A New Method of Virtual Reality Based on Unity3D

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Abstract—In the area of geographic information system, there are always two methods to get 3D virtual reality, one is to use a 2D professional platform such as ArcGIS software to get the virtual reality by secondary development, the other is to use a 3D or 2.5D software as a platform for development, such as the Skyline software. In this paper, we will use a different platform, Unity3D, which is usually treated as game development software, as a virtual reality development platform. Firstly, the hierarchical approach of geographic information system is adopted in the study area, and the area is divided into four layers: Terrain Layer, Building Layer, Transport Layer, Vegetation Layer, additionally, the raw data of Terrain Layer is obtained by GPS measurements. Secondly, all the geographical entities which related to different layers are converted to 3D model by AutoCAD and 3dsMax software. Thirdly, the 3D models are imported into the Unity3D, and programming with Javascript language in Visual Programming Language Editor in order to achieve Gameobjects and Scenes. Lastly, the Scenes are integrated and published on the network. The attribute data of study area is stored by MySQL which is connected with Unity game platform by external interface. Visitors can download the ActiveX control to browse the study area, the scene is keep on updating 60 times per second, the viewer will subconsciously input and immediately immersed in the virtual scene for spontaneous exploration and observation. With a full range of personalized mode of operation, the users can choose their own way to browse and participate in the virtual reality, and give full play to their imagination according to their own wishes without affecting the others by using the designated keys on the keyboard.

Keywords—Virtual Reality; Unity3D; GIS

I. INTRODUCTION

Virtual reality (VR) is a technology which allows a user to interact with a computer-simulated environment. Michael Heim(1994) identifies seven different concepts of virtual reality[1]: simulation, interaction, artificiality, immersion, telepresence, full-body immersion, and network communication. Now virtual reality is widely used in industry and public service with its intuitive visual and simple operation.

Unity3D is one of the most famous virtual reality tools, it is cross-platform game development software, and now besides Mac OSX, Unity3D can fully support WindowsXP/Vista/7, Unity3D supports three scripting languages: JavaScript, C#, and a dialect of Python called Boo. All three are equally fast and interoperate, and can use the underlying .NET libraries which support databases, regular expressions, XML, file access and networking. Scripting is frequently thought of as limited and slow, but in Unity3D scripts are compiled to native code and run nearly as fast as C++. It is easy to get the fast iteration times and ease of use for someone who likes scripting languages. These three languages in game development projects can also be mixed-use. Unity3D also supports the Windows platform, C#, VB.net, VB6, Delphi and other programming languages. The Unity3D game engine and the Unity3D development environment are tight integrated, so it provides a very powerful visual editor and language levels of the network.

In this research, we use Unity3D as the development platform for virtual reality. The study area is the campus of Henan Institute of Urban Construction, Pingdingshan, China, with an area of 1,066,667m², ranging from 33°46'11"N to 33°46'42"N, 113°10'52"E to 113°11'36"E.

II. FRAMEWORK AND IMPLEMENTATION

A. Framework

Browser-Server three-tier architecture VR-based framework is designed in the research area and including 3 layers: presentation layer, logic layer and data layer [2].

1) Presentation layer is mainly used for interface display and to achieve the user's query.

2) Logic layer consists of web server and application server [3]. Workflow of Logic layer is as follows: a) Web server receives the user’s HttpRequest which send by the browser; b) request is passed to the application server; c) application server convert the HttpRequest into the statement that database can identify; d) sending the request to query in the database; e) When the query is complete, the query result sets are returned to the application server; f) application server analyze and process the result sets; g) sent the result to web browser by web servers; h) download the three-dimensional scene files that user requests from Presentation layer; i) show a virtual three-dimensional scene by a plug-in which embedded in the browser.

3) Data layer includes the related spatial data and attribute data, such as DEM data.
B. Implementation

In this study, the hierarchical approach of geographic information system is adopted, and the study area is divided into four layers: Terrain layer, Building layer, Transport layer and Vegetation layer. Figure 1 shows the details of the layers in study area.

![Figure 1. The details of the layers in study area](Image)

In the virtual reality system, Two-dimensional maps are used as base maps in 3D scenes to express the geographic entity’s three-dimensional location information. 3DsMax and other software are used to create three-dimensional models of features in the study area. Three-dimensional models need to add texture and attribute information. Textures which collected through outdoor jobs can truly reflect the surface features of geographic entities. After processing by tools such as Photoshop, textures are imported into 3Ds Max to integrated with models. All the models are placed on the Terrain Layer, and then, combined with geographical location and attribution information to generate a complete virtual three-dimensional scene. Unity3D is used to edit and optimize the scenes in order to have a realistic environment and to achieve the best visual display by maximize the amount of data.

Overall, there are two kinds of works: one is the works outside Unity3D, including models, animations, textures, sounds and GUI graphics; the other is the works in Unity3D, outside Unity3D, including models, animations, textures, display by minimize the amount of data.

III. WORKS OUTSIDE UNITY3D

A. Data Collection

There are two kinds of data we need in the study: spatial data and attribute data. The data was collected from three sources:

- The terrain maps which scale is 1:500, obtained by GPS.
- Two-dimensional maps of the study area including architectural design maps and design sketch that the research area previously saved.
- Texture of roads, lawns, trees, public facilities, buildings taken by camera from different angles.

B. Modeling

Modeling is an important piece of the visual reality system. The choice of modeling system dictates what type of geometry will appear in the system. For the virtual reality system to be successful, the modeling system is better to be completed and in place early in the development process. The main tools for modeling are 3Ds Max and AutoCAD [4].

The virtual reality environment consists of roads, lights, traffic symbols, trees, buildings and so on. It is essential to build fine, sophisticated models of every real object which will be placed in a virtual field. The precise geographic location, attribute information and models of geography entities are needed for achieving good quality objects of scenes [5].

1) Terrain Layer: First of all, terrain information of geographic entities should be determined. As situations are different, different approaches are taken to get the information about terrain. Figure 3 shows the Logical sequence to get models of terrain layers.

With the promotion and application of Google Earth, it provides a lot of high-precision images and elevation information.

If the resolution in the study area meets the requirements of the terrain, we can directly access the high resolution terrain information from Google Earth by using a tool named Google SketchUp 6.0. With the help of Google SketchUp 6.0, the three-dimensional terrain information of study area can be saved as .3ds format, so as to communicate with 3Ds Max.

Else, if the resolution can’t meet the needs, we can get the terrain information by field measurement. In this research, we use GPS to measure and obtain high resolution terrain information of the study area. Then the data obtained by GPS, which format is .dat, imported into AutoCAD software to generate a terrain map with the scale 1:500. After interpolation and fitting in AutoCAD, the data also is saved as .3ds format so as to communicate with 3Ds Max.

2) Transport layer: When the modeling work in Terrain Layer is finished, roads and facilities in Transport layer will be modeled according to the real location on the Terrain Layer. At the same time, we edit textures, lights, materials and other physical attributes by using MaxScript, a built-in scripting.
language in 3ds Max. The logical principle of editing work for Transport Layer is similar to Terrain Layer.

![Diagram of logical sequence to get models of terrain layers]

3) Building layer: 3D building models are important in the virtual environment. The reproduction of the real building is an important aspect of final visual effect, which impacts the authenticity of scenes. Visual modeling tools (3Ds Max, etc.) are used to modeling the building. The raw data of the models comes from building’s construction design maps. Liking Terrain Layer and Transport Layer, we also need to pasting textures on models to show the true appearance of the building. Textures are obtained by pictures from different angles of building’s surface [6].

4) Vegetation layer: There is a powerful vegetation editor in unity3D. The editor is easy to use, it is powerful and automatic animation (effects of wind etc.). So the vegetation models are added directly in Unity3D.

C. Export

When the modeling is completed, the 3D models are saved as the format .sbx so as to compatible with Unity3D. Animations, textures, scripts, and sounds are saved in the asset file in a Unity3D project; they are added as new Gameobjects in the process of creating scene.

IV. Works in Unity3D

Unity3D has a highly optimized graphics pipeline for both DirectX and OpenGL. Animated meshes, particle systems, advanced lighting and shadows, all run blazing fast. It also support individual operations for we can create rain, sparks, dust trails, anything that we can imagine. During the process of creating a scene, works in Unity3D are as follows:

A. Shading

Unity3D comes with 40 shaders ranging from the simple (Diffuse, Glossy, etc.) to the very advanced (Self Illuminated Bumped Specular, etc.) All the built-in shaders integrate perfectly with any type of light, with cookies or without. If it is not enough we can write our own shaders in Unity3D's powerful ShaderLab language with Cg and GLSL. In the study, besides the ordinary shaders, there are more requirements, so we write our own shaders, such as MirrorReflection.shader. It achieves a more realistic scenario results by using the shaders.

B. Programming

If we want to achieve some special functions of the scenes and the functions are simple, we can use the script or editor of unity3D. However, the most powerful editor is Visual Studio [7], the scenes in Unity3D can also compile with Visual Studio by adding UnityEngine.dll.

C. Collision Detection

Unity contains the full capabilities of the Ageia PhysX next—gen Physics Engine and is used in games like Unreal Tournament 2007 and Ghost Recon 3. Unity3D supports full Rigidbody physics. Rigidbodies act under forces, collide, and work in joints with no scripting required. It makes the virtual reality more true to our daily life. After writing scripts on a certain GameObject, users can press the mouse to determine any display area, and then press keys on the keyboard to choose where to go. The navigation person is ended with collision detection in the process of walking around, so, when running into buildings, the navigation person will automatically return to the road, to ensure that the route of the road is not affected by the nonlinear structure.

D. Showing Information by GUI Control

Geographic entities are not only having spatial information but also attribute information. If we want to get dynamic and real-time effects, we can use GUI controls to show the attribute information. All the attribute information is stored in database—MySQL data management system, parts of the code is shown as fellow:

```csharp
private static void openSqlConnection(string connectionString) {
    dbConnection=new MySqlConnection(connectionString);
    dbConnection.Open();
    result = dbConnection.ServerVersion;
    //Debug.Log("Connected to database."+result);
}
// Disconnect from database
private static void closeSqlConnection() {
    dbConnection.Close();
    dbConnection = null;
    //Debug.Log("Disconnected from database."+result);
}
```
In this research, when the user clicks the object, the information will show on GUI message box.

E. Publishing

If we want more persons to use the virtual reality system, we can publish it online. Users can browse it by downloading a small Unity Web Player Plug-in (about 3 MB). It auto-installs without a browser restart, and already has an 8-digit distribution. It works on all modern browsers including Internet Explorer, Firefox, Safari, and most Mozilla-based browsers.

F. Others

Sounds, animations, videos will be added in Unity3D by GameObjects. Thus really enhance the user's immersion in the virtual reality system [8].

G. Integrating

When all the works above are completed, we save the scenes, scripts, audios, attribute data, pictures, textures etc. in a Project in Unity3D. The asset in a Unity3D Project is automatically and immediately imported upon save. Assets can update at any moment, even while users visiting inside the Editor. If the project is big, Unity Asset Server could be used to optimize the big Project.

V. RESULTS OF VIRTUAL REALITY BASED ON UNITY3D

The purpose of all the work is to generate a virtual reality system. Unity3D provides seven kinds of system by ‘build settings’: Web Player, Web Player Stream, OS X Dashboard Widget, Windows Standalone, OS X Universal Binary Standalone, OS X PPC Standalone and OS X Intel Standalone.

In this study, in order to publish online, the virtual reality system is generated by the first kind: Web Player. The project generates the system by ‘build settings’ in File. We can also generate other kinds of systems, such as Windows Standalone, if we choose this kind of ‘build settings’, there will be an executable file and can set up in user’s computers. So, the virtual reality system could be run in different purpose even different operation system.

When files are modified, their status is updated instantly. Renaming and moving assets are handled elegantly. Updates, commits, and graphical version comparisons are all performed inside the Unity Editor.

Figure 4 illustrates the results of virtual reality based on unity 3D. Objects in the virtual reality system can be seen from any angle. According to the adjustment of sunshine, it can achieve real-time sunshine effects both day and night. In addition to sunshine effects, there are also mirror reflection effects (Figure 5). Besides mentioned above, Users can also watch videos, listening music in the system, they can walk alone on the road or guided by an instructor. Therefore, geographical entities in the system are more realistic.

The system also has functions of illumination analysis, distances measurement, querying attribute information and so on, which are similar to 3DGIS.

VI. CONCLUSION

This study generates a virtual reality system based on Unity3D for taking a campus as an example. The virtual reality system is highly vivid, strongly interactive. Users can download a Plug-in to browse the study area online. With a full range of personalized mode on operation, they can choose their own way to browse and participate in the virtual reality, and give full play to their imagination according to their own wishes without affecting the others by using the designated keys on the keyboard. The scene keeps on updating 60 times per second, users will subconsciously input and immediately immersed in the virtual scene for spontaneous exploration and observation. It shows that Unity3D not only can serve for game development, but also can be used in real world. The virtual reality system can also query information, about the research area, and do some simple spatial analysis such as illumination analysis and distance measurement.

In the area of geographic information system, there are always two methods to get 3D virtual reality, one is to use a 2D professional platform such as ArcGIS software to get the virtual reality by secondary development, the other is to use a 3D or 2.5D software as a platform for development, for example Skyline software.

This is only the preliminary results of our study. The next step is to Co-GIS software with the system together, so that it will possess the sophisticated spatial analysis functions of GIS.
This will not only increase the function of the virtual reality system, but also provide new ideas about the development of 3DGIS.

REFERENCES