

Serious Game: River Trash Recycling

Xie Jiachen

Guangdong Peizheng College, Guangzhou, Guangdong, 510000, China

Keywords: Serious Game, Recycle, River Trash, Unity 3D, Environment, Education

Abstract: As one of the most rapidly developing types of games in recent years, serious games have been widely used or theoretically can be widely used in many fields because of their characteristics such as imparting knowledge, training professional skills, and simulating real situations. In addition, serious games are relatively cheap, widely available, and fun, which has led to a growing interest in them. In this article, we try to apply serious games to one of the most important branches of environmental protection: Recycle The River Trash projects. The project is a serious game based on the Unity 3D engine, and it also tells the player what the trash in the river is and how to simply classify it for environmental protection. In addition, there will be some emergencies that will also have an impact on the environment. The project consists of several static and dynamic 3D environments and models, showing the differences between the rivers in different environments. At the same time, different types of trash are designed for different rivers in different environments, so that the game has more accurate information and better educational significance. Allows the player to clean up river trash and sort through it with simple actions and positive feedback for successful completion of a level.

1. Introduction

In recent years, more and more attention has been paid to the concept of "serious game". The term "serious games" was first coined by Ben Saeyer in consideration of bottlenecks and obstacles in the development of games, as well as the interdisciplinary development of games in many other fields such as education, health care, environmental protection, etc[1]. Since then, Zyda has defined the concept, which is now widely accepted -- serious games are essentially puzzles that use computers as interfaces to connect games and other disciplines[2].

In 2003, International Game Developers Association (IGDA) activities director Jason Della Rocca in China Joy conference titled "Serious" games: The potential impact of the game on the society and economy, "the theme of the speech, he put the" serious games "is defined as" not for entertainment for the main purpose of the game ", and illustrates lots of serious games to support his opinion such as DOOM which is used to training the marines.

Environmental pollution, especially the pollution of rivers, has become an important problem that cannot be ignored by human beings in recent years. In this regard, we can use the form of serious games to advocate the classification of trash in rivers, to achieve the purpose of protecting the river environment. The game will educate people and sort trash through a distinctive interface and level design, as well as easy-to-use operations. At the same time, different types of trash will be designed specifically for different types of rivers to help people better understand the measures and

importance of trash classification.

In addition, the use of serious games as a vehicle to disseminate other scientific knowledge to people has also been widely used in recent years. By designing the knowledge we want to spread as game content, we can make it have a greater impact through the game, and it will be seen, played, and finally learned by more people. Our project will ultimately be a simple game, but it will cover a lot of knowledge about river environmental protection and river recycling, and it will help more people learn. At the same time, the use of The Unity engine also allows the game to become more mature and can be distributed on more platforms.

1.1. The characteristics of serious games

Serious games are a cross-boundary, interdisciplinary game application that uses elements of video games in a variety of related verticals, including design elements, digital technology, and other aspects of innovative game design. The goal is to combine different fields of expertise so that participants can gain knowledge or improve their skills through games, thus promoting the development of related fields. However, the essence of serious games is still video games, with the characteristics of video games [3].

At the Serious Games Summit in 2004 and 2005, most people at the conference defined a Serious game as:

1) Interactive technology applications that go well beyond the traditional game market, including personnel training, policy discussion, analysis, visualization, simulation, education, and health and medicine;

2) Can solve other problems such as training soldiers to adapt to a foreign culture, getting people to work as a team, and teaching children to understand the principles of science.

3) The 2012 App (Serious) Games Summit further defined the concept of serious games and app games. Prof. Fei Guangzheng, director of the Department of Game Design, School of Animation and Digital Arts, Communication University of China, and chief strategy officer of CSEDIAN Digital Technology Co., LTD., elaborated on the basic concept of application games, social value, how to promote application, design principles, and development mode. Fei believes that the application of games is not a serious game, but the expansion of the concept of games. The industry scope of the application of games does not stop at the entertainment industry but should be expanded to various fields and industries of knowledge dissemination, skill training, interest training, and other aspects.[9]

The conference defined serious games as something that we should focus more on in terms of function and form. For a serious game to be fun and engaging from the player's point of view. Imagine that if serious games were not fun and lost their character as games, the difference between serious games and books or other traditional forms of education would disappear and serious games would lose their meaning. The essence of serious games can be seen in two main antagonists: traditional games' approach and fun combine scientific mechanics and knowledge to amplify their influence; The other is to preserve the character of a video game without losing its entertainment.

Serious games not only retain the inherent attributes of games: playability and entertainment but also increase the meaning of their existence. Serious games exist not only for people's entertainment, so when we develop and produce serious games, we should also think more about the innovation of game modes and what advanced meaning the game itself can bring, rather than focusing only on the development of gameplay and entertainment.

Compared with the traditional education model, serious games give full play to its characteristics of high participation, enthusiasm, and immediate feedback as games, which is also an important reason why it has been widely used in various industrial fields[4]. At the same time, compared with

ordinary entertainment games, it has added some new practical functions, aimed at learning important knowledge and skills and solving some practical problems.

1.2. The necessity of river protection

Water resources depend on the existence of river channels, and water resources are also important natural resources, closely related to human activities. People need to protect water resources, and river courses are very important in the management, protection, and development of water resources. River courses can relieve the pressure of floods and play a great role in ensuring the safety of people living nearby. At the same time, the river, along with its water resources and various ecology, constitutes an important part of the earth's ecology and has nurtured numerous life for thousands of years. Aquatic life and land animals are closely connected by river channels. Together with nature, river, and water resources, human civilization and economic development have been supported. In short, river courses are of great importance because of their function and influence. [8]

At present, the main pollution of our rivers is organic pollution, among which trash pollution caused by human activities is one of the important reasons. Therefore, it is very necessary to collect and classify trash in rivers. For rivers in different environments, there are different types of trash, so we need to study and classify them.

1.3. Major problems and project tackles

1.3.1. The game engine.

The first problem is the choice of the game engine, because this is a serious game, besides the gameplay, we should consider the educational significance so that as many people as possible can receive the relevant knowledge from it. Therefore, the engine needs to have good compatibility, platform applications, simple and mature operation, and other characteristics. After careful consideration, we decided to use the current relatively mature technology Unity engine to produce this game.

The platform supported by Unity3D game development is undoubtedly a more popular platform at present. U3D's convenient multi-platform publishing features also make it one of the most cost-effective engines available.[10]

1.3.2. Gameplay.

The second problem is the gameplay of the game. Since our goal is to make the game accessible to the public, the gameplay should be simpler and more direct. Therefore, we will use mouse dragging as the main operation mode of the game, to achieve the purpose of being simple and easy to use. The simplicity of the game allows the player to focus more on the game itself.

In this project, players will drag different types of trash from rivers in different environments and put them in the right places (i.e. different bins) for recycling. If classified correctly will get the corresponding scores and included in the total score as a symbol of customs clearance, on the contrary, to collect fail increases pollution scores, rules of the game simple and clear, player base through the play can master the rules for the first time, which will concentrate more on our set rubbish type, learn how to the difference between different types of trash. There will also be different contingencies to help the player learn about other ways to go green.

1.3.3. Level design.

The third problem is the level design. For this serious game project, our main purpose is to teach people how to protect the river and how to separate the river waste, so the level design needs to pay more attention to its deeper meaning. We will design levels for different river environments, showing people what waste there is in each environment, and how to properly classify and dispose of it.

In different game-level designs, different types of trash are designed to support the level. For example, in the desert River level, the trash types are mainly recyclables and dry trash, which considers the types of trash that are likely to be present in the environment. In addition, the speed of trash flowing through rivers is different at different levels. The higher the level, the faster the trash flow, which usually requires the operator to have a higher level of operation. In short, the type of trash and the speed of the trash flow is the main differentiating factor in a level.

1.3.4. Visual design.

The final issue is visual design. Because we need both game effects and educational effects, we also need a sound audio-visual design for serious games. We will use simple but rich environmental characteristics of the painting style to decorate the scene of the game, reasonable visual design will increase people's willingness to play, to unknowingly improve the educational significance of the game. We also enhance the experience with appropriate background music.

In this project, the main menu view interface is divided into three sections, and different styles are applied to represent three levels: desert, village, and city. In each level, there are decorations that fit the character of the level and are applied to the game scene through simple modelings, such as desert levels with many pyramids and columns, and villages with trees and scattered houses. With sound music and a combination of visual and auditory, players can feel the characteristics of the environment for the first time, so that they can collect river trash with the background of the environment to increase knowledge.

2. Related Work

At present the global river pollution is increasingly serious, has become a big trouble that can not be ignored. Statistics show that every year around the world, more than 420 billion cubic meters of sewage is discharged into rivers and oceans, about 14 percent of the water has been polluted to some extent. Millions of tons of waste are dumped into rivers, lakes, and streams every day, according to the United Nations World Assessment of Water at the Fourth World Water Forum[5]. Each ton of waste-containing wastewater pollutes eight liters of fresh water, and only a handful of rivers around the world barely meet water standards.

The pollution of rivers and water resources is very harmful to human health. Every year, more than a billion people around the world do not have access to clean drinking water, and more than 25 million people die from unsafe drinking water. And there are many more hazards like this[5]. Moreover, the pollution of drinking water will greatly increase the possibility of people getting cancer and other diseases. Therefore, it is extremely urgent to educate people to protect rivers and water sources[5].

The main reason for water pollution in various countries and regions in the world is the population density and industrial development. Not only will these behaviors themselves pollute water resources, but their types and quantities will also have an impact to a certain extent. In addition, the non-standard and inefficient waste discharge will also pollute water resources. In recent years, according to the United Nations' annual World Water Day (March 21), there are still

more than a billion people in the world who do not have access to safe drinking water. Millions more die each year from diseases caused by water pollution. Tens of millions of people have been affected or even killed by water pollution or water shortage. If the status quo is maintained and no changes are planned, by 2025 more than 5 billion people will not have enough water, and more than half will be short of water. Because people drink polluted water, this is one of the main reasons people get sick and even infect.[5] Figure 1 shows a heavily polluted river.



Figure 1: River Trash

At present, this project mainly integrates the concept of river trash classification and recycling and river environmental protection into the framework of serious games through the Unity engine and simple operation. In addition, this project divides three typical river environments, namely desert river, village river, and urban river. Different kinds of trash and recycling methods are designed for different environments, which plays a role in publicity and education to a certain extent. In order to attract more people to the game, here's a look at gameplay, design concepts, and trash collection.

2.1. Gameplay and level

In the specific game flow, we will use the basic process of "Drag -- Classification -- Judgment" as the framework, as shown in Figure 2. In the game, there will be new trash that is consistent with the current environment, and the player will drag it to the right trash can for sorting and recycling. According to whether the classification is timely and whether the classification is correct, two different scores and winning and losing conditions are designed to make the game logic look simple and clear, and easy to understand.

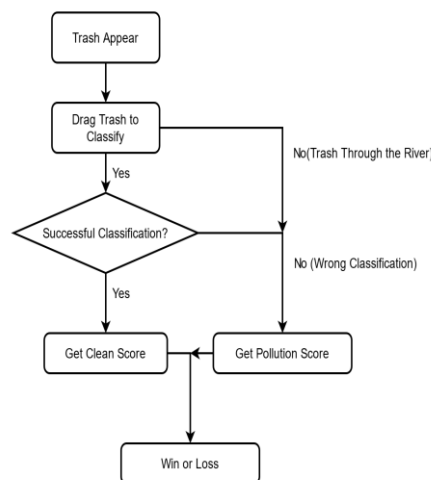


Figure 2: Basic Game Logic

2.2. Design concept

In terms of visual design, we designed a distinctive main menu for the project, which was decorated with a model in FBX format, so that players could intuitively see the characteristics of different levels. As shown in Figure 3, this is a map where we plan to divide the river levels into three different environments on the main menu. Players can select the rivers they want to learn about trash collection to enter the game.



Figure 3: Main Menu Modeling Diagram

According to the main menu design style, we will also design specific visual effects and corresponding trash types of levels based on these three environmental styles in the following specific levels.

2.3. Trash collection

Another focus of the project is the classification of the waste in the river, so the classification is very important. For trash classification, we refer to a classification method commonly used at present. This method divides waste into four categories: recyclable, dry, wet, and hazardous[6]. We will design detailed objects for each type of trash in the project and endow them with reasonable scenes, so as to better help people know and learn how to classify and deal with trash.

3. Design and Implementation

3.1. Design Goals

As can be seen from the above article, the problem of river pollution is becoming increasingly urgent, and the impact of river waste is one of the main causes of river pollution. Every year, a considerable number of people are affected by river pollution, thus putting their health at risk. For these reasons, it is necessary to educate people on how to recycle river waste and protect the river environment, which is the main purpose of our project.

Furthermore, education does not converge because different regions face different types of problems. In the case of river recycling, for example, there are different types of waste that need to be recycled in different environments, so people need to be told what kind of waste is produced in different environments and how to recycle it properly.

3.2. Design

Game design is designed to convey to the player what the designer wants, so designers often prefer a more logical approach to design so that the player can naturally understand the knowledge and information the designer wants the player to receive after playing the game. In a game named Genshin Impact, where water meets a large amount of fire and evaporates into steam, it is easy to understand this logic when the player first triggers it, thus delivering a message. The simpler and more direct the message is, the easier it is to be accepted by players, and the more likely it is to reach more people and expand its influence.

The main purpose of our project is to guide and educate people on how to separate and recycle river waste and protect the river environment through simple operation, mature engine, and distinctive presentation. Therefore, in terms of gameplay, we designed a rough schematic diagram of the game based on the above concepts. In terms of gameplay and education, there are multiple dimensions and standards designed to lead people to learn more about them and to achieve the intrinsic meaning of serious games

3.2.1. Visual effect

Designed according to the objective of educating people to recycle and protect rivers, we use the Unity game engine to design the main view shown in Figure 4 below. The circuit of the game is mainly the river, which includes various types of waste from one end to the other. On either side of the river are scenes that match the level style and trash type.

In addition, in the UI design above, we also try to use the UI panel that conforms to everyone's habits. Two buttons respectively represent the top left corner of the stop and return to the main menu. The button next to the score represents each level's cleaning score (victory) and pollution score (failure). On the interface's right side, there are several bins made to differentiate between different colors of bins and nameplates.

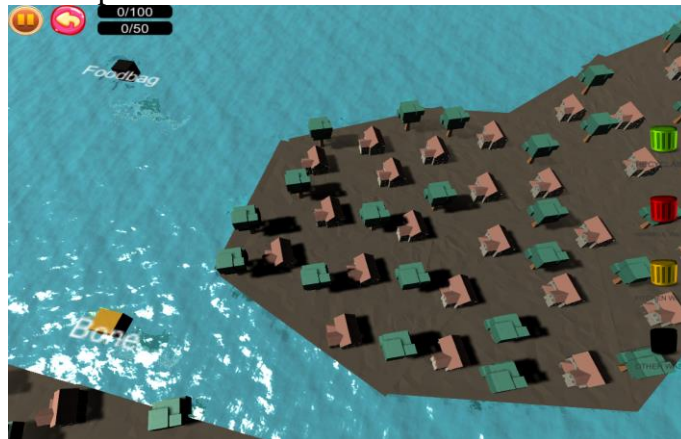


Figure 4: Level Main View

3.2.2. Score

In terms of game feedback, we designed two kinds of scores, one for completion and one for failure. One is the Clean Score, which is awarded for successfully recycling the corresponding type of trash. This score reaches a certain point to help the player complete the current level. The other is the Pollution Score, which is awarded for not collecting trash or putting trash in the wrong bin, and the current level fails when this score reaches a certain value.

3.2.3. Trash classification

After collecting trash, it is necessary to classify trash. In terms of trash classification, we will divide trash into four types: recyclable trash, dry trash (other waste), wet trash (kitchen waste), and harmful trash.

- *Recyclable trash.*

Recyclable trash refers to a kind of trash that can be comprehensively recycled to reduce pollution or save resources, including the following types: paper, plastic, glass, metal, and cloth, etc. The game is represented by green objects and trash cans[7].

- *Dry trash.*

Dry waste mainly includes some other types of trash beside the above, including ceramics, muck, toilet paper, fruit shells, and food bags[7]. This kind of waste is mainly disposed of by sanitary landfills. In this project, we will use black objects and trash cans to represent them.

- *Wet trash.*

Wet waste generally refers to kitchen waste, mainly including the following types: leftovers, bones, roots, and leaves of vegetables, peel, and other food waste[7]. Such waste is usually composted on-site, which produces a lot of organic fertilizer. In this project, we're going to use the yellow object and the trash can.

- *Harmful trash.*

Harmful trash usually refers to heavy metal substances, toxic substances that are harmful to human health, or the wastes that cause actual or potential harm to the environment. Mainly include battery, fluorescent lamp tube, light bulb, mercury, paint bucket, some home appliances, and drugs[7]. This type of waste is usually treated specially. In this project, we will use red objects and trash cans to represent them.

3.3. Implementation

In view of some design ideas and purposes in our project, using the corresponding functions of the Unity engine, our solutions are as follows:

3.3.1. Visual effect

On the visual side, the above design for the game scene and UI function buttons is almost implemented. With the river as the track, the scenery and decoration on both sides in line with the theme, and the objects representing trash that can let people get relevant information, such a fusion scene can well convey the knowledge of trash recycling in the river. The location and functionality of the UI also take care of most functional requirements, such as pause, return, scoreboard, and trash collection. And the style will be related to the level, the first level will be desert style, with pyramids and ruins. The second pass is village style, decorated with trees and a few small houses. The third is the town, which consists mainly of a large number of houses.

3.3.2. Score

Designing the score into two types of scores, indicating victory or defeat, allows the player to intuitively understand the mechanics of the game and what actions have what consequences. Designs that are clear and direct to the player's message are often more popular. At each level, the player will know if he or she is "doing the right thing" and when the current level is completed. A sample score is shown in Figure 5.



Figure 5: Score Logic

3.3.3. Trash classification

In the project, we divided the trash into four categories according to the above trash classification method and placed them appropriately in each level. In order to convey information simply, our trash was a cube in appearance -- with different colors and names.

By the way, in the previous article, we also mentioned the need to distinguish between levels, in addition to the types of trash, the speed of trash is also different in different levels. The more advanced the level, the faster the trash will be, which also reflects the design purpose of separating levels and adding challenge to the advanced level.

4. Results and Evaluation

4.1. Computer Hardware

This project is being run on a PC. We set the resolution as 1920×1080. After testing, this project can run smoothly and bring a good game experience. In addition, the project will display and run well at a 2:1 resolution, which will work well on most phone screens.

4.2. Level

According to our previous project plan, there was data for different levels. The first is the type of trash. In the three levels of the game, the type of trash appears as shown in Figure 6:

Level	Trash
Level 1	Recyclable trash & Dry trash
Level 2	Recyclable trash, Dry trash & Wet trash
Level 3	Recyclable trash, Dry trash, Wet trash & Harmful trash

Figure 6: Level Setting

The second differentiator is the speed of the trash flow, and obviously, the trash flow in levels 2 and 3 will be faster than the trash flow in levels 1.

4.3. Random

The next part is to complete the establishment of one or more random databases, which are used

to store some random events or items (mainly trash) that may be used in the game. Then, based on the characteristics of the game level, make a partial or overall decision, so that the events or objects can be used correctly in the game, in order to achieve the significance of its design. After the call, we still store the data in our random database, because the game needs to be played over and over again, so data storage is also important.

In addition to random incidents, there is also a part of the trash that should be random. You never know what kind of trash or what name it will be next. So the project made two random libraries, namely the randomness of the occurrence of trash categories and the randomness of the occurrence of species names within the categories. For example, the next type of waste to appear could be either recyclable or hazardous. Assuming that the next item is recyclable trash, it could be paper or cloth.

4.4. Feedback

The following part of the plan is to give feedback on the game's actions and determine whether the game wins or loses. Our games need to provide feedback on the actions of the game, which requires us to determine the actions of the game and anticipate the consequences of those actions. The behaviors in the project mainly include the right or wrong trash collection and the judgment of random events series. We can set behavior for the library, the different types of trash and the corresponding can do a binding, then as a correct action, and give it a tag 'correct', all the behavior of the points we were able to play on the label when players perform actions that will be combined with the corresponding points, as the behavior of positive feedback, We also plan to reinforce the feedback with possible sound effects for right and wrong actions. In addition, we will take the score as the decision condition to judge the game's victory and defeat. The scoring rules and feedback rules can be found in the Score section above.

4.5. Evaluation

The final version of our project achieved the following targets:

- Menu with the theme, you can clearly know the level characteristics.
- The trash can flow through the river correctly along the river, and the trash type can be called randomly.
- Trash can be dragged to a designated location for sorting and collection, and the corresponding type should be determined.
- The score is calculated correctly, and different behaviors should correspond to different scores.
- Random events can be generated correctly and generate feedback.
- Projects can try to help people become aware of river waste recycling and the corresponding classification of waste.
- Models can be generated and imported correctly.
- The UI layout can be reasonable, and the buttons and controllers should be used correctly.
- Levels can be able to connect correctly, and levels should have corresponding criteria.
- Visual and auditory representation can be consistent with the theme.

In summary, our project can achieve the above functions in varying degrees. Figure 7-- Figure 10 is a view of the main menu and three levels in the game project.



Figure 7: Main Menu

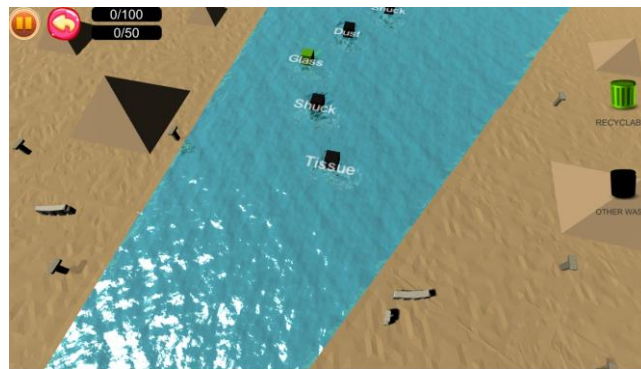


Figure 8: Level 1



Figure 9: Level 2

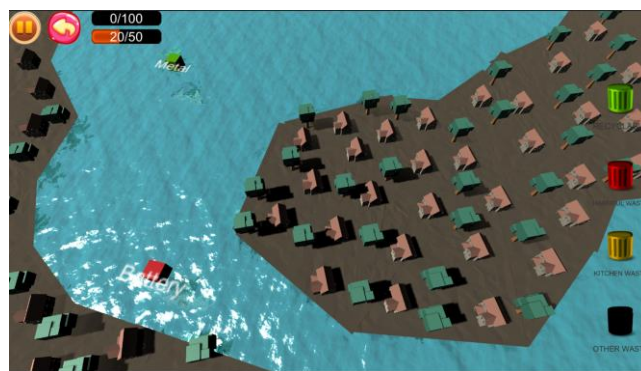


Figure 10: Level 3

5. Conclusion

This project mainly constructs the theme scene through the engine, combines the concept of serious games and trash sorting, and delivers the knowledge concept of game protection and trash recycling to the players. The player sees that trash can be collected and sorted with a simple drag-and-drop operation, and learns how to recycle trash. Combined with the generation of random events to enrich the content of the game, increase the educational significance.

In general, the project is designed to teach people about recycling and protecting the river environment, and to serve as many platforms as possible, so that more people can learn about it. The powerful functions and compatibility of the Unity engine can serve our project well. The operation mode and publishing platform can be well applied to PC, IOS, and other regular platforms, which can attract potential players. In addition to the operation and platform, we also set some metrics and methods for the specific gameplay, including UI layout, gameplay, levels, visual presentation, music, and many other aspects, and got relatively good implementation. At the same time, the introduction of random items and random events greatly increases playability, which indirectly helps players learn more about environmental protection.

References

- [1] Dan Pa. 2014. *Design and practice of surgery training game based on Unity3D*. Shandong University.
- [2] Jing Xie. 2017. *Research on the software interface design of virtual reality art*. *Contemporary educational practice and teaching research*, 2017(03), 45.
- [3] Xiaomei Hu and Tao Yu. 2012. *Distributed virtual reality technology*. Shanghai University Press.
- [4] Hongsheng Zhang. 2016. *Virtual reality technology and the development of the cultural industry*. *Media*, 2016(24), 13-15.
- [5] *Current situation of global water pollution and current situation of water pollution in China*. 2019. Available at: https://www.sohu.com/a/325692875_100236305
- [6] *Trash sorting - look at this, how do you sort trash*. 2020. Available at: <https://baijiahao.baidu.com/s?id=1674711158346463014&wfr=spider&for=pc>
- [7] 'What kind of trash are you?' *Do you know the classification of trash?* 2019. Available at: <https://baijiahao.baidu.com/s?id=1639401527163292013&wfr=spider&for=pc> Conference Name: ACM Woodstock conference Conference Short Name: WOODSTOCK'18
- [8] *The importance of river management*. Available at: https://www.sohu.com/a/249485244_651611
- [9] *Serious games don't have to be serious, and virtual reality is a promising prospect*. Available at: <https://www.vrp3d.com/article/overseasnews/1138.html>
- [10] *What are the advantages of developing games with Unity3d?* Available at: <https://blog.csdn.net/JtNbCOC8N2I9/article/details/78557144>