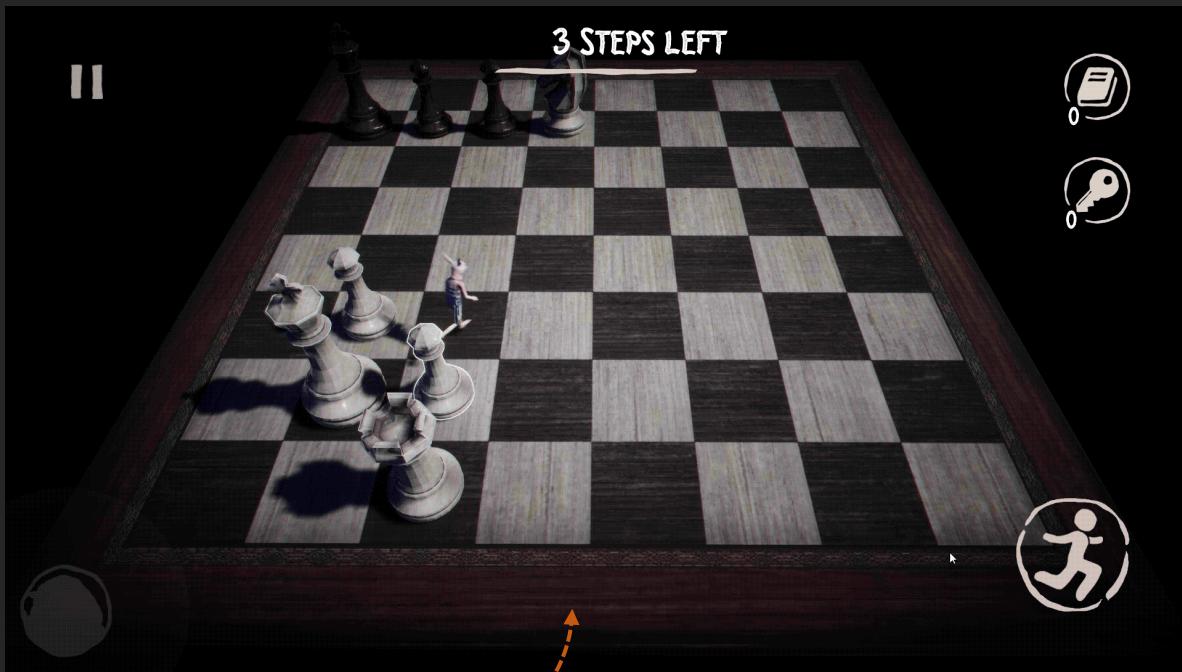
Tap the disc-shaped joystick on the left side of the screen to control movement

Tap the jump button on the right side of the screen to jump

Tap the specific interactive button on the right to push and pull and perform time backtracking

Game Flow Design





Puzzle Design

In addition to the puzzle solving in the main plot, there are also small puzzle-solving modules in the game to assist in the advancement of the plot.

Tips are set in the diary



- For example: International Chess
- Pull and Push the chess to the correct position
- We hope players can successfully solve the chess endgames and pass the game. Therefore, we first searched for famous endgames on the Internet and screened them according to the difficulty of the players' operations. Finally, we made an endgame into the game and left a tip inside the diary. Players can move the pieces on the board freely, but you should notice that there will be hints about the number of remaining steps in the game.

Character Design



A boy suffers from domestic violence but is eager for love and care. His miserable childhood forces him to wear bunny headgear to isolate and protect himself.

The girl's love is the salvation of the boy's life.

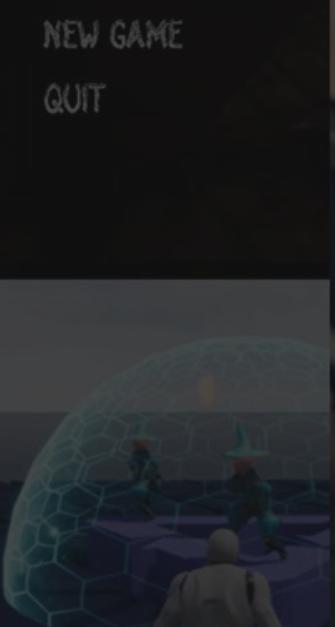
LOGO Design



A combination of boy, rabbit and paper plane, which are the key factors of the game.

Game Project

Qi Rui





Platform | VR Oculus2

Date | 2021

Tools | Unity – Maya – Substance – Adobe Illustrator

Developer | Material Artist

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- Click on <https://aliciarui.github.io/> to access all my previous works online.
- Web links for this project: <https://aliciarui.github.io/fatherandson.html>
- Web links for gameplay video: <https://v.qq.com/x/page/i3264xpskmi.html>

Project Summary

- A VR puzzle adventure game in which players take on the role of a disabled boy in a wheelchair actively pursuing his dreams. The game was developed by the Raspberry team and was shortlisted for several awards.

Roles and Responsibilities

- My main role is the Game Developer and Material Artist.
- Developed flying gameplay based on unity, designed and defined gameplay trigger mechanisms and conditions.
- Created stylized mapping for models using substance series software.
- Adjusted and optimized the model to ensure its suitability and integrity.
- Worked closely with game designers to discuss gameplay design and design details.
- Also responsible for part of the documentation work.

What I learned

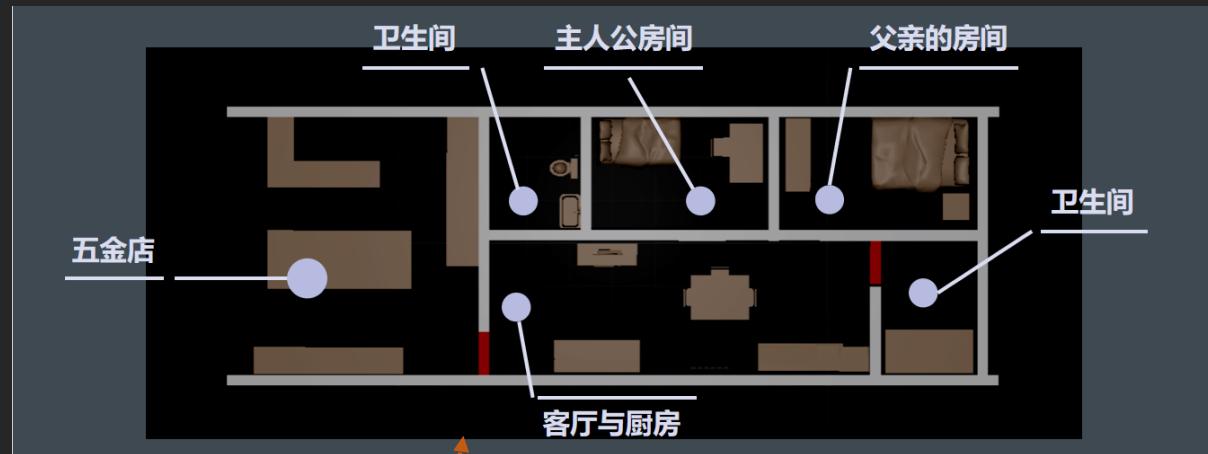
- Learned how to use Substance series software.
- Learned to implement gameplay features in unity and debug based on VR.
- Had a better understanding of VR game design, development, and experience.



- **This is a VR indie game classified as a puzzle game called Father and Son**
- You will play the role of a teenager Xia Yu in a wheelchair in virtual reality.
- After an accident, you lost your legs. After nearly half a year of recovery, you returned to your hometown, a front room next to the hardware grocery store, but at that moment your father left without saying goodbye. You are free to explore at home, interact with scenes and objects that can be seen everywhere, understand the story between Xia Yu and his father, and explore the real reason why his father left home.

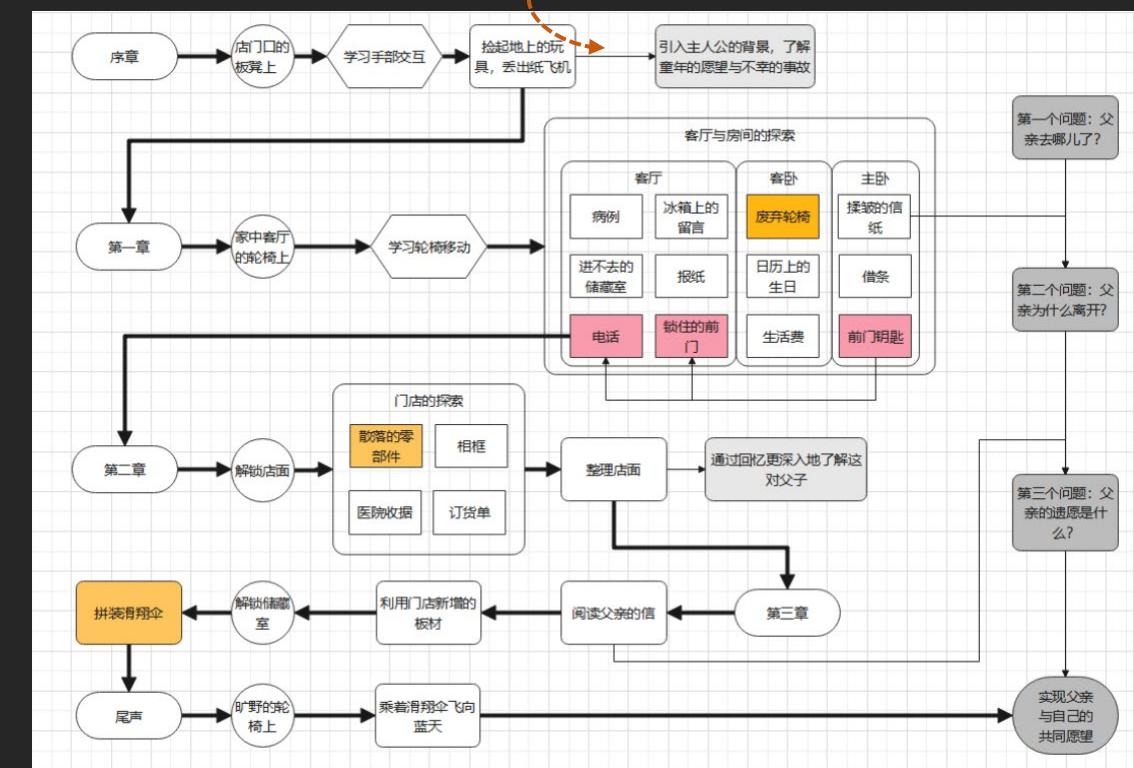
Purpose of Game Design

- **PROJECT**
- We combine virtual reality with the gameplay of a “walking simulator.” Using the current Virtual Reality Equipment (head-mounted display and the handles), we decided to create more interactive gameplay and a more immersive narrative experience in our game.
- **VALUES**
 - Help players experience the lives of disabled people in the game. The game not only brings players fascinating interactive gameplay, realistic virtual worlds, and moving storylines but also allows them to think about the relationship between the disabled and individuals, families, and the whole society after the game.
- **EXPERIENCE**
 - 1 Experience the feeling that the disabled can only use both hands to examine the wheelchair and control the movement
 - 2 Experience the feeling of moving freely in a more spacious area naturally in virtual reality environment
 - 3 Players can grasp and pull the objects and do other hand interactions, which may satisfy their curiosity
 - 4 Designed assembling gameplay according to basic “hand-object interaction” to make simple interaction more interesting
 - 5 Exploration and adventure help players discover details in the story



Level Design

Game Flow Design





Wheelchair Locomotion

In virtual reality games, movement is always limited to a small physical play space, which is a considerable limitation for designers to construct a highly immersive virtual world. Therefore, they have developed two types of solutions: non-real mobile input and restrictions on virtual space, which are not natural or free, respectively. In this game, we introduced the core element of the wheelchair and proposed our innovative solution: input the movement of the hand through the handle and simulate the direction of the wheelchair in the virtual reality world. This can be used in a more extensive range of virtual worlds and can complete the input of instructions truly and naturally.

Interaction and Assembly

The player can also interact with many objects in the scene. There are a large number of daily necessities for the player to pick up and view: photo frames, letters, toys, books, etc. At the same time, we designed unique interactive gameplay for essential items in the game, such as taking apart the photo frame to find the other half of the photo. The player can interact with objects freely within reach in the game, which will primarily increase the immersion and fun of the player while playing. The player can also pick up things and move them with him/her.



For certain specific items, such as utensils with missing parts and semi-finished products corresponding to drawings, players can pick up the missing items with their hands and place them in the appropriate positions to complete the assembly, thereby promoting the further development of the plot. The player may be filled with fun and a sense of accomplishment in the assembling process.



Puzzle & Story Design

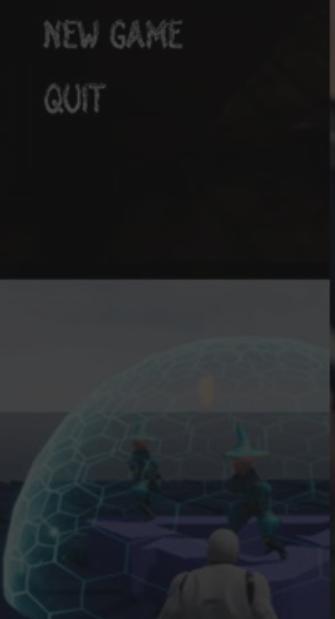
We hope that the player can learn the plot of the story from the interactive elements in the scene, the text information on the objects and the narration of the protagonist.

Caption Design

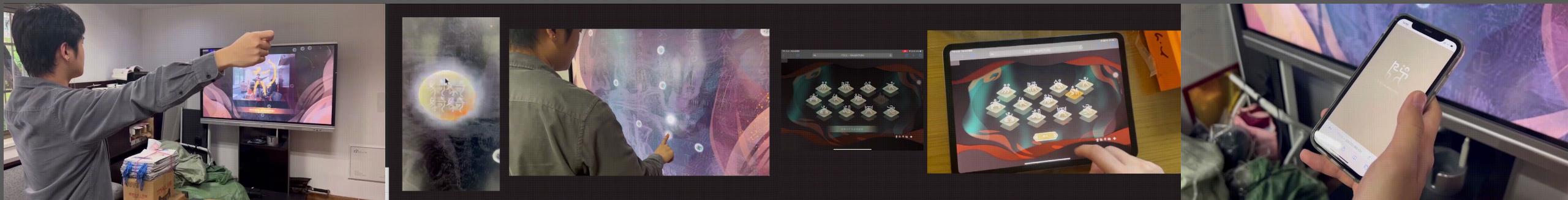


Game Project

Qi Rui



Seal Cutting Display System



DATE | 2022

TEAM | Alicia, LXY, CSJ

Lead Developer

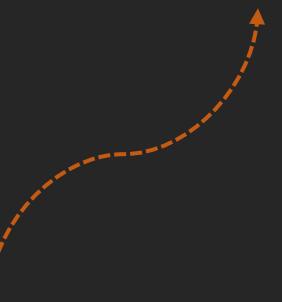
JavaScript / Python

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- Click on <https://aliciarui.github.io/> to access all my previous works online.
- Web links for this project: <https://aliciarui.github.io/sealcutting.html>
- Web links for code samples:

<https://github.com/Aliciarui/CodeSample/blob/main/codesample.js>



Project Summary

- A large-screen interactive display system with the theme of seal cutting, combined with pads and other mobile devices, to popularize the culture of seal cutting and introduce interactive games to participants. The system was involved in the innovative exhibition and was deployed online during the exhibition.

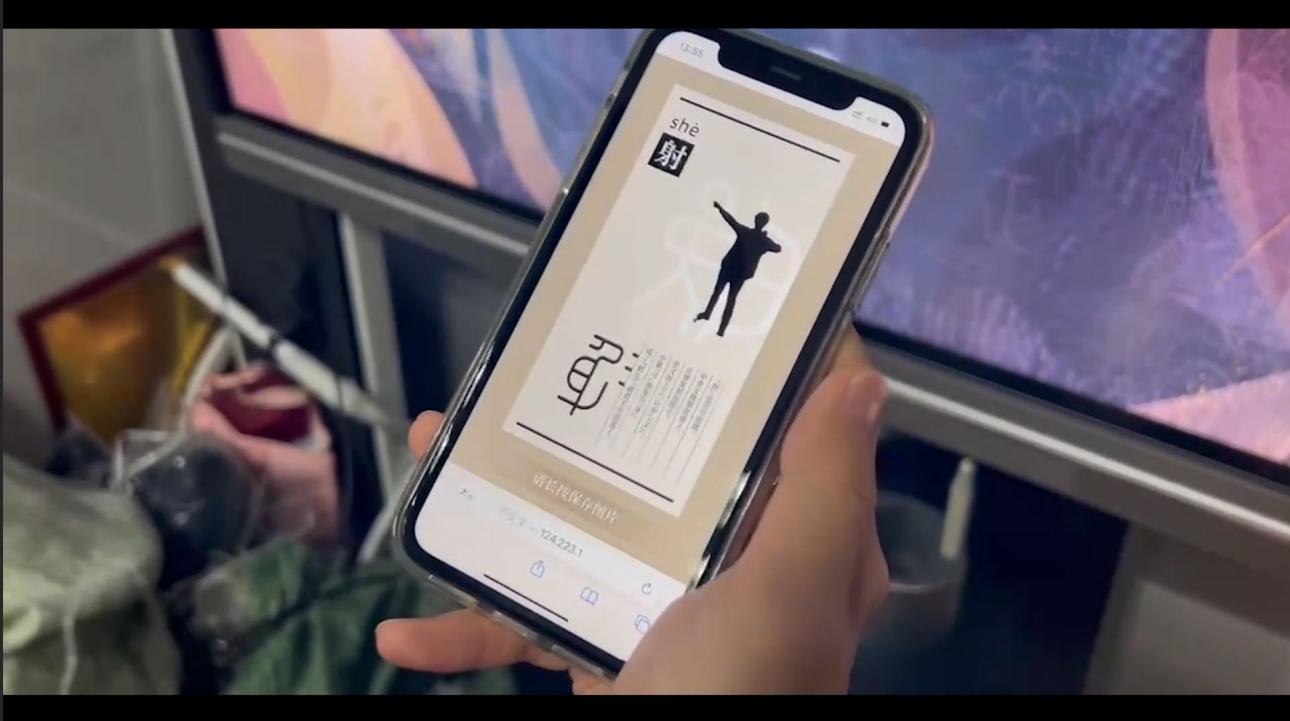
Roles and Responsibilities

- My role is the Lead Programmer.
- Determined the implementation of the system at the early stage of development, and the way of communication between multiple devices.
- Introduced Matterjs to build the front-end physical system, realized the bubble interaction function and logic, modified and optimized the interface performance based on the design requirements.
- Responsible for the front-end development of the display interface.
- Studied the implementation principle of target detection, introduced technical interface and created a personal data set.
- Built database, created Django server, and deployed the web page online.
- Worked closely with designers and project leaders to modify and improve project details

What I learned

- Learned a lot more tips for front-end development and physical effects implementation by actually making them.
- Learned how to deploy web pages and link to databases.
- Learned the principles and methods of target detection and created a personal data set.

Introduction



- As an important part of Chinese traditional culture, seal cutting carries the national spirit and cultural connotation. The Seal Cutting Display System aims to solve the problem of the lack of popularization of seal carving education in the post-epidemic era, promote the knowledge of seal carving in the form of an offline interactive exhibition, and help school students and exhibitors to understand the culture and history of seal cutting and experience the charm of seal characters. It has high value in the popularization of science.
- The seal-cutting display system is able to bring a more powerful experience to users compared to traditional exhibitions. The system is displayed in an offline technology exhibition, connecting iPads, large interactive screens, and mobile devices (mobile or otherwise) through the **Web**. With this platform, users can have real-time interaction with the big screen and experience the fun of interacting with the bubble components in the online physical world created. At the same time, photos are taken and processed by the system to get a page marker, which helps users understand the connection between human action and seal characters while keeping a memory of the experience for them.
- The seal-cutting display system is introduced with verbs, allowing users to unlock a limited range of content. The following 12 words are included: "paw", "swing", "strike", "lift", "lift straddle", "climb", "run", "ride", "shoot ", "kick", "throw", "swim".

Introduction of modules

The seal engraving interactive system contains four modules: user selection, gesture recognition and scoring, large-screen interaction and image processing.

The main contents are as follows.



- **(1) User selection module**

It contains the functions of selecting and deselecting seal characters.

Obtain user-selected seal characters and design the signal transmission method and logic of seal character selection in combination with the database. Launch the corresponding unlocking process of the seal character for the user's selection. Design CSS animation to increase user interface performance.

- **(2) Posture recognition and scoring module**

It includes pose recognition and background scoring functions.

Perform gesture recognition for images taken by users, design gesture recognition scoring criteria based on gesture recognition, realize background scoring of user's action standard, and return evaluation or guides users to try again for recognition based on scoring.

- **(3) Large screen interaction module**

It includes bubble interaction and bubble display functions.

According to the user's unlocked seal character to generate the corresponding bubble components, using the front-end physics engine related technology to design the bubble structure and drawing performance, to achieve bubble component generation, disappearance, collision, regular movement, fusion and interaction with the user and other functions, designed to enhance the user interface components expressive power.

- **(4) Page Marker generation module**

It includes image selection and saving functions.

The image processing is carried out for the images taken by users, and the image processing process including target detection, portrait keying and other functions is designed in conjunction with the database to realize the function of generating customized tabs based on user images.

Architecture

- The B/S architecture was chosen for the development of the system. The front-end development uses HTML5, CSS and JavaScript, and the JS part is mainly developed using the jQuery library, while several packaged JS libraries such as Tensorflow.js and Matter.js are used to assist in realizing the functional requirements within the project. The back end mainly uses the Flask web application framework to implement related APIs.

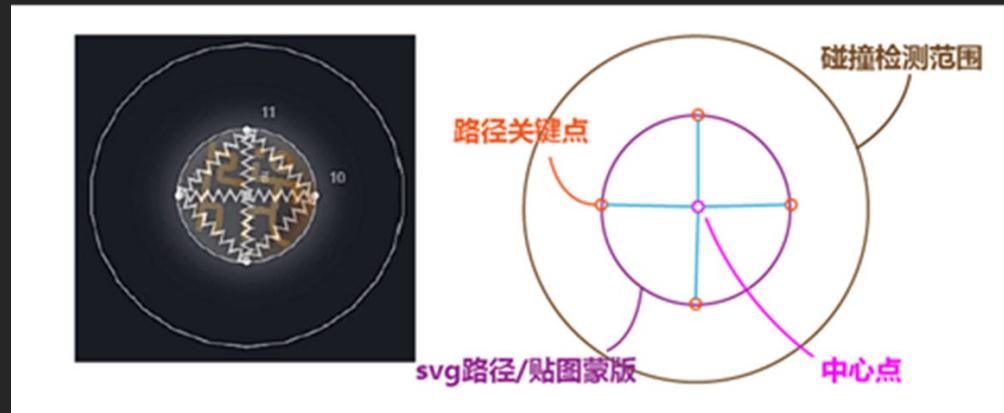
Principle of implementation

- **Front-end physics engine**
 - The front-end physics engine provides a physics system close to everyday life by pre-simulating variables such as mass and velocity of objects, giving realistic physics effects to rigid, soft and other components, allowing them to simulate various types of everyday physical performance, such as floating effects supported by the buoyancy of water bodies, motion effects by spring force, etc. The front-end physics engine enables realistic simulation of physics effects, making the entire physics system infinitely closer to the real world. Front-end physics engine library can help front-end developers who lack in-depth understanding of physics to complete various development tasks.
- **Image matting**
 - Image matting refers to the extraction of a portrait as a foreground from a complex background. At present, the technology of portrait keying has become more mature, and it has good effect on hair part and noisy images. Portrait keying can be divided into two categories according to processing methods: traditional methods and deep learning, and two categories according to interactivity, requiring human interaction and not requiring human interaction.
- **Target Detection**
 - The target detection algorithm outputs an enclosing frame to delineate the range of objects of a specified category in the image, which is widely used in the fields of medicine, agriculture, and transportation, and has practical applications in lesion detection, pest detection, and traffic surveillance cameras. The algorithms can be classified into two categories: one-stage algorithms and two-stage algorithms. One-stage algorithms include YOLO algorithm, SSD algorithm, etc., also known as regression-based target detection algorithms. Faster R-CNN and other R-CNN series algorithms are the representatives of the two-stage algorithms.

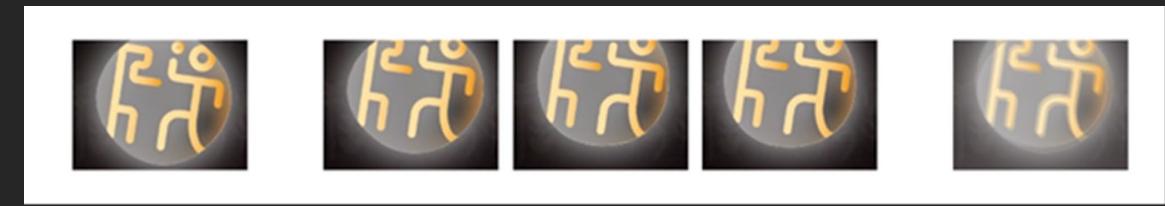
Technical implementation details

- **Front-end physics effects**

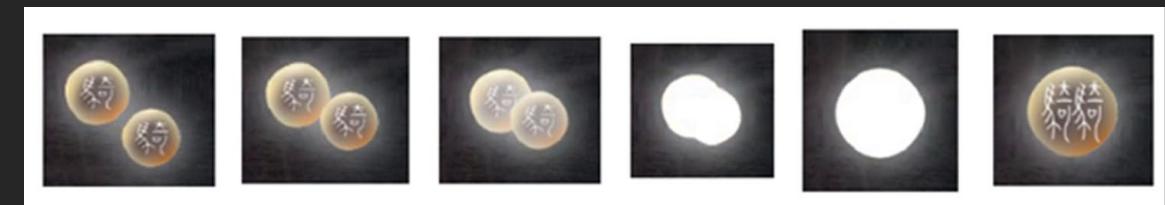
- Matter.js (front-end physics engine) is used to build the physical world in the large-screen interaction module, forming bubble components that conform to the laws of physics and pre-defined motion logic. Since Matter.js supports user input to control the components, during the actual presentation of the project, users can interact with the bubbles through the touch screen and apply external force to the bubble components to enrich the fun of the experience. The bubble is generated after the successful unlocking of the corresponding seal character. At this point, users can watch a series of bubbles from generation to disappearance in the bubble display. The bubble is generated from the middle of the screen, randomly selects a preset trajectory to rise, and stops rising when it touches the top. 500s later, the bubble continues to rise and leaves the screen, and disappears after a short time. During the active bubble cycle, users can use the interactive screen to drag the bubble position or let the bubbles collide with each other to form a combination of seal characters.



- Combined application of Paper.js and Matter.js, the key point in Paper as the base component of the physics engine, and use the constraint component in Matter (Matter.Constraint) to connect the key point component, so that when the collision of the composite component occurs, the force effect on each part of the component will be due to the properties and position of the constraint component, so that when the collision of the composite component occurs, the force effect of each part of the component will change due to the properties and position of the constraint component, thus producing a small deformation in the bubble collision effect, as shown in Figure 4.5, which can increase the bubble expression and more realistic.



- The actual project, combined with the traditional bubble fusion effect implementation ideas, through the sequence of frame animation and halo effect to simulate the bubble fusion effect.



Technical implementation details

- **Page marker generation and image processing process**
- Get the captured image (get the captured image and the corresponding action id from the database)
- Target detection (identify the portrait in the image)
- Weight calculation and filtering (weight calculation based on the size of the recognition frame and the distance to the middle of the image, and filtering the target portrait recognition frame in reverse order according to the weight value)
- Crop the image (crop to get the corresponding recognition frame area)
- Key the portrait (remove the background)
- Get the mask (extract the pure black silhouette of the portrait (masked area))
- Image overlay (overlay with the corresponding id background image)
- Output tab (user can save the generated tab as a memento)



Demo collections

Qi Rui

Material Art

-substance designer-



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- Click on <https://aliciarui.github.io/> to access all my previous works online.
- Web links for this project: <https://aliciarui.github.io/substance.html>

Project Summary

- Material design, part of the material reference to the surrounding items.

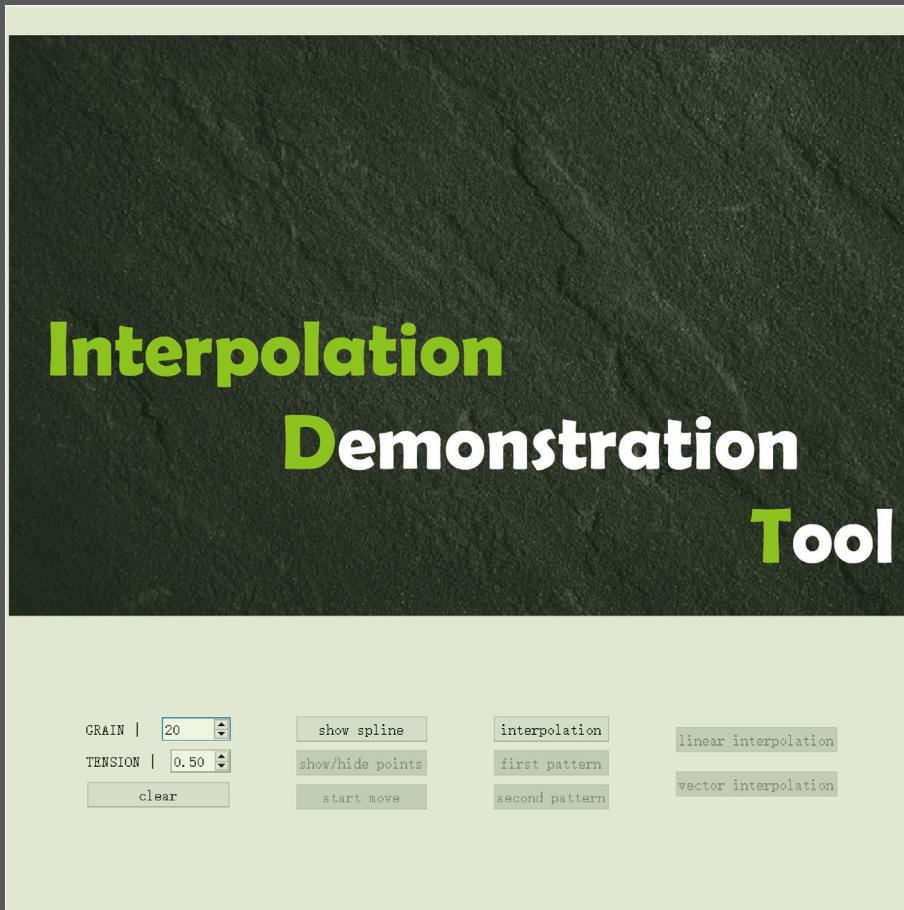
Roles and Responsibilities

- Solo Work
- Used Substance Designer to complete all content.

What I learned

- Learned a lot about the use of SD and creative material designing.

Interpolation Demonstration Tool



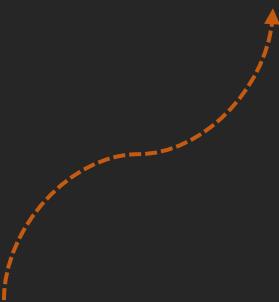
QT 5.12

C++

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- Click on <https://aliciarui.github.io/> to access all my previous works online.
- Web links for this demo: <https://aliciarui.github.io/interpolation.html>
- Web links for source code: <https://github.com/Aliciarui/CurveNInterpolation>



Project Summary

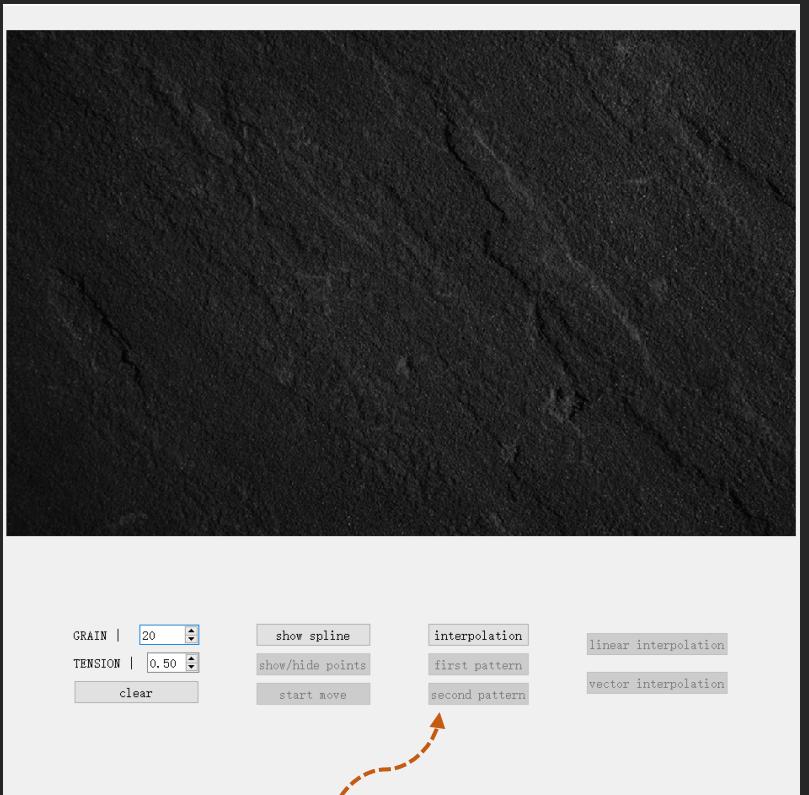
- A simple interpolation calculation and animation presentation tool with the option to set multiple custom parameters.

Roles and Responsibilities

- Solo Work
- Studied two interpolation methods and the principle of interpolation animation.
- Completed the basic interface design and implementation in QT.
- Implemented all functional requirements based on C++ and fixed the bugs caused by the operation order.

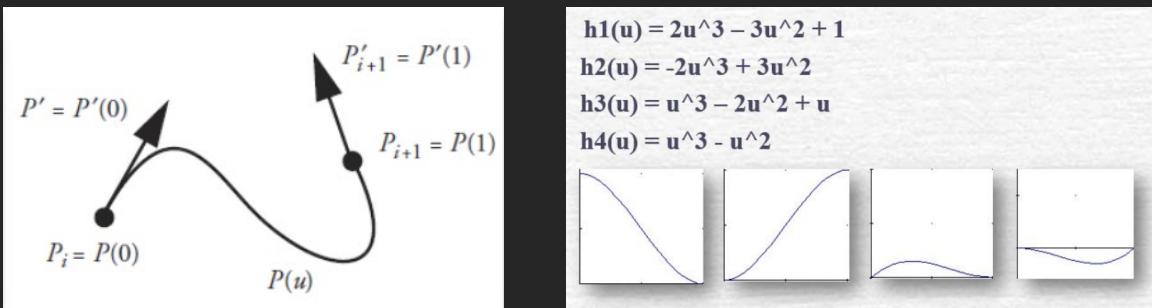
What I learned

- Learned a variety of interpolation principles and consolidated the foundation of computer animation.
- Getting familiar with the primary interface and operation of QT.



Interface Style

- **principle of the project**
- Hermite curve
- If you need to understand the Cardinal curve, you first need to understand the principle of the Hermite curve. If we need to obtain a curve, we essentially need to get a cubic function between two points. That is, $y = Ax^3 + Bx^2 + Cx + D$, there are still two ways to express a new parameter u between $[0,1]$, and write both x and y as a cubic function of u , that is $\mathbf{x} = \mathbf{Au}^3 + \mathbf{Bu}^2 + \mathbf{Cu} + \mathbf{D}$ and $\mathbf{y} = \mathbf{Au}^3 + \mathbf{Bu}^2 + \mathbf{Cu} + \mathbf{D}$, this is a two-dimensional parameter system equation. So what we have to do is to find this $P(u)$



- Four different types of curves represent different slopes. Multiply it with the slope to get the expression of $P(u)$

$$P(u) = [u^3 \quad u^2 \quad u \quad 1] \begin{bmatrix} 2 & -2 & 1 & 1 \\ -3 & 3 & -2 & -1 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} P_i \\ P_{i+1} \\ P'_i \\ P'_{i+1} \end{bmatrix}$$

- **Cardinal curve**
- Cardinal curve adds slope calculations to its formula when compared to Hermite curve.

$$\begin{aligned} \mathbf{p}(u) &= [u^3 \quad u^2 \quad u \quad 1] \begin{bmatrix} 2 & -2 & 1 & 1 \\ -3 & 3 & -2 & -1 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} \mathbf{p}_i \\ \mathbf{p}_{i+1} \\ \mathbf{p}'_i \\ \mathbf{p}'_{i+1} \end{bmatrix} \\ &= [u^3 \quad u^2 \quad u \quad 1] \begin{bmatrix} 2 & -2 & 1 & 1 \\ -3 & 3 & -2 & -1 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} \mathbf{p}_i \\ \mathbf{p}_{i+1} \\ \tau(\mathbf{p}_{i+1} - \mathbf{p}_i) \\ \tau(\mathbf{p}_{i+2} - \mathbf{p}_i) \end{bmatrix} \\ &= [u^3 \quad u^2 \quad u \quad 1] \begin{bmatrix} 2 & -2 & 1 & 1 \\ -3 & 3 & -2 & -1 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -\tau & 0 & \tau & 0 \\ 0 & -\tau & 0 & \tau \end{bmatrix} \begin{bmatrix} \mathbf{p}_{i-1} \\ \mathbf{p}_i \\ \mathbf{p}_{i+1} \\ \mathbf{p}_{i+2} \end{bmatrix} \\ &= [u^3 \quad u^2 \quad u \quad 1] \tau \begin{bmatrix} -1 & 2/\tau - 1 & -2/\tau + 1 & 1 \\ 2 & -3/\tau + 1 & 3/\tau - 2 & -1 \\ -1 & 0 & 1 & 0 \\ 0 & 1/\tau & 0 & 0 \end{bmatrix} \begin{bmatrix} \mathbf{p}_i \\ \mathbf{p}_{i+1} \\ \mathbf{p}_{i+2} \end{bmatrix} \end{aligned}$$

Sample Code

Code

- Cardinal curve

I need to code to calculate the curve. So I create cspline class and obtain grain and tension from the user input interface.

Through GetCardinalMatrix(), combined with the value of tension, the matrix M is generated. Then through the value of Matrix() and grain, the corresponding interpolation point is generated, and the interpolation point information is stored in the Spline array.

```
void cspline::CubicSpline()
{
    dot *s, *k0, *kml, *k1, *k2;
    int i,j;
    double alpha[50];
    GetCardinalMatrix();
    for(i=0; i<grain; i++)
        alpha[i] =((double)i)/grain;
    s = Spline;
    kml = knots;
    k0=kml+1;
    k1=k0+1;
    k2=k1+1;
    for(i=0; i<n-1; i++) {
        for(j=0; j<grain;j++) {
            s->x = Matrix(kml->x,k0->x,k1->x,k2->x,alpha[j]);
            s->y = Matrix(kml->y,k0->y,k1->y,k2->y,alpha[j]);
            s++;
        }
        k0++; kml++; k1++; k2++;
    }

    void cspline::GetCardinalMatrix(){
        double a1 = tension;
        m[0] = -a1, m[1] = 2 - a1, m[2] = a1 - 2, m[3] = a1;
        m[4] = 2 * a1, m[5] = a1 - 3, m[6] = 3 - 2 * a1, m[7] = -a1;
        m[8] = -a1, m[9] = 0, m[10] = a1, m[11] = 0;
        m[12] = 0, m[13] = 1, m[14] = 0, m[15] = 0;
    }

    double cspline::Matrix(double a, double b, double c, double d, double alpha){
        double p0,p1,p2,p3;
        p0=m[0]*a+m[1]*b+m[2]*c+m[3]*d;
        p1=m[4]*a+m[5]*b+m[6]*c+m[7]*d;
        p2=m[8]*a+m[9]*b+m[10]*c+m[11]*d;
        p3=m[12]*a+m[13]*b+m[14]*c+m[15]*d;
        return(p3+alpha*(p2+alpha*(p1+alpha*p0)));
    }
}
```

(For the specific code, please refer to the source file)

- Interpolation

Establish the Interpolation class and perform two interpolation calculations.

```
class interpolation
{
public:
    interpolation();
    void LinearInterpolation(int t);
    void VectorInterpolation(int t);
    void setnum_dot(int n);
    std::vector<dot> result;
    std::vector<dot> start;
    std::vector<dot> end;

    dot temp;
    int num_dot=0;
private:
    int num=10;
};
```

Store the intermediate image information in the result container, call QTimer to obtain the interpolated image at a fixed frequency, and draw it on the screen.

The biggest difference in the realization of these two kinds of interpolation should be linear interpolation and vector linear interpolation respectively using (x, y) coordinates and polar coordinates for operation.

It is particularly important to note that the implementation of vector linear interpolation requires additional consideration of the ambiguity of the angle, that is, it is necessary to ensure that the difference is clockwise or counterclockwise. In the implementation process, I choose to ensure that the final angle is greater than the initial angle.

(For the specific code, please refer to the source file)

- Animation

The goal is to move the picture of the sphere along the direction of the spline curve and rotate the picture



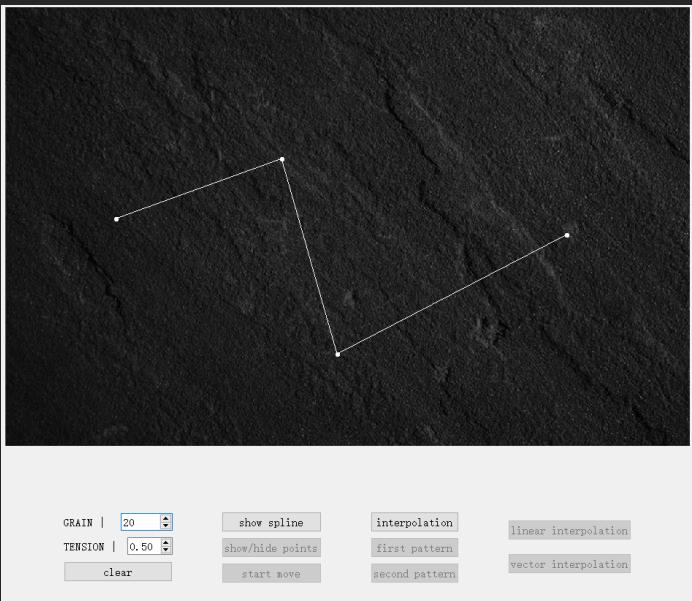
according to the slope. (sphere) Use getSlope() to obtain the slope of the curve, and use QTimer to obtain the characteristic point information of the curve at a fixed time frequency to change the position of the picture.

```
double *cspline::getSlope()
{
    int temp=(n-1)*grain+1;
    for(int i=1;i<temp-1;i++){
        slopes[i]=tension*(double)(Spline[i+1].x-Spline[i-1].x)/(double)(Spline[i+1].y-Spline[i-1].y);
    }

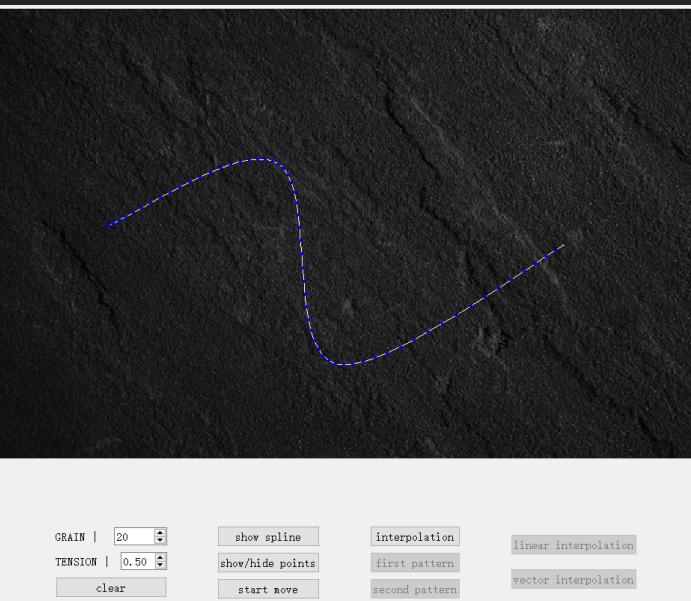
    slopes[temp-1]=tension*(double)(Spline[temp-1].x-Spline[temp-2].x)/(double)(Spline[temp].y-Spline[temp-1].y);
    slopes[0]=tension*(double)(Spline[1].x-Spline[0].x)/(double)(Spline[1].y-Spline[0].y);
    return slopes;
}

double temp=atan(s->getSlope()<new_count]);
temp=judgesymbol(temp);
temp=temp/(2*PI)*360;
paint.translate(s->getX(new_count),s->getY(new_count));//set the center
paint.rotate(temp);
paint.drawPixmap(-25,-25,50,50,*piximg);
```

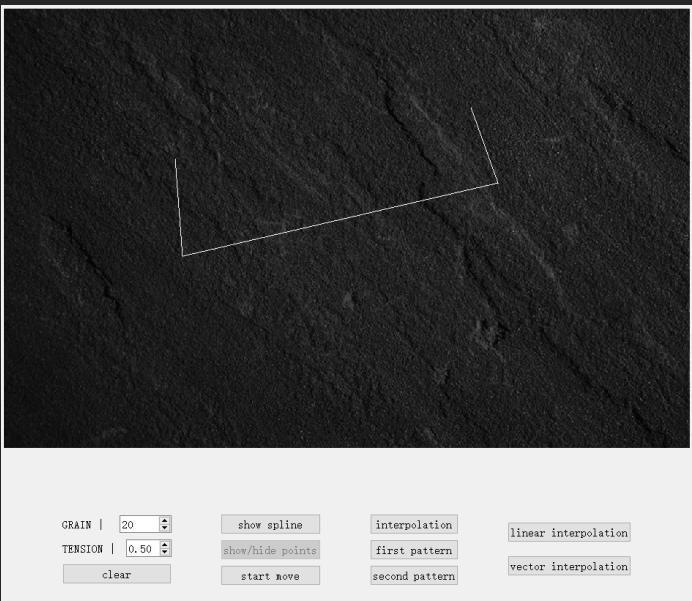
The image size is fixed at 50*50. The translate function is called to change the center position of the image. In order to make the sphere rotate smoothly without flipping, use judgesymbol() to determine the positive and negative relationship between the two double variables to ensure that each call is compared to the previous one. The symbol does not change.



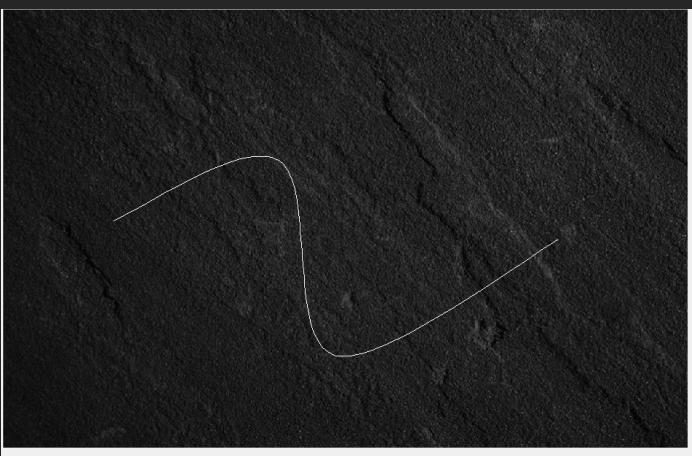
click to create dots



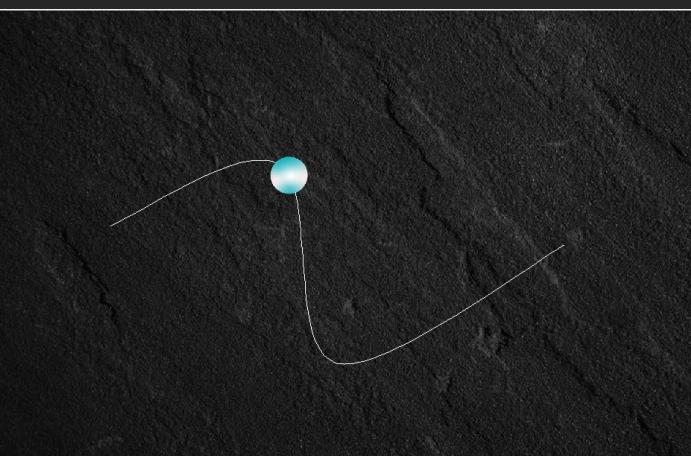
choose to show interpolation points



linear interpolation



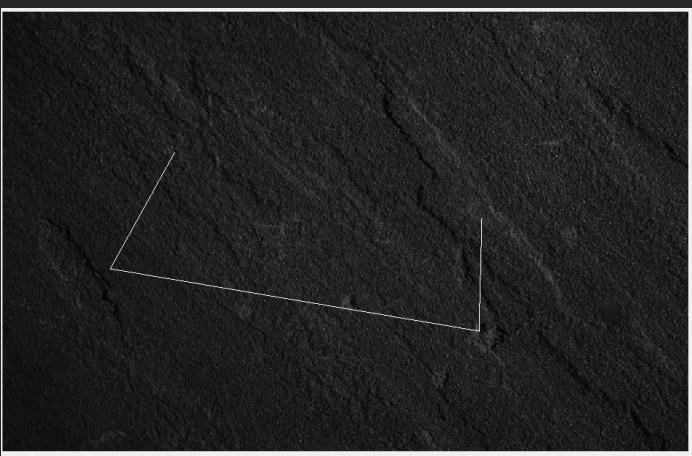
Result



show spline(unlock buttons)

GRAIN | 20
TENSION | 0.50
show spline
show/hide points
clear
start move
interpolation
first pattern
second pattern
linear interpolation
vector interpolation

move and rotate the ball



GRAIN | 20
TENSION | 0.50
show spline
show/hide points
clear
start move
interpolation
first pattern
second pattern
linear interpolation
vector interpolation

vector interpolation



Demo: Bliss

Tools | UE4 – Maya – Substance Painter

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Project Summary

- An adventure game DEMO, with gameplay demonstration as the primary requirement.

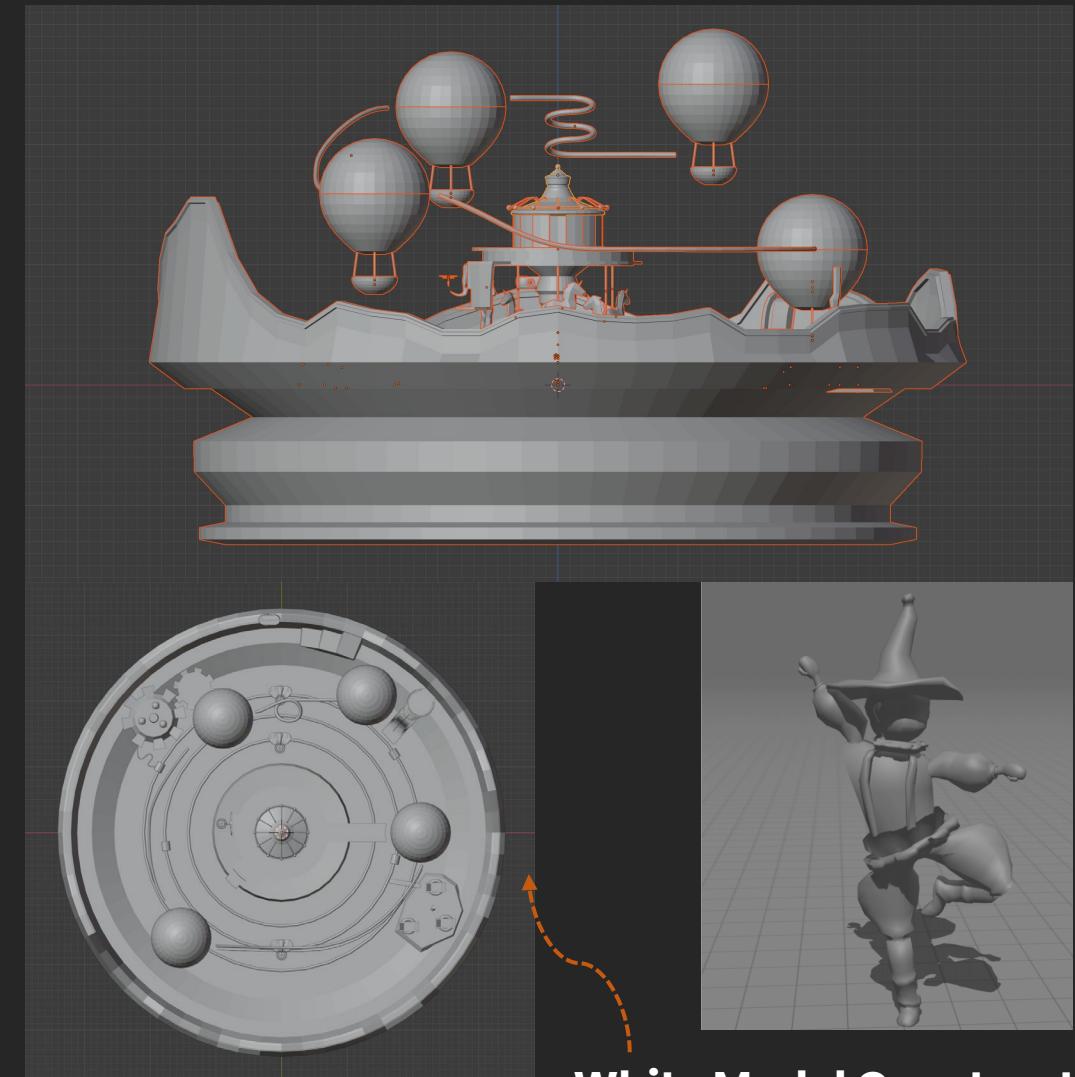
Roles and Responsibilities

- Solo Work
- DEMO was designed and implemented in a minimal time frame.
- Set up the narrative and story background.
- Implemented all gameplay functions and logic based on UE4 to create a playable DEMO.
- Used modeling software to design scenes and characters and built white model scenes.

What I learned

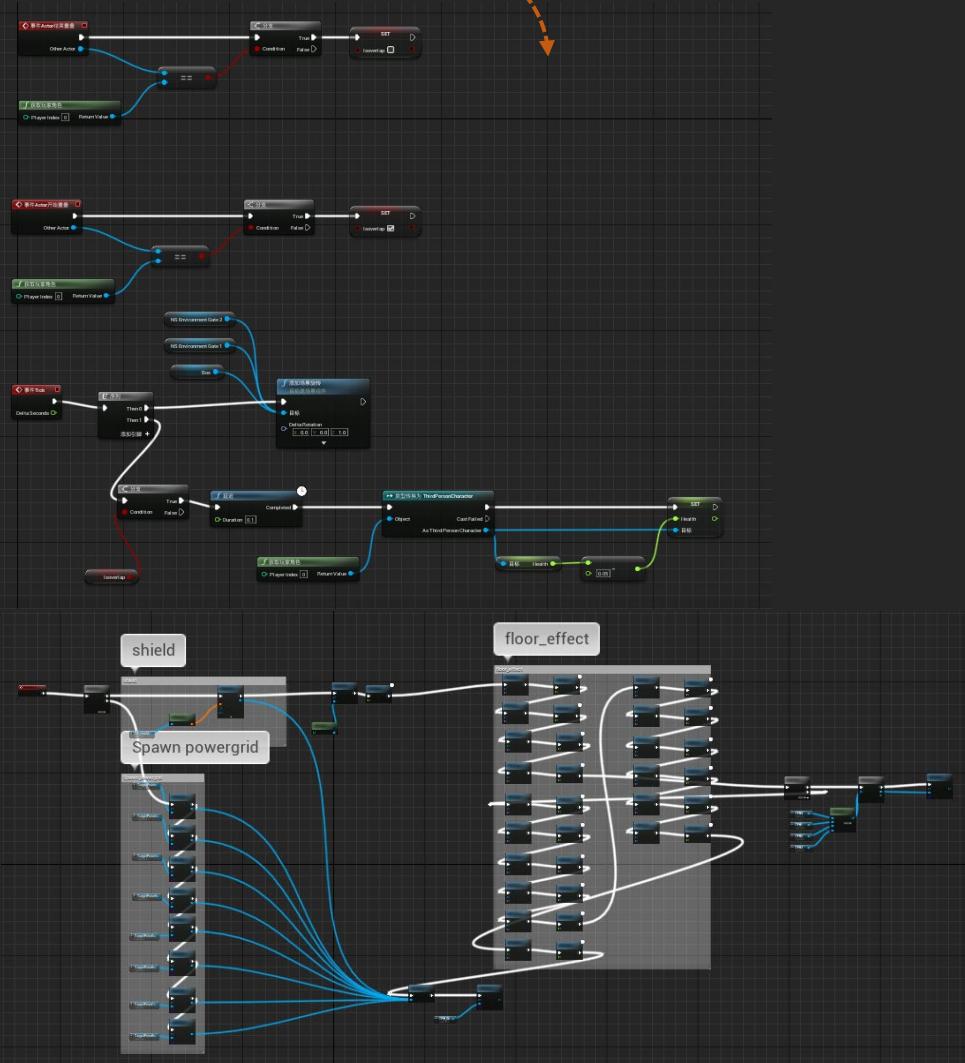
- Getting familiar with UE4 blueprint.
- Learned a lot about work with a combination of UE engine and modeling software.
- Learned about character animation design and binding.

Level Design



White Model Construction

Blueprint Design



Settings

引擎及版本: Unreal Engine 4.26

关卡类型: 线性流程, Demo演示中共有三个关卡模块

关卡规则: 走位躲避巫师技能并获取技能打倒巫师

关卡背景设定:

- 完整故事背景设定

玩家扮演整理论文材料时电脑意外断电黑屏, DDL却迫在眉睫的主人公Aya。为了拯救论文资料, Aya化身为灵魂的状态钻进电脑屏幕拯救文件。

Aya身处的时代正是WindowsXP流行的年代, Aya进入到了WindowsXP经典壁纸Bliss拍摄的场景, 并在这里见到了拍摄者Charles和他的夫人, 并见证了他们之间的故事。Aya受Charles之托追回遗失的Bliss原件, 并在旅途中拯救自己的文件。

在探索的过程中发现, 原先电脑屏幕的2D图标, 在这个世界中则是真正的3D场景。

Aya将要开始探险, 迎接她的有:

- 巨大的垃圾回收站-----对应回收站
- 大肚子电脑模型-----对应我的电脑
- 冰雪企鹅-----对应QQ
- 及其他

本Demo中的场景建立在了垃圾回收站中, 女巫夺走了回收站的电源, 在回收站中建立起了自己的发电厂, Aya正在回收站中进行探险。

- Demo故事背景设计

前来探险的Aya早被女巫所发现, 等待着她的重重机关, 她需要不断躲避机关保证自己存活的同时点亮机关获得攻击技能从而打倒女巫, 机关共有三个部分, 然而每解锁一个部分女巫就会恢复力量, 让玩家进入新的关卡进行冒险。

Code Sample

```
syncNode.cpp AsyncNode.h <= cppprojectCharacter.cpp cppprojectCharacter.h
1 // Fill out your copyright notice in the Description page of Project Settings.
2
3 #pragma once
4
5 #include "CoreMinimal.h"
6 #include "Kismet/BlueprintAsyncActionBase.h"
7 #include "AsyncNode.generated.h"
8
9 /**
10 * ...
11 */
12
13
14 DECLARE_DYNAMIC_MULTICAST_DELEGATE_TwoParams(FResponseDeleget, int32, Number, FString, Data);
15
16
17 UCLASS(ClassGroup=(Custom),meta=(BlueprintSpawnableComponent))
18 class CPPPROJECT_API UasyncNode : public UBlueprintAsyncActionBase
19 {
20     GENERATED_BODY()
21
22     public:
23         //different threads
24         UPROPERTY(BlueprintAssignable)
25             FResponseDeleget First;
26
27         UPROPERTY(BlueprintAssignable)
28             FResponseDeleget Second;
29
30         UPROPERTY(BlueprintAssignable)
31             FResponseDeleget Third;
32
33         UPROPERTY(BlueprintAssignable)
34             FResponseDeleget Fourth;
35
36         UFUNCTION(BlueprintCallable, meta = (BlueprintInternalUseOnly = "true"))
37             static UasyncNode* AsyncFerox(const int Number);
38
39         //void isEqual();
40
41         int temp = 0;
42
43         //virtual void activate() override;
44
45     };
46
47 }
```

Gameplay Mode Design



- **Dangerous Terrain**

- The player will first encounter the dangerous terrain. Once the player steps on such terrain, he will be deducted (the lower left health bar is reduced). Therefore, he needs to move, jump, etc., to avoid dangerous terrain.

- **Rotating Component**

- After entering the second stage, the player will see many rotating rays in the scene. The player still needs to avoid such rays by moving, jumping, etc. Otherwise, his blood will be deducted (the health bar in the lower left is reduced)

- **AI Tracking**

- While the player is trying to avoid obstacles, there is also an AI lightning in the scene. Once the player is found, the lightning will follow the player to move. If the player stops moving, it will be caught up by the lightning.

- **Level Prop**

- Each time the player passes through a stage, he can unlock the corresponding level prop layer. After a certain period of time, he will return to the same game field. According to the design, there will be a puzzle-solving part around it, but it has not yet been completed.

- **Heart & Shield**

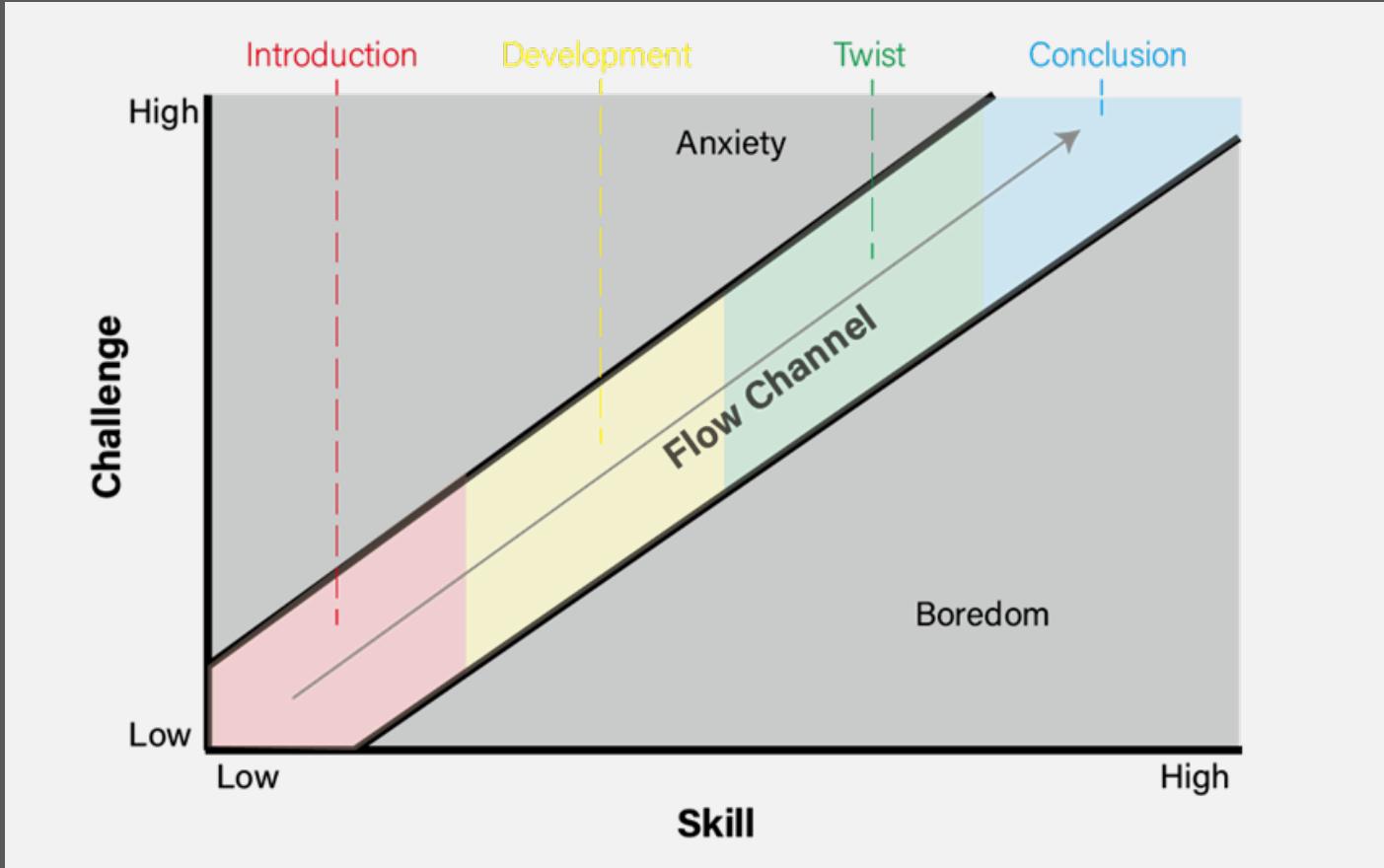
- There are a lot of props and obstacle designs in the game. In order to prevent the player from staying in the same position all the time, there are love-shaped props scattered in the scene, which means that the player can obtain them by picking them up. There will also be power barriers around, and only after passing the corresponding stage can you enter the outer circle to look for Level Prop

- **Attack Witches**

- The player can find the attacking props in a specific position. Use the right mouse button to launch an electric ball to attack the witch (due to the barrier blocking it cannot attack directly). If the player has attacked 3 witches while avoiding the AI chase, the game wins.

Essay | Game Analysis

Qi Rui



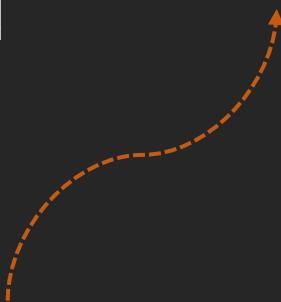
Essay

Kishōtenketsu Theory in Game Design

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Kishōtenketsu Theory in Game Design

Introduction

Kishōtenketsu is a narrative structure that originated from the Chinese Yuan Dynasty poetic style and is currently widely used in designing games (Wikipedia, 2022). This paper introduces the application of Kishōtenketsu in game design by giving examples and discussing its advantages for game design.

Keywords: Kishōtenketsu; Game Design; Narrative Structure

How Kishōtenketsu is used in games

Koichi Hayashida proposed the application of Kishōtenketsu in game design in 2002, where he divided individual game mechanics structure into the following four steps (Stilleatingoranges, 2012): (1) Introduction of a new gameplay mechanic in a safe environment; (2) Development offers a slightly more complicated scenario to use the mechanic; (3) Twist which is using the mechanic in an unexpected way, and (4) Conclusion going through boss challenges with comprehensive use of this mechanic (Fig. 1 and 2).

Such a four-step structure is also widely used in the level design of Super Mario: Odyssey and the uproot challenge in the wooded kingdom can be a good example.

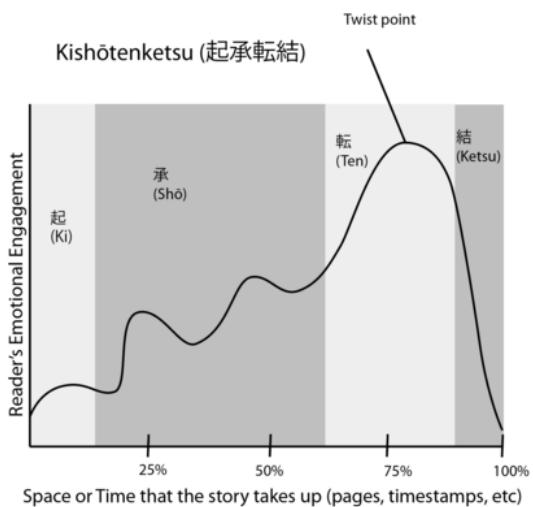


Fig. 1: Kishōtenketsu steps (Retrieved from Wikipedia. (2022). *Kishōtenketsu*.

<https://en.wikipedia.org/wiki/Kish%C5%8Dtenketsu>

In the first stage, players first meet an uproot, a creature that can stretch many times its height forward. There is a safe area for players to explore freely, manipulating uproots to stretch, smashing bricks and tree fruit or attacking other uproots. In the second stage, more complex terrain appears, forcing players to learn skills such as jacking up panels, breaking bricks, and moving between complex platforms (Mariowiki, 2022). Players should follow the rhythm to stretch the uproot to get through this terrain. The third stage involves timely actions where players need to advance around a towering column to the top, paying attention to the appearance of greenery platforms while controlling jumps to avoid moving obstacles. And in

the final stage, players are guided to use all the previous mechanics in the boss fight, which means they have to top off the bricks to break the boss and then give it a fatal blow.

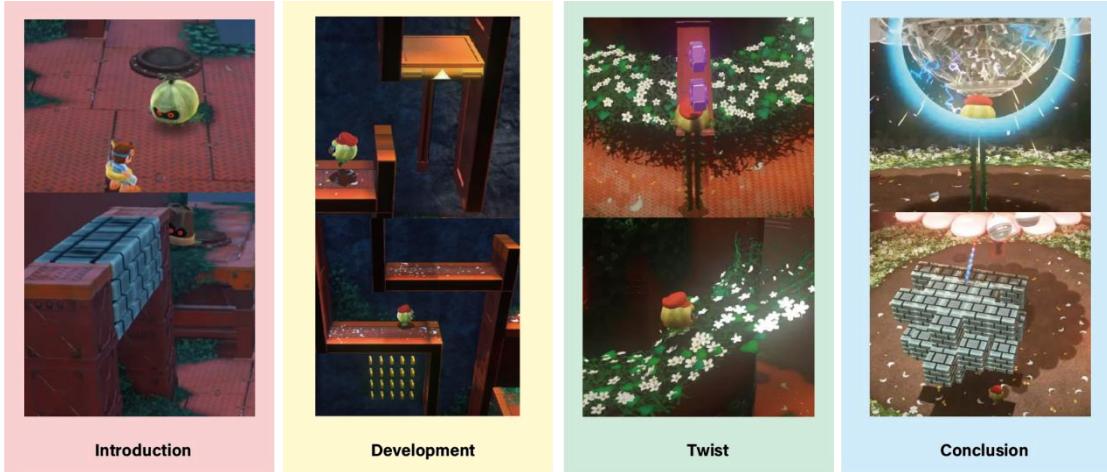


Fig. 2: *Super Mario: Odyssey* steps

Kishōtenketsu is not only reflected in *Super Mario: Odyssey* but also in numerous other games, such as *The Legend of Zelda* games, *It Takes Two*, etc. It is widely used in game design because it helps designers create mind-flow experiences and control the game-level pace.

Mind-flow Experience Shaping, Immersion Enhancement

The flow theory was originally developed by psychologist Mihaly Csikszentmihalyi, who believed that people who enter a state of mind flow become completely focused and immersed in their current activities and situations, experiencing a sense of accomplishment and forgetfulness (Csiksentmihalyi 1992). He proposed the original flow model, while Chen Sing-Han pointed out that flow in game design only needs to encapsulate three important elements: the balance between player ability and challenge, the sense of control, and the sense of satisfaction (Sing-Han, 2006).

First, players are introduced to the mechanic at a minimum, while low-level challenges and safe environments are configured for players to explore on their own to stimulate their curiosity. In this stage, players' skills and challenges are at a low level.

Second, players are guided to explore and gain proficiency in skills by breaking through mandatory instructions and barriers in the scenario, corresponding to the middle part of the mind-flow model.

Third, players are given a series of tasks in a new direction, and they are asked to actively think about it from a fresh perspective. In this stage, players' skills and challenges both rise to new heights.

The final stage verifies the players' ability through boss battles, when both players' skills and the difficulty of challenges reach their peak, corresponding to the final stage of the mind-flow model.

Aligning with the flow theory, the Kishōtenketsu structure divides the level into four stages, in which players' skills and the difficulty of the challenge increase simultaneously so that players can intuitively and clearly feel their own growth and thus more easily reach the state of mind flow (Fig. 3).

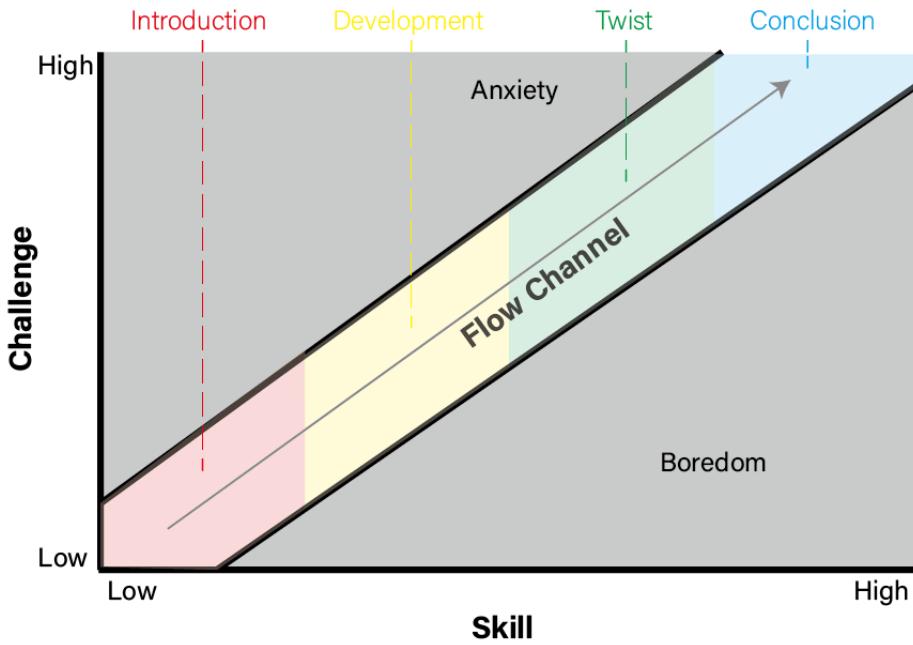


Fig. 3: Kishōtenketsu structure alignment with the flow theory

Level Pacing Control, Freshness Maintenance

Compared to introducing players to all the gameplay applications at once, Kishōtenketsu theory assists the designer in gradually showing players the application scenarios of the new mechanics and even stimulates their desire for active exploration. At the same time, it shortens the time it takes for players to adapt to the new mechanism, focusing instead on each new application scenario in steps until they finally encounter the boss battle, where they need to combine all the previous skills to complete the comprehensive test.

For example, in the first stage, uproot, and its manipulation methods are introduced; then, in the second stage, new organs (such as blocks, bricks, etc.) and various rewards are introduced; in the third stage, players are guided to discover the floating time difference possessed by uproot and use it to pass the time-limited puzzle; The last stage aggregates all the previous application scenarios and merges them in the same boss design. Therefore, by adopting such a level design law, designers can better split the level design, master the progress and rhythm, and avoid a certain part of the experience from being too long or too short. At the same time, it allows players to constantly receive new ideas, avoiding the boredom caused by simply repeating and experiencing the same application scenario and keeping the players' freshness and desire to explore the game.

Conclusion

This paper introduces Kishōtenketsu, a widely-used level design structure that breaks down the introduction of new mechanics into four steps within a level. This paper also analyzes the advantages of this level design structure by using the example of Super Mario: Odyssey, which can shape the mind-flow experience and keep the players fresh. In the future, as the game world evolves and the gameplay mode iterates, the evolvement of the new level design

structure and continuous development of the current structure would advance gaming industry.

Reference

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<https://stilleatingoranges.tumblr.com/post/25153960313/the-significance-of-plot-without-conflict>
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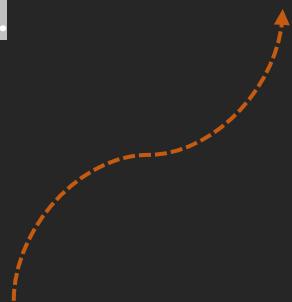
Game Analysis

Cuphead

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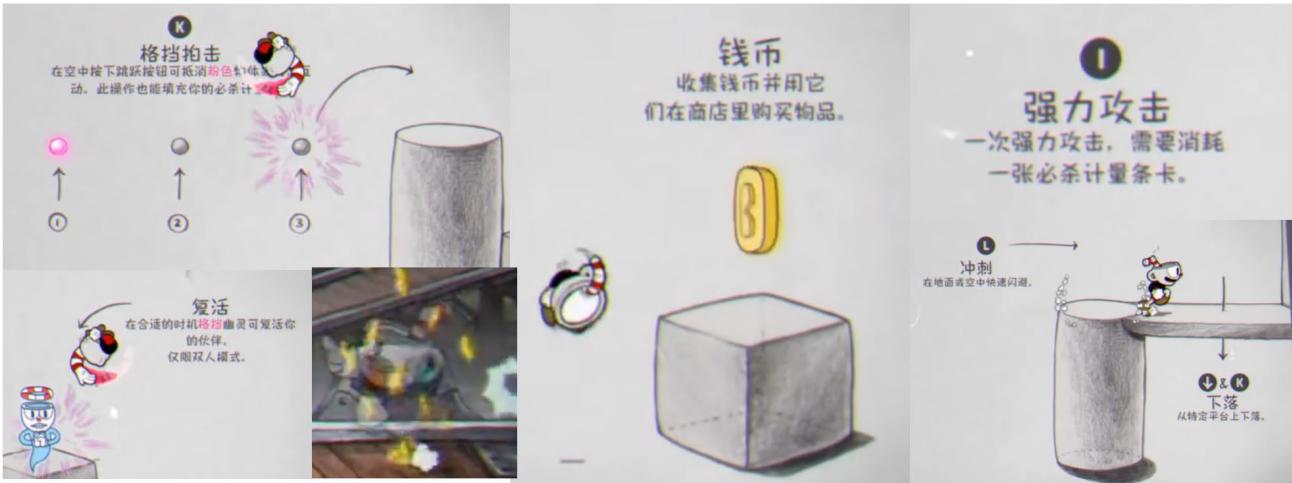
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Introduction

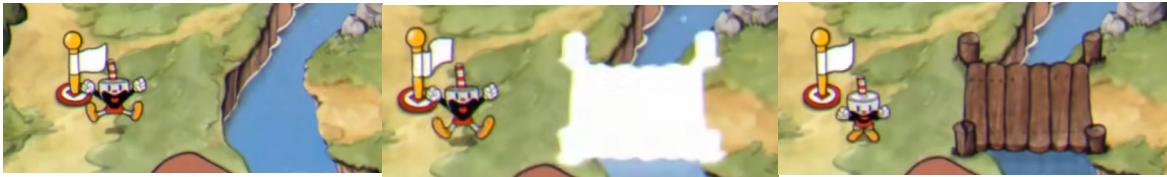
Cuphead is a horizontal jumping and shooting game, independently developed by Studio MDHR released in 2017 on PC and XBOX platforms. It is the 2018 IGN Game of the Year.



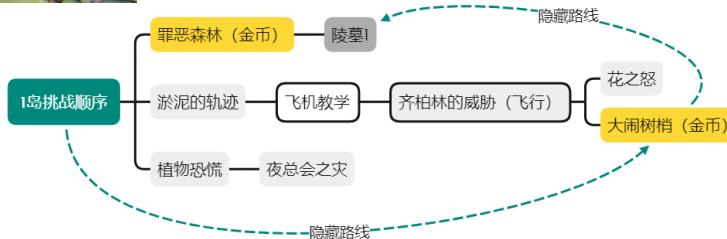
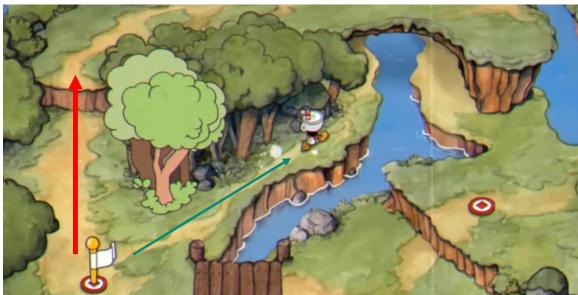
Cuphead tells a story about the devil and debt: the two brothers of Cuphead enter the devil's casino and get into debt under the temptation of the casino boss. In order to pay off the devil's debt and avoid having their souls taken away, the two brothers begin their adventure on the Murphy Island.
After entering the teaching level, players will learn how to crouch, jump, sprint, drop, shoot, aim, block, resurrect, power attack and use coins.

Map Exploration

The complete game contains three islands and one final boss. Every time the player gets through a level, the map will appear with white flags and new access. The island has both hidden routes and an invisible level challenge sequence



White flags appear on the map after defeat the boss as well as new access roads



Players can choose to enter the store and spend gold to buy various weapons and amulets, or talk to NPCs to get hidden gold

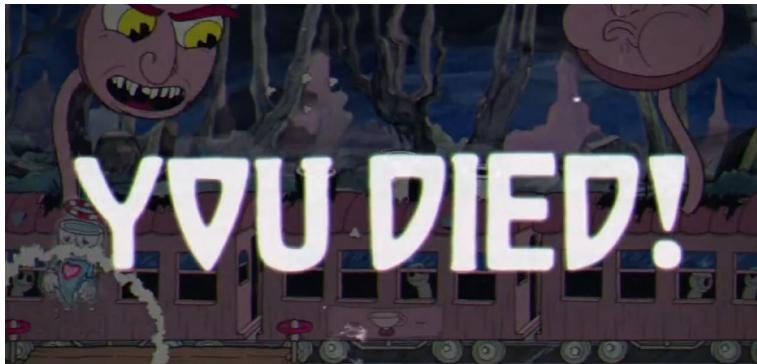


Levels contain horizontal scrolling level (gold level), tomb challenge level and boss battle (regular and flight mode). Only players who successfully pass the normal difficulty boss battle can obtain the contract, and need to collect all the contracts to challenge the final boss.



Level Design

Before entering the level, players can choose the type of weapon, kill technique and amulet to configure, and choose the difficulty to challenge. After completing the challenge, a score panel will be displayed and will indicate the performance of the level. Otherwise, if you do not pass the challenge, a death screen will appear.



Take Carnival kerfuffle : Beppi the clown as an example.

This level is divided into four stages, the details of which can be seen in the stage division by entering the death screen.



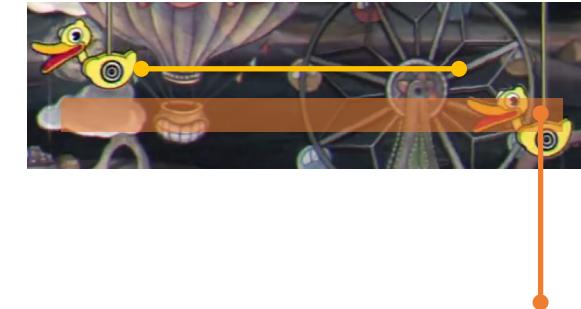
Next will be a breakdown of each stage, including how each monster attacks, the interval between appearances, and the location on the screen. It will also go through the following ways to rate the difficulty of each stage.

- Shooting difficulty (boss size, boss location, displacement speed, predictability, chance presentation)
- Safety (safe area range, safe area stability, safe area randomness)
- Attention distribution (intensity, degree of distraction, reaction time)
- Learning difficulty (first appearance, ease of use)
- Challenge randomness

Phase one

Bottom 1/2 of the screen: bumper car boss

Top 1/2 of the screen: a row of ducks
Rolling at a constant speed, up and down
JUMP HEIGHT of the character
SPRINT DISTANCE of the character



Standby

- Swaying in place
- Small rhythmic movement back and forth



Sprint forward swing

- Longer time(1.5s)
- Small backward



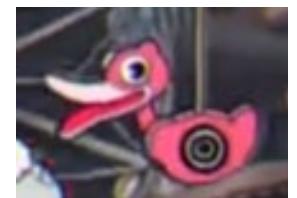
Sprint

- Fast forward impact
- Until it hits the walls on both sides, it will turn and return to the standby state



Ordinary ducks

- Its target is always facing the player before being hit



Pink ducks

Blockable



Light Bulb ducks

- Drops a light bulb when it appears directly above the player vertically/when attacked
- Change to normal duck after drop its bulb



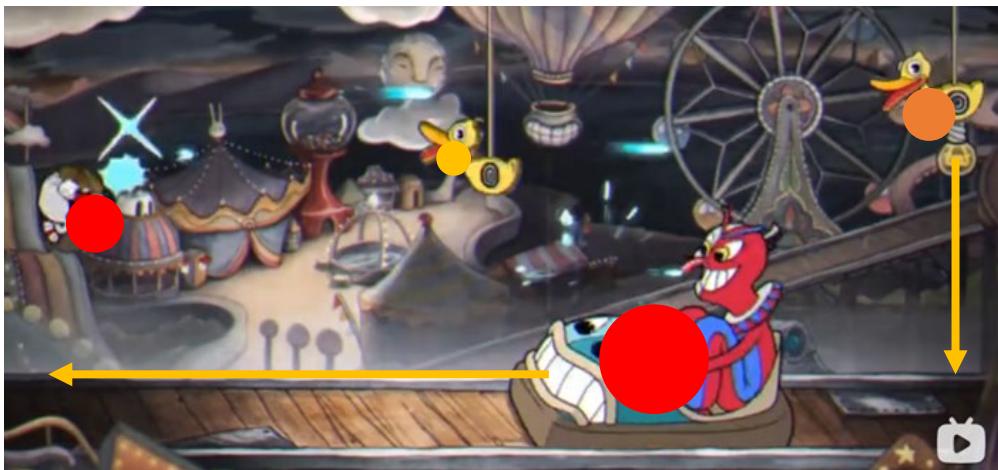
- Rotate back after being hit or blocked
- Loss of damage judgment

Phase One



Player challenges(in order of importance)

- = Create safe areas, timing
- Jump to avoid boss crash below
- Shoot bosses horizontally
- Dodge and jump horizontal to shoot the duck array above
- Move horizontally to dodge falling light bulbs
- Block the pink ducks



Player location: Lower complete ground

Actual Player Behavior : Attack and Defense Switch

(Dodge) Dodge/jump to the back of the boss by timing the boss impact; Dodge falling light bulb

(No dodge) Shoot the duck array above and knock down the bulb early; Jump dash to avoid the boss impact

(bonus) Block the pink ducks

Shooting difficulty: Horizontal direction 100% hit, the boss does not disappear

Safety: Complete ground, no randomness and instability

Attention distribution

Strong(Player location, Boss location)
Medium(bulb duck current/possible location)
Weak (normal/blocked duck, bulb drop, boss sprint location)

Learning difficulty: All appear for the first time, easy to learn by player perception

Randomness: no randomness

Summary: Low challenge difficulty; Combination of predictable and immediate reaction mechanism



Phase Two

Top 1/9 of the screen: balloon boss

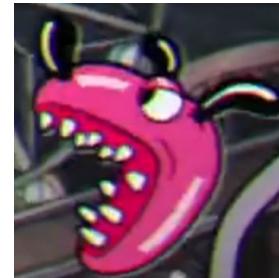
Full screen range: Balloon ball tracking bomb

Bottom 1/2 of the screen: train (uniform horizontal movement)



Balloon tracking bomb

- Randomly generated at 6 pipe openings
- Track player location
- Disappears when touching the ground/being attacked

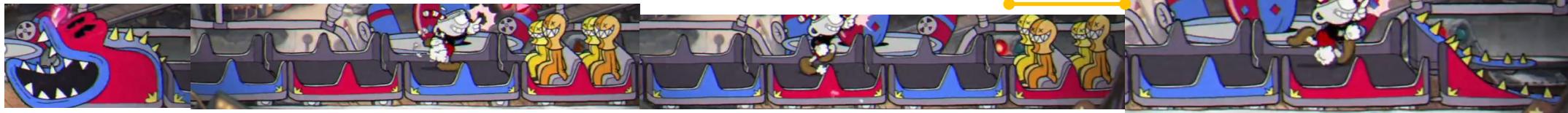


Pink balloon tracking bomb

Blockable

Train

Uniform horizontal winding



Head of the train
Blockable

- Carriage section**
- Safe to stand, same as the ground
 - Rolling to the left

Passenger section
Horizontal interval: Sprint distance

Phase Two

Player Location: Lower complete ground
Actual player behavior:

Move/Sprint/Dodge to avoid tracking bombs and move position; Attack to destroy tracing bullets; Ensure output position and within the range of bullet attack; Avoid pipe exit and the train start point (try to be in the middle)
(Bonus) Block pink tracing bullets, front of the train

Shooting difficulty: Limit the location of the attack, the boss is fixed and does not disappear

Safety: Complete ground, the train has randomness, but no instability; Actual safety area is narrow and scattered; High difficulty in moving between safe areas

Attention distribution: Extremely scattered, no regularity, need to pay attention to a wide area; Strong (player position, tracking bomb position) Medium (upper tracking bomb, lower pipe exit, train barrier, train start point)

Weak (boss location, upper pipe exit)

Learning difficulty: All appear for the first time, easy to learn by player perception

Randomness: Train appears with randomness and low reaction speed requirement

Summary: High challenge difficulty, strong randomness of difficulty; Predictable and random mechanism combination



Player challenges

=Switch safe areas to find a location to attack enemy

- Dodge obstacles below
- Dodge tracking bullets/attack to destroy
- Find the output position
- Attack the balloon above the middle
- Avoid pipe exit, train start position
- Blocking (pink tracking bomb, front of the train)





Horse(boss)

- Appears on the top left or right of the screen
- Disappears for a short time after firing a bullet



Yellow Horse

- Appears on the top right of the screen
- Fires a horizontal line of bullets
- After a short time the bullets fall vertically and cannot be destroyed



Train

Uniform horizontal winding



Head of the train

Blockable

Carriage section

- Safe to stand, same as the ground
- Rolling to the left

Passenger section

Horizontal interval: Sprint distance

Phase Three

Top 1/9 of the screen: balloon boss

Full screen range: Balloon ball tracking bomb

Bottom 1/2 of the screen: train (uniform horizontal movement)



Green Horse

- Appears on the top left of the screen
- Each round launch 2 bullets spiral to the right, the player will be hit if close to the boss
- A total of two rounds fired, can not be destroyed

Phase Three



Player challenges

=Reserve a safe distance to ensure the output position

- Dodge the obstacles below
- Quickly react to boss attacks

Find a safe position

Ensure the boss is within output range, attack

- Block (head, pink spiral bullets - horseshoes)



Player Location: Lower complete ground

Actual player behavior:

(*dodge*) Wait on the left, react to which boss, determine the way of attack

(*Green*) directly to the boss below the output, dodge obstacles

(*Yellow*) avoid vertical falling bullets, switch weapons output

(*no dodging*) If the train does not appear by sprinting to change position, otherwise basically no solution

(*bonus*) Block the front of the car and pink horseshoes

Shooting difficulty: Small boss size, short existence time; Location has randomness.

Safety: Complete ground; train has randomness, but no instability

Attention distribution:

Strong (player location, boss location, train obstacles near boss)

Medium (bullet attack blind spot - safe location)

Weak (train head, train path)

Learning difficulty: Train repeatedly appear; Horse appear for the first time

Randomness: Boss randomness, train randomness

Summary: Challenge randomness, big difference in experience; Test immediate reaction, need to reserve a safe distance



Phase Four

Bottom 1/2 of the screen: trains, penguins

Full screen range: tracking bomb

Middle 1/2 of the screen: horizontal right-shift platform

Middle of the screen: boss without collision



Penguin

- Appears on the ground
- After four appear at the same time began to launch tracking bombs

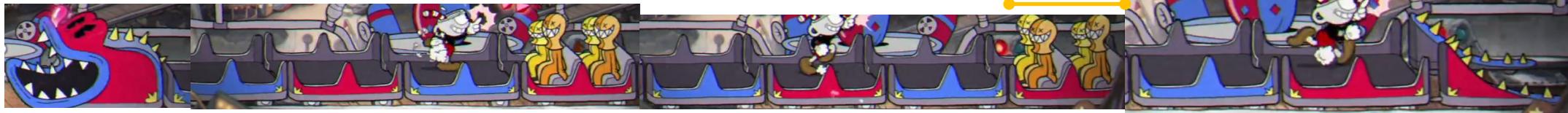


Tracking bullet

- Fast movement speed
- Disappear after hitting obstacles
- Cannot be destroyed by attack

Train

Uniform horizontal winding



Head of the train
Blockable

Carriage section
· Safe to stand, same as the ground
· Rolling to the left

Passenger section
Horizontal interval: Sprint distance

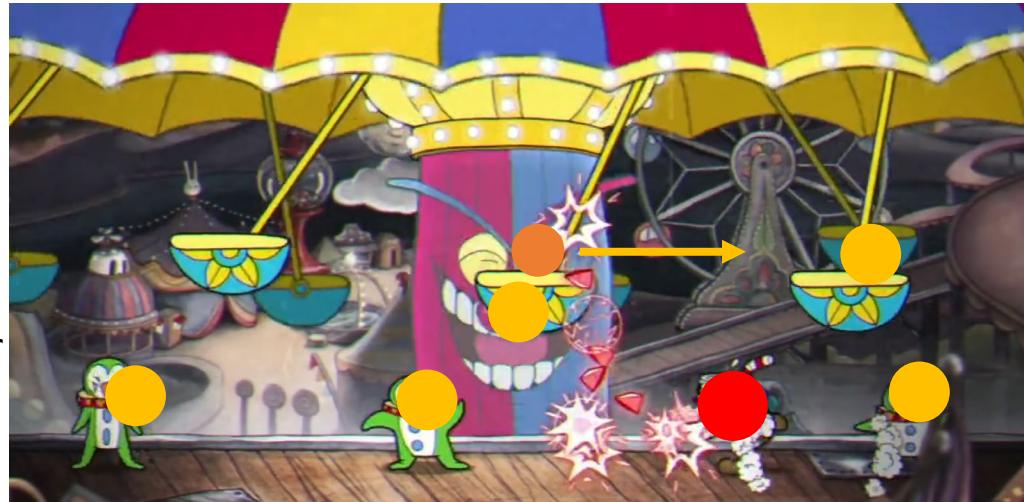
Phase Four



Player challenges

=Create safe areas and secure output positions

- Jump between platforms
- Ensure that the boss is within output range
- Choose the right ability to clear the penguin obstacles below
- Dodge train obstacles
- Blocking (pink tracking bomb)



Player Position: Upper horizontal moving platform

Actual player behavior: Dodge / dash way to switch between platforms

(Clear) After four penguins appear, jump to the floor below; Attack and release a big move to clear the penguins

(No clearing) Dodge/jump to avoid the tracking bomb, wait for the train to clear the penguins

(Bonus) Block the pink tracking bomb

Shooting difficulty: Boss position fixed and does not disappear

Safety: Moving platform, horizontal movement, need to switch

Attention distribution:

Strong (player position, number of penguins)

Medium (platform close to boss)

Weak (boss position, penguin position, away from boss platform)

Learning difficulty: Repeated appearance of trains, first appearance of penguins, high learning difficulty

Randomness: Train has randomness

Summary: New monsters appear for the first time, increasing challenge difficulty; High randomness, high variability of experience. Relatively focused attention.

Analysis

In the level design of Carnival kerfuffle : Beppi the clown, the main features are as follows.

- 1 The level design mainly adopts the way of limiting the player's action space, which shows that there are very few safe positions for players; the boss design is very exaggerated, with very eye-catching colors and volume; there is little standing space, and the space is fragmented and cut, such as designing narrow and uniformly scrolling stations, or designing blocks containing dangerous elements to force players to give up their original occupancy; designing monsters for tracking attacks, so that players always need to judge the safety of the current position
- 2 At the same time, the attack mode in Cuphead game is very simple, only simple shooting and must-kill technique two. The challenge also does not test the player's shooting accuracy, which is reflected in the large size of the boss, most bosses can occupy the entire height or width of the screen, which means that the player can hit the boss on any platform and use automatic tracking weapons to assist.
- 3 The level design has a very strong randomness, which is reflected in the randomness of the challenge in some of the levels, ensuring the uniqueness of the player experience. The experience of each challenge is not exactly the same, and there are differences in difficulty, which exactly fits the player's gaming psychology.
- 4 There are complex elements in the level design, the player needs to focus on a lot of content at the same time, to a certain extent, distracting the player's attention. There are very many fixed obstacles within the level, such as platforms that restrict movement, as well as a very large number of small monsters that restrict players in addition to the boss. Players need to pay attention to their location at the same time, and even pre-judge the path of action and movement to avoid putting themselves in a dangerous situation.
- 5 The overall pace of the level contains fast-paced attack and dodge, so in the battle with a sense of exhilaration, the player needs to switch the rhythm of attack and defense according to the enemy attack moves, determine the timing of the release of the necessary kill technique and ensure dodge. These form a test of the player's reaction speed, operational proficiency, and foresight.



Other

Another major feature of this game is its rare art style. Take the 1930s traditional old-style Disney cartoon art style as a reference, and frame by frame animation performance, to exaggerate and bright color art style to create a visual impact. At the same time in each level there are fixed background scenes, and bosses even if the constant transformation also maintains the same color scheme. For example, in the Carnival kerfuffle level used bumper cars, carousels, roller coasters, and design targets and other common elements.



Actually, as a player who has experienced this game, may have the following more intuitive feeling.

- Malicious game design

The game may have foreground blocking, hidden enemies, bullets beyond the screen and completely random attack direction, so that players remain nervous for a long time or even unable to predict the enemy's attack.

- High training cost

The high blood volume of a single boss and the low blood volume of the player in stark contrast make the game difficult, and players will keep repeating the initial stage of the challenge in the early stages.

- Strong sense of purpose

The game is designed to give players a very strong sense of purpose at the beginning, including fighting bosses, getting gold, etc. There is no calm training phase, and players are almost always in high spirits.

- Level design is full of surprise

This is reflected in the level design theme which is close to reality but at the same time exaggerated processing, so that players feel familiar and at the same time pleasantly surprised.

Conclusion

All in all, Cuphead is an excellent indie game. In this article, I talked about the game design, especially the level design of Cuphead, from my personal point of view. I welcome all of you reading to discuss and experience this game with me!