Research and Application of Water Simulation Method Based on Unity3D

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Abstract

With the acceleration of urbanization and the frequent interventions of human activities, the environmental problems of cities and their water bodies are becoming more and more serious. Lake water environment management and ecological restoration have become a hot and difficult problem all over the world. The three-dimensional visualization simulation technology of lakes is one of the key technical means to establish "digital lake", which can provide an intuitive visualization platform for informatization management and evaluation and decision-making of cities and lakes, so it has important practical application value. At the same time, the rapid development of virtual reality technology, but also for urban roaming and water simulation system to provide technical support and protection. Based on the computer virtual reality technology, this paper constructs a three-dimensional platform of urban roaming and water simulation with scene switching function and a certain human-computer interaction capability by deeply studying the 3D wave simulation technology and Unity3D scene construction technology. In this paper, the construction of urban roaming and water simulation system as the focus, mainly completed the following aspects of the research content and results of the target area of the building and lake environment analysis, collection of modeling data; Unity3D based on the Water module to achieve the water Three-dimensional simulation, simulation of realistic lake wave effect. Based on the method and theory described in this paper, a city roaming and water simulation based on Unity3D was established to visualize the terrain and topography of a certain area and its surroundings, and provide multi - level scene roaming for the decision maker and manager to provide intuitionistic Display platform and related technical support.

Keywords

virtual reality; urban roaming; water simulation; Unity3D.

1. Introduction

Computer 3D visualization technology as an important means of virtual reality, in recent years has developed rapidly. Based on the application and expansion of this technology, military, meteorology, aerospace, manufacturing, medical, tourism, agriculture, urban planning, virtual tourism, education and training, environmental protection, computer network, digital earth, geographic information services and so on have been huge development of. All areas are more intuitive and real way to get people to re-understand and understanding, thus contributing to the rapid development of applications. This paper focuses on the application of the technology in urban roaming and water simulation, which provides intuitive display and technical support for the research and protection of the city and its lake environment.

Computer visualization technology is a popular research direction in recent years, and has a wide range of application prospects in various fields. At present, the three-dimensional graphics technology in military, aerospace, aviation, medicine, geological exploration, three-dimensional games and so

has a very wide range of applications. 3D rendering engine is an important support to achieve three-dimensional graphics technology, after years of research and development, Unity3D as a game engine, with its powerful cross-platform features and brilliant 3D rendering effect gradually get attention and use, this article through the three-dimensional visualization Display, modeling and simulation, the urban environment and urban lakes in a more intuitive way to show to the decision makers and managers, the real reproduction of the reality of the scene, to help the technical staff intuitive view of the simulation results, providing urban roaming and water simulation Of the three-dimensional visual display platform.

2. Introduction to Unity3D

Unity is a 3D platform next generation game engine, the game engine with its powerful cross-platform features and brilliant 3D rendering effect is famous. Unity takes a completely closed source form, making the engine safer and effectively protecting the engine's intellectual property. It has many features such as integrated editing, graphics engine, resource import, one-button deployment, shader, terrain editor, networking, physical effects, audio and video, script, Unity resource server. Most importantly, Unity3D cross-platform features. Unity3D for users to solve the problem of differences between platforms, reducing the platform factors to the developers of the trouble. However, due to the different hardware conditions of the platform, such as PC hardware conditions will certainly be stronger than the mobile platform, so developers need to do a different platform for a choice.

3. Development of Three - dimensional Modeling of Water Body

The current three-dimensional water modeling, in fact, are basically the surface of the modeling. To achieve this model, we generally use two methods.

First, we use the familiar three-dimensional modeling software, such as Sketch Up, 3DMAX, etc., first draw the surface, and then use the image processing software to get the water wave picture, and finally deal with a good watermark material to draw a good surface , Get the initial modeling of the water. Demonstrate the model as a 3D model supported by ArcGIS and cover it over the surface to complete the modeling work on the surface.

The second, through ArcGIS to draw the vector surface, and the vector surface of the filling pattern changed to water, and then cover it on the surface above.

This modeling method is relatively simple, but the flaw is that it can not reflect the water data with the depth of the water changes, can not show the state of water spray.

4. Discussion on 3D Modeling of Water Body

Water three-dimensional modeling according to different needs have different ways. Basically, the three-dimensional modeling of water body there are three different needs, one is only abstract to become a surface covered with a surface, only as a landscape needs, called the reward needs; taking into account changes in water layer factors, the water Abstract for the three-dimensional body, called the body needs; taking into account the role of natural wind and other needs, the need for water abstraction called the movement of the water, called the demand for power.

From the current situation of 3D modeling of water body, the current three-dimensional modeling of water body is mainly reward demand, with the improvement of technical level and the development of water conservancy information construction needs, the latter two needs are getting more and more attention.

The following will introduce several major three-dimensional modeling of water bodies.

(1) Water wave modeling method based on physical model The basic idea of water wave modeling based on physical model is to find the physical mathematical model of water wave adaptation, and then to solve the water wave physical model, through a series of mathematical approximation and calculation simplification , With the mathematical laws of the law to constrain the movement of water waves, and then use the computer graphics method to simulate the shape of the object rendering, and

can guarantee the real-time performance of water wave rendering. There are three common methods for mathematical modeling of water wave modeling: Navie-Stokes equations for hydrodynamics, mathematical models of ordinary differential equations, and hydraulics equations. Although the method based on the physical model is more extensive, but the calculation of high cost and complexity, for a large area of water waves can not achieve the effect of real-time rendering.

(2) Based on the wave analysis method Based on the wave analysis method The waveform surface is directly constructed by the waveform function formula to construct the surface of the water wave. That is to say, this type of method is used to analyze the properties of the simulation wave, Rendering the water droplets dripping into the water surface of the formation of vibration waves, as well as in the wind field environment formed by the surface of the water ripples and other short peaks. Waveform function has the properties of wave, in general, the use of superficial sine cosine function to represent the surface of the water wave, you can also use a more advanced waveform function to achieve more realistic wave rendering. Simple sine wave stack as follows:
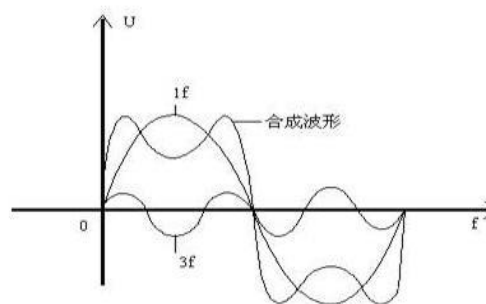

Figure 1. sine wave superimposed graph

Using the cosine wave to simulate the water waves, the effect will appear very much like a cloud roll, the effect of superimposed after the beginning of the water wave model, but can not meet our visual requirements.

(3) Method based on particle system model The general idea of using water particle wave modeling method of particle system model is to think of water wave as a particle group and have certain attributes including color, size, transparency and so on. Physical mathematics under the rules of movement. In the rendering rendering, the particles can be used as a point set to represent the shape of the water wave; can also be seen as the shape of the water particles by the irregular structure of the surface. This kind of method regards the water wave as a discontinuous particle system, and under the condition of particle characteristics, it is successful to virtualize the render effect of water and wave.

The basic principle of the particle system model is to use the specific trait, the specific size, the massive large number of tiny particles as the basic rendering unit, in the specific mathematical physics equation, generate three-dimensional graphics effect to describe the water wave. For the general model of the particle system to simulate the case of water waves, the main consideration is the water particle properties, including shape, size, etc., the use of the class can be used to define.

The particle system model is suitable for the rendering effect of the wave of water waves, which can model the irregular motion such as water waves, but the limitation of the particle system makes it impossible to achieve the effect of rendering smoothness. And does not apply in the process of large-scale water wave three-dimensional rendering.

(4) Modeling method based on statistical wave model The basic principle of statistical wave model is to combine a series of different frequency, phase, amplitude sine wave and cosine wave into a height field wave of water wave, that is, As a result of a large number of different frequencies, different phases, different amplitude of the sine cosine wave superposition of the results. In this way, we can directly establish the mathematical model of water wave, that is, FFT-based water wave modeling method, through the fast Fourier transform FFT to obtain the amplitude value in the Fourier

domain, the amplitude value has a very typical mathematical statistics, Data calculation and processing.

However, taking into account the three-dimensional display of the whole city lake, the three-dimensional effect of the water body and the urban building three-dimensional model in the same scene compatibility, we seek a kind of More convenient and efficient three-dimensional simulation of water bodies.

5. Simulation of Water Wave Based on Unity3D Water Module

The most basic requirement for the three-dimensional modeling of water bodies is the display of the fluidity of the water, and secondly, it is possible to reflect the images of the sky and the shore on the basis of the true calm water, and to exhibit certain particle effects such as water. The production of water in the three-dimensional scene is mainly through some technical means to describe the flow of water, reflection, refraction and particles and other characteristics, in order to better show the scene of the water effect, we as much as possible to describe these characteristics.

The Water module in Unity3D is well suited to meet the needs of urban water wave simulation effects. Its parameters cover the grid size of the Fourier transform, the wind field data, the water depth, the reflection and refraction of the water, the wave size and the spray And other factors.

Vector4 waveSpeed = mat.GetVector("WaveSpeed");

float waveScale = mat.GetFloat("_WaveScale");

Vector4 waveScale4 = new Vector4(waveScale, waveScale, waveScale * 0.4f, waveScale * 0.45f);

double t = Time.timeSinceLevelLoad / 20.0;

Vector4 offsetClamped = new Vector4(

(float)System.Math.IEEERemainder(waveSpeed.x * waveScale4.x * t, 1.0),

(float)System.Math.IEEERemainder(waveSpeed.y * waveScale4.y * t, 1.0),

(float)System.Math.IEEERemainder(waveSpeed.z * waveScale4.z * t, 1.0),

(float)System.Math.IEEERemainder(waveSpeed.w * waveScale4.w * t, 1.0)

);

mat.SetVector("_WaveOffset", offsetClamped);

mat.SetVector("_WaveScale4", waveScale4);

Vector3 waterSize = renderer.bounds.size;

Vector3 scale = new Vector3(waterSize.x*waveScale4.x, waterSize.z*waveScale4.y, 1);

Matrix4x4 scrollMatrix = Matrix4x4.TRS(new Vector3(offsetClamped.x,offsetClamped.y,0), Quaternion.identity, scale);

mat.SetMatrix("_WaveMatrix", scrollMatrix);

The above code through the Unity 3D engine, such as Vector3, Vector4, Matrix4x4 and other three-dimensional vector, four-dimensional vector, transform matrix and other functions to achieve the flow of water effects and wave effects. double t = Time.timeSinceLevelLoad / 20.0 is the random transformation formula with time variation of water wave velocity. After several tests, it is set to 20, and the flow effect and wave effect produced by the water surface are more realistic.

Figure 2. Based on Unity3D Water generated wave effect

The optical behavior of the surface of the water body is very complex, and in the rendering of water waves, the effect of light simulation is affected by light reflection. Through the study of the optical behavior of the surface of the water wave, we can realize the reflection and refraction effect of the water surface.

In the ideal case, the surface of the water wave is a nearly perfect mirror reflection surface, with typical reflection and transmission characteristics. Of course, in some cases, the surface of the water wave does not exhibit the effect of a specular reflector, especially when the surface of the water wave reflects the solar direct light is particularly prominent, at this time from a relatively far distance can be observed in the water wave reflected light dispersion effect. The general effect of the water mirror will make the reflected light showing a sparkling visual perception.

Unity3D water body reflection and refraction effect is mainly through the texture rendering and add auxiliary camera to achieve, described as follows:

```
if( mode >= WaterMode.Reflective )
{
if( !m_ReflectionTexture || m_OldReflectionTextureSize != m_TextureSize )
{
if( m_ReflectionTexture )
DestroyImmediate( m_ReflectionTexture );
m_ReflectionTexture = new RenderTexture( m_TextureSize, m_TextureSize, 16 );
m_ReflectionTexture.name = "__WaterReflection" + GetInstanceID();
m_ReflectionTexture.isPowerOfTwo = true;
m_ReflectionTexture.hideFlags = HideFlags.DontSave;
m_OldReflectionTextureSize = m_TextureSize;
}
reflectionCamera = m_ReflectionCameras[currentCamera] as Camera;
if( !reflectionCamera ) // catch both not-in-dictionary and in-dictionary-but-deleted-GO
{
GameObject go = new GameObject( "Water Refl Camera id" + GetInstanceID() + " for " + currentCamera.GetInstanceID(), typeof(Camera), typeof(Skybox) );
reflectionCamera = go.camera;
reflectionCamera.enabled = false;
reflectionCamera.transform.position = transform.position;
reflectionCamera.transform.rotation = transform.rotation;
reflectionCamera.gameObject.AddComponent("FlareLayer");
go.hideFlags = HideFlags.HideAndDontSave;
m_ReflectionCameras[currentCamera] = reflectionCamera;
}
}
```

The above code shows the basic principle of the reflection process of the three-dimensional water body and the setting of the reflection camera, and realizes the reflection effect of the water surface, and the water refraction effect is basically the same as the reflection effect realization principle.

Through the above operation, we use Unity3D Water module to perfect the three-dimensional water flow, wave, reflection and refraction characteristics, to meet the urban lake water simulation needs.
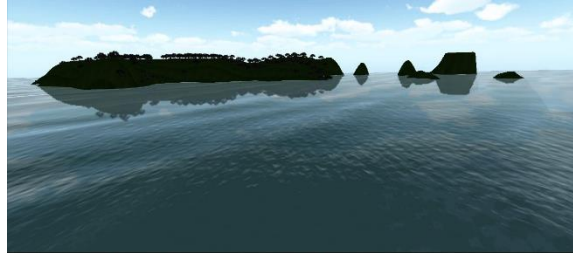
Figure 3. shows the effect of water reflection

6. Summary of this chapter

In this chapter, the present situation of water body simulation and the modeling method are discussed. In view of the reality, the water module of Unity3D is used to simulate the water body, showing the flow, wave, reflection and refraction characteristics of the water body, and the water environment Wave simulation.

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