Virtual Ship Environment Creation Method

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Abstract. Based on the real ship structure and equipment, the game engine is used to construct a three-dimensional visual model scene. Multigen Creator will be used to model, and after format conversion, the model will be driven by Unity 3D to complete the virtual ship platform construction. By introducing control logic such as roaming logic and navigation logic, the user is allowed to perform operations such as roaming and navigation in the virtual scene. The system has the characteristics of strong sense of reality, friendly interface, and interaction, which meets the needs of information teaching. With the cross-platform features of Unity3d, PC and mobile programming are respectively carried out to realize the network development of VR training platform.

1. Introduction
Virtual Reality (VR) is a scientific method and science that is created and produced by human beings in the process of exploring nature and understanding nature. It is gradually formed to understand nature and simulate nature, and then better adapt and utilize nature. Using virtual reality technology, based on real scenes, relying on geographic information technology, 3D modeling technology and game engine to construct a virtual reality scene with both realism and interactivity.

At this stage, the application of virtual reality technology in navigation teaching focuses on training students' use of collision avoidance rules and understanding of ship handling performance, and research on the structure of ships, the working principle of equipment and the interaction between various components. Still in the exploration stage [1]. In order to provide students with a teaching environment close to the real ship, it is planned to use virtual simulation technology to build a virtual ship laboratory, and use the video card virtualization technology to build a network training platform to reduce teaching difficulty, improve teaching quality, and save teaching costs. Improve the safety factor of hazardous operations.

In recent years, the informatization construction of the campus has been rapidly developed, and the development of virtual teaching resources is an important part of the campus information construction. Most of the traditional digital teaching resources are two-dimensional data, which is difficult to meet the needs of contemporary information teaching [2]-[3]. The latest virtual reality technology has the characteristics of strong sense of reality, interaction, multi-device compatibility, etc., and its application in the construction of information resources can make up for the inherent deficiencies of traditional teaching resources.

The core content of the virtual ship training platform is the ship structure model. In order to reduce the hardware requirements, the model is simplified as much as possible while ensuring the teaching requirements. Therefore, Multigen Creator is selected to create a real-time 3D model of the visual simulation [4]. The created model can be driven by the Unity3D engine and rendered through a VR
helmet to enhance the immersion of the virtual environment [5]- [7]. The graphics card virtualization technology can expand the network of the virtual ship laboratory to realize interactive operation on any PC or mobile end.

In view of the above background, this paper uses virtual reality technology, uses Multigen Creator to build 3D models, builds virtual scenes with Unity3D, and introduces corresponding control logic through C# programming to construct a virtual ship with both realism and interactivity[8]- [9]. The virtual ship supports operations such as roaming and navigation, and can be deployed on different platforms to provide services for campus publicity, planning, and information management.

2. System design

2.1. Building process

In the process of system development, based on the software engineering methodology, the functions of each module in the system are designed based on actual needs [10]. The development process of the system is mainly divided into three parts: model construction, 3D virtual scene construction and introduction of control logic, just as shown in Figure 1. In addition, the developed system can be deployed on different platforms with cross-platform compatibility [11].

![System development process](image)

Figure 1. System development process.

2.1.1. The construction method of model construction 3D model is becoming more and more mature. Multigen creator is a software package developed by Multigen-Paradigm of the United States to create real-time 3D models for visual simulation. Efficient and optimal generation of real-time three-dimensional (RT3D) database, and closely integrated with subsequent real-time simulation software, is conducive to saving graphics workstation rendering overhead, ensuring system fluency and multi-terminal sharing experience[12].
After obtaining the ship's frame through data import in the early stage, the ship's structural details and the size of the equipment entity can be obtained through field measurement. The ship's structural details and equipment entities should be as close as possible to the actual ship, in the position where the details need to be reflected (e.g., the compass light). The position can be adjusted as needed.

Texture maps should be processed using Photoshop graphics processing software before importing texture maps into Multigen creator. On the one hand, the effect of point light source and lightness on the image is eliminated when the texture map is shot; on the other hand, the image needs to be stretched and cropped to ensure that the width and height of the image should be a power of 2, and the captured image is kept in RGBA format.

2.1.2. 3D virtual scene construction with the continuous development of virtual reality technology, software platforms and modeling languages for VR system development have emerged. Multi-dimensional model files generated by Multigen creator in Open Flight format can be called by many professional virtual reality development software packages. If you only deal with 3D model files in Open Flight format, VEGA Prime will be the best choice. In view of the ship's interaction with the waves and the network topology requirements of the virtual ship training platform, you have to choose rich development tools and development. Unity3D, which is fast and supports multi-platform program release, is driven as a view engine.

In recent years, Unity Technologies has developed the Unity graphics and image engine to make building visualization and real-time 3D animation easy to create. After the model is built, simply import it into Unity3D and visually complete the layout of the objects in the scene to complete the construction of the 3D virtual scene. To enhance the realism of the virtual scene, further configuration of the objects in the scene is required. For example, in the real world, objects are not allowed to walk freely. According to this rule, a collision detection mechanism needs to be added to objects in the virtual scene to avoid the phenomenon of passing between rigid bodies.

2.1.3. The introduction of control logic allows you to easily manipulate objects in a virtual scene by controlling scripts to achieve human-computer interaction. Unity supports writing control logic in C# and JavaScript. From the functional division, the control logic can be divided into: roaming logic (which defines the roaming behavior of the characters in the system, such as the way of roaming, the speed of roaming, etc.), navigation logic (the navigation method of the character), and interaction logic (mainly including users and Interface interaction, role interaction with objects within the system, etc).

2.1.4. Wave system. Although Unity3D provides many tools for surface rendering and water baud, it focuses primarily on visual effects and does not correspond to wave characteristics in specific sea areas. In order to ensure the accuracy of the simulation, the marine environment in which the ship is located can be obtained by generating a one-way random wave by the spectrum[13]-[14].

Similar to the fluctuating wind velocity, the wave slope is calculated as follow:

\[
\theta(t) = \frac{1}{2} \sum_{i=1}^{N_{\omega}} \frac{\omega_i^2 a_i \sin(\omega_i t + \varphi_i)}{g} \quad (1)
\]

Where

\[
a_i = \sqrt{2 S_{\text{wave}}(\omega_i) \delta \omega} \quad (2)
\]

The sea elevation in metres is modelled using the spectrum recommended by the 15th International Towing Tank Conference (ITTC) as follows:

\[
S_{\text{wave}}(\omega_i) = \frac{A}{\omega_i^2} \exp\left(-\frac{B}{\omega_i^2}\right) \quad (3)
\]

Where

\[
A = 172.75 \frac{H_{1/3}}{T_{01}^2} \quad (4)
\]

\[
B = 69.1 \frac{T_{01}^2}{T_{101}^4} \quad (5)
\]

\(H_{1/3}\) is the significant wave height (m) and \(T_{01}\) is the mean wave period (s).
2.2. Functional Analysis

2.2.1. Manual roaming. Manual roaming manipulates the movement of characters within the system through control information from external devices. In the virtual scene, you can use the keyboard's "W", "A", "S", "D" keys to control the movement of the character, press the right mouse button and drag to rotate the view angle, press the space bar to jump. During the roaming process, the character encounters obstacles and stops moving forward. This system uses the first person character control preset body that comes with Unity3D, which defines the movement, jumping, and acceleration of the character when the character moves, making the character's movement process realistic.

2.2.2. Automatic roaming. Auto roaming allows a character to roam along a given route without any input after the roaming event is triggered. The auto-roaming feature can be triggered by components of the user interface layer, and the character will automatically move according to the preset path. The implementation of the automatic roaming function is realized by the external plug-in-behavior tree in Unity3D, which is mainly applied to the AI behavior control of the objects in the system, and the control of the role can be realized by the combination of the nodes on the behavior tree.

2.2.3. Virtual navigation. Virtual navigation refers to the input of the current coordinate point of the character and the target point. The corresponding navigation method is used to generate the route from the starting point to the target point. This function is also implemented through the behavior tree. Unlike automatic roaming, virtual navigation first has to be baked out of the scene's navigation grid through Unity3D[15]. In order to simplify the operation and lower the usage threshold, a static map can be generated in advance in the scene, and the external user only needs to visually select the target position on the map to navigate.

3. System implementation and testing based on the above construction method

3.1. Ship hull model
It can realize the overall display of the ship, facilitate the analysis of the hull structure and the division of the ship area, and facilitate the macroscopic understanding of the ship. At the same time, it is the development platform for other functional virtual devices, as well as the working basis and behavior carrier for in-depth development of ship survival, ship fire, boat operation, anchoring, cargo operation.

The main place where the bridge is working as a deck crew is the installation and storage of internal communication equipment, external communication equipment, navigation equipment, distress warning equipment, meteorological equipment, control equipment connected to the engine room and other necessary equipment. The space is relatively small. And the relevant equipment must be placed in accordance with relevant regulations. The VR laboratory can describe the resettlement of related facilities and equipment in a flexible way, which can directly reflect the impact of each ship structure on the facilities and equipment, and provide a unique perspective that can’t be achieved by actual ship observation.

3.2. Propeller work simulation
The propeller is under water, and it is not easy to apply the real ship propeller working scene to teaching. The existing related resources are mainly obtained through animation simulation or real ship shooting. The two forms of teaching resources can’t achieve all-round multi-angle observation. At the same time, the video effect will also affect its clarity due to the underwater environment. The hull-propeller-rudder attachment relationship can be presented using virtual modelling techniques. With Unity3D's Particle System, you can realize the dynamic flow performance of the ship's tail water flow under the joint action of the hull-propeller-rudder. Figure 2 is a screenshot of the model. It can be used to vividly describe the working principle of the rudder, the propeller biasing effect and the ship's directionality to the ship. Performance influences are difficult to understand.
4. Concluding remarks

The virtual ship based on the design method of this paper uses Multigen Creator to build the model and build with the Unity3D 3D virtual scene. In addition, the introduction of control logic solves the problem of interaction between external users and virtual scenes. The virtual reality interactive system built is realistic and practical. However, this method still has certain limitations. For example, the system has relatively single functions and the data does not have persistence. In future research, rich interaction logic and database connection to achieve dynamic access of data will be the focus.

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