



# Design of Zoo 3D Roaming System Based on Unity3D Virtual Reality Technology

Yunchao Yang<sup>1a</sup>, Zhengheng Lu<sup>1b</sup>, Yan Xu<sup>1c\*</sup>

<sup>1</sup> School of Information Science and Engineering, Linyi University, Shandong Province 276000

<sup>a</sup>1834364017@qq.com, <sup>b</sup>2378614519@qq.com, <sup>c</sup>xy-jaki@163.com (Corresponding author)

## Abstract

With the improvement of people's living standards, there is a growing demand for zoo visits. In the case of the large-scale popularization of smartphones and tablet computers, relying on the innovation and entrepreneurship project of college students, a VR experiential zoo 3D roaming system has been developed. In this paper, we used Unity3D engine, 3DMAX software and C# language as development tools, and analysed the key points of VR zoo design and the implementation methods of key technologies around key links such as requirement analysis, overall design, technical implementation, and testing and result analysis. The test results show that users can achieve better interactive effects and immersive experience only by using related devices. The development of 3D virtual zoo will open a new era of zoo display, which has certain economic and social value.

**Keywords:** *Unity3D; virtual reality; 3D zoo; roaming system design.*

## 1 INTRODUCTION

Today, zoos have become a standard part of cultural and recreational facilities in many major cities. However, with the normalization of epidemic prevention and control, the reservation system has also become a normalized management method for attractions. Due to the limited area of some zoos, it is difficult to expand the capacity, and the number of people making reservations is also limited, so people cannot enter and leave the zoo at will. Due to environmental factors, human factors, etc., many animals in the zoo are in a state of daze and lack the spirituality they deserve. When the children greeted zebras and ostriches in unison, the animals were dull-eyed and unresponsive. When people try to get the attention of tigers and lions by waving their hands or even holding food, they turn a blind eye, and when we look forward to finding our favourite animals, we find that they are also listless.

Virtual reality technology can be traced back to the mid 20th century [2], and it was originally a flight training simulator developed to reduce the cost of initial pilot training. With the rapid development of modern graphics technology, the development of virtual reality technology has officially entered the fast lane, and is widely used in medical, military, time-travel, military aerospace, games, education, automobile maintenance and other industries. Virtual reality technology is an

important direction of computer simulation, which integrates various technologies such as computer graphics, digital image processing, human-computer interaction technology, and sensor technology. It is a relatively complex cross-technology [1] [8]. We can use the computer to develop a virtual zoo roaming system with this technology, which effectively simulates the various behaviors of living creatures in the natural environment and builds a simulated zoo. Users can immerse themselves in the environment through related equipment to achieve the purpose of a real zoo visit.

The virtual zoo roaming system we developed allows users to experience the various poses and growth environments of animals through VR video and human-computer interaction. Compared to traditional 2D images and videos, VR has the advantage of allowing people to have a deeper understanding of the relationship between humans and nature while staying at home. The unique charm of VR can also be substituted into schools and communities, so that different groups can enjoy the new experience of combining VR technology with nature and animals without leaving their homes [3] [6].

## 2 DEMAND ANALYSIS

The virtual zoo system is mainly to meet the market progress and governance needs of zoos in the new era, and to further improve the quality of tourists' parade

experience. At present, with wide spread of smart phones and tablet computers, in order to keep up with the pace of "Internet +" in the progress of the zoo, according to the following survey, the development purpose and audience of this system are clarified.

(1) *The Needs of Zoos*. Based on the development needs of the zoo market, the 3D virtual zoo can enrich the display of the animal resources and strengthen the promotion and publicity of the park. In the past, zoos mainly relied on traditional media for publicity and promotion. Now, for zoo managers, if they choose to develop a virtual zoo system, and enter the WeChat platform, they can make the virtual zoo system get more attention from users through various channels and expand their brand influence. Every zoo will encounter some tourists overfeeding the animals or littering by the animals, which sometimes has serious consequences. Through the virtual zoo platform, visitors can feed or interact with the animals in a similar way to the game. This will prevent visitors from interacting directly with the animals, reduce the risk of occurrence, and also reduce the amount of work for zoo officials to correct bad behaviour of visitors.

(2) *The Needs of Tourists and Users*. Improve the cruise experience of modern tourists. In the context of the normalization of epidemic prevention and control, the 3D virtual zoo overcomes the boundaries of time and space, and carries out three-dimensional virtual display of the zoo according to the real scene. Tourists can visit the zoos in their spare time without leaving home. In China, the distribution of zoos is uneven, and mainly concentrated in first- and second-tier cities. Unbalanced resources are extremely detrimental to scientific research, especially popular science education for primary and secondary school students. The development of the VR zoo roaming system compensates for this shortcoming. With the help of VR technology, students can visually display the images of animals that they do not see in daily life, which can help improve cognition and understanding.

### 3 OVERALL DESIGN OF THE SYSTEM AND REALIZATION OF KEY TECHNOLOGIES

The system primarily used on-site zoo scene shooting to collect data, used 3DSMAX, Unfold3D and other software to model and process the model, and used Photoshop to process the model material map. We imported the model into the Unity engine for integration and related components, used UGUI to design UI interface and realize UI functions, wrote relevant scripts to realize human-computer interaction functions, and finally tested and released. The process of system development is shown in Figure 1.

#### 3.1 System Development Process and Main Functional Modules

The virtual tour system is a kind of virtual environment that can integrate vision, hearing and feeling. It can simulate the virtual space in real time, and users can browse, observe and interact with virtual objects from any angle. The main design scheme of the system is that users can control specific 3D scenes through various hardware devices. The main system function modules are shown in Figure.2.

When navigating the virtual zoo system, users can talk to these animals in places such as lion houses and panda houses, and even play games with them for close contact, which is not possible in traditional zoos. Even with the increase of animal models, players can experience extinct dinosaurs or other creatures, and also learn some biological knowledge while playing, truly integrating education and entertainment.

#### 3.2 Program implementation key technology

##### 3.2.1 Scene UI design

For the UI (interface) in the scene, we used the GUI system of the unity3D system to design, in which two touch buttons were designed in the main interface, as shown in Figure 3.

In the main scene, the GUI mainly has the third view, manual walking, setting, and return. Among

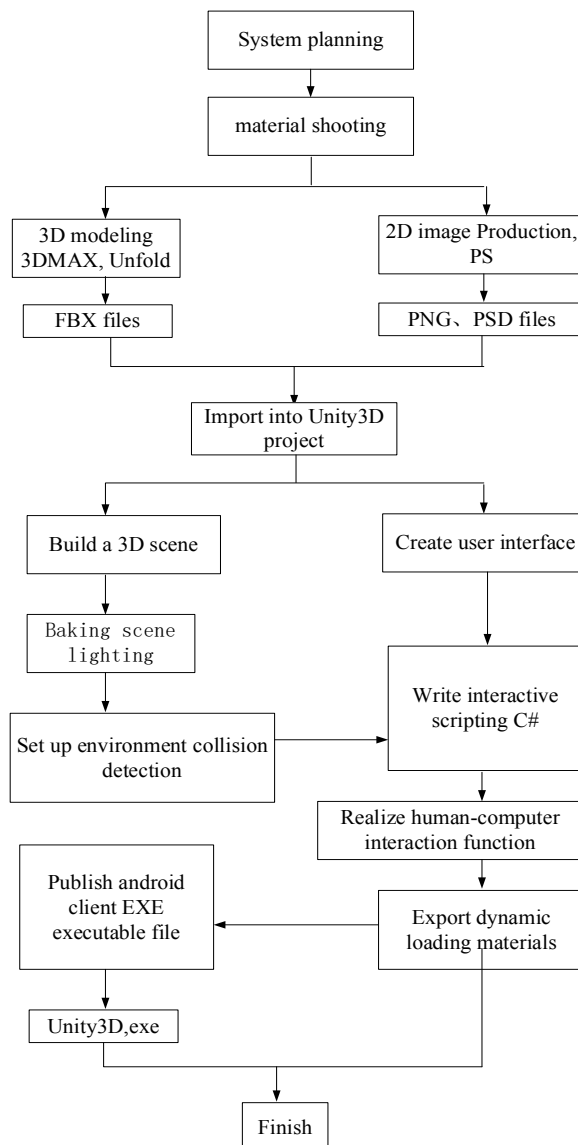


Figure.1 System development flow chart

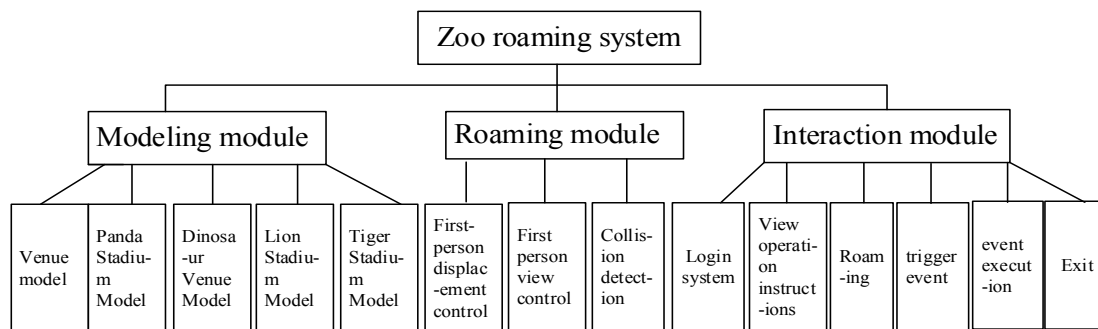


Figure.2 Design of system function module



**Figure.3** The zoo entrance scene

those, the "third view" is the change of the camera's own coordinates, which is the conversion of the scene into the first angle of view tour and the third angle of view tour. The main codes of view transformation are as follows:

```

void LateUpdate()
{
  If (target==null)
  {
    return;
  }
  // Set the float when switching views
  wantedHeight = target.position.y+height;
  currentHeight = transform.position.y;
  currentHeight= Mathf.Lerp(currentHeight,
    wantedHeight, heightDamping *Time.deltaTime);
  transform.position=target.position;
  transform.position=Obj.transform.rotation*Vector3.
  Forward*distance;

  transform.position = new
  Vector3(transform.position.X, currentHeight,
  transform.position.z);

  transform.parent=target.transform;
}
void OnGUI()
{
  GUI.skin=guiskin;

```

```

if (GUI.Button(new Rect(770,580,80,40),gui))
{ if (type==1)
  { type=2;
    gui=" the first angle of view";

```

```

}
else
  { type=1;
    gui=" the third angle of view";
  }
if (type ==1)
  { distance=0; height=2;
  }
else
  { distance=9; height=3;
  }
}
}

```

Where, the parameter "distance" is to set the distance between the camera and the characters, and the "height" is to set the height between the camera and the characters, and the first and third views can be changed by clicking the button. The "Manual Walk" button mainly controls the way the character walks, while the "Auto Walk" button allows the character to walk automatically through a pre-designed route. The "Settings" button is mainly to control the volume, and the "Return" button is to return the current scene to the main interface of the system. Figure.4 is the first view of entering the Panda Pavilion, and Figure.5 is the first view of entering the Giraffe Pavilion.



**Figure.4** Panda Pavilion scene



**Figure.5** Giraffe Pavilion scene

### 3.2.2 Character animation and character walking control

In the process of 3D software development, it is impossible to avoid using an animation system. If you simply use physical displacement for animation, it will often make various movements appear stiff and unrealistic. The character animation in the VR Zoo is mainly divided into two categories, one is the actions of various animals, such as roaring of lions, pandas eating bamboo and dinosaurs stretching their necks; the second is the "tour guide" who plays the role of route guidance and introduction in the zoo visit. Whether it is animal animation or character animation production, on the basis of creating models, through 3DMAX software's skeleton creation, skinning, weight drawing, controller binding, key frame animation, curve editor and other links, we created realistic and smooth animation. We exported the FBX file with animation information from 3DMAX and imported it into Unity3D to create and configure the avatar, Animator Controller and Blend Trees for the character, thus laying the foundation for the playing of character animation. For the triggering and interaction of character animation, it is mainly implemented through C# script and UI interface.

The automatic walking of the characters is mainly carried out by unity3D plug-in iTween. iTween is an animation library, which aims to achieve maximum output with minimum input and make development easier. The core of iTween is numerical interpolation. You give iTween two values (the start value and the end value) and it automatically generates some middle value.

### 3.2.3 Human-computer Interaction

Human-computer interaction, as the name implies, means that clients and machines can exchange information and control data, and control various events

in the application program according to the subjective wishes of the user. The human-computer interaction module is mainly used by programmers to set various trigger conditions for various events and control various actions in the scene with the help of basic GUI controls in Unity3D. It mainly realizes the interactive functions of players in character selection, scene switching, video playing, and audio adjustment and so on. The interactive interface design of the VR zoo mainly includes the main interface, selection dialog box, guide arrows, etc. With the help of peripheral devices such as VR helmets, VR controllers, and VR glasses, users can realize scene switching, visiting mode selection, action triggering, animal selection and other functions, bringing them a more immersive and humanized interactive experience [4] [5].

For the design and implementation of the interactive interface, this system mainly used the UGUI of the Unity3D engine for UI interface layout and aesthetic design, and used C# scripts to achieve dynamic interaction. For example, in the production of guide arrows, first we used PS software to draw the "arrow" graphics, then created the "Image" control of the Unity engine UGUI system, and dragged the created arrow graphics file to "Source Image". In this way, you can see how the created "arrow" appears in the scene [7]. The "arrow" plays a guiding role in navigation in the scene roaming. In order to strengthen the guiding role of the "arrow", the C# language can be used to realize the resizing and flickering effect of the "arrow" [6].

## 4 PRODUCT RELEASE AND TESTING

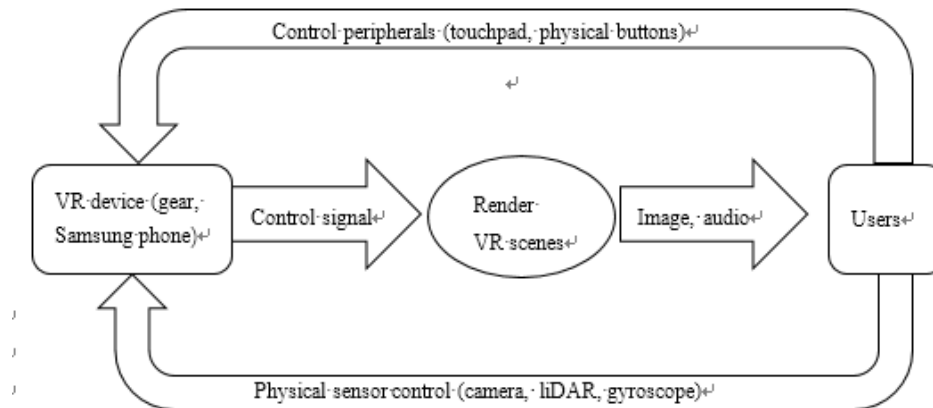
The platform released in this project is the Android platform, and the corresponding SDK version uses the API of Android 5.0. Of course, it is possible to use a higher API version, because the SDK of android devices is backward compatible.

In Figure.6, the physical sensor can form various digital signals, including the rotation angle collected by the gyroscope, the rotation direction, the motion acceleration collected by the acceleration sensor, the contour of the surrounding environment collected by the LiDAR, etc. After converting these physical data into data signals, the VR device can change the external parameters into the parameter information perfectly rendered into the 3D scene through the CPU, GPU, audio, screen, and control the switching of the visual angle in the 3D scene, the position movement of the scene

**Table 1** Hardware test environment comparison table

Type	Version	CPU	ROM	Operation
Samsung Galaxy F52	Android 11	Adreno619 Eight-core	128GB	works perfectly
Huawei Enjoy 10	Android 9.0	Mali-G51-MP4, Eight-core	128GB	works perfectly

According to the test results of the VR zoo roaming system, all functional tests meet the expected results, which fully confirms the usability, stability and security of the developed VR zoo roaming system.

**Figure. 6** Schematic diagram of system implementation scheme.

## 5 DISCUSSION AND CONCLUSION

In this paper, we have completed the development of the "3D virtual zoo roaming system" from the aspects of demand analysis, design ideas, system requirements, functional design, and arrangement of park contents. The expected system architecture and functional design have achieved preliminary results. The zoo in the system is digitally modeled and virtualized with multiple elements; it has completed the free movement of the controlled characters in the zoo park, simulated some near-real actions, such as leaping, eating, wandering, foraging and other gestures; and simulated the real weather conditions, such as a situation where the sun is shining brightly. Users can interact with animals by touching the interface of the mobile terminal.

Virtual reality roaming technology is a comprehensive computer technology that is widely used. It uses computers to create realistic virtual environments, and makes users feel presence through roaming and interaction. In this paper, we use 3DMax and Unity3D tools to achieve a 3D virtual zoo roaming system, which shows the scene of the zoo in reality. It breaks the single function of real display and can meet more needs of users. Meanwhile, it further enhances the popularity of the zoo by spreading entertainment culture. With the help of the Internet platform, the virtual zoo roaming system has built a bridge to the physical zoo for potential tourist

groups, which can not only popularize the knowledge of various animals (especially wild animals), but also be used for simulation training teaching. The 3D virtual zoo roaming system can achieve virtual expansion, breaking through the limitations of space and even time, and the types of animals and the experience of visiting the park have become infinitely richer.

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