Design and Realization of Ship Fire Simulation Training System Based on Unity3D

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Abstract. Ship fire training is a very important training to ensure the safety of the ship, but limited by the characteristics of the ship itself, it is difficult to carry out fire training on the ship. This paper proposes to introduce a virtual reality technology to build a set of ship fire simulation training system, used to improve the quality of training, reduce training costs. First, the system design ideas are elaborated, and the system architecture diagram is given. Then, the key technologies in the process of system implementation are analyzed. Finally, the system examples are built and tested.

1. Introduction

With the development of computer technology, virtual simulation has become a must for a variety of complex situations, especially related to large energy consumption and risk training is essential to a content, through the virtual simulation, can be all kinds of systems and tasks to learn and training The Ship fire is an emergency task that is likely to occur during boarding and landing. The equipment involved is highly specialized and has a wide range of people. The division of labor is clear and the cooperation must be appropriate, otherwise it will probably be a major disaster. As a new crew is difficult in the case of an emergency without error to complete the task, in general should strengthen the operating procedures, familiar with the use of various types of fire equipment. Due to the large cost of conventional training, and by the characteristics of the ship itself is difficult to carry out, but also with a certain risk. Therefore, it is of great significance to improve the level of fire safety and ensure the safety of the ship by exploring and designing a system to simulate the operation and training of the ship in the fire.

2. Design system

Ship fire simulation training system mainly includes data layer, service layer, function layer and presentation layer, as shown in Figure 1.

a). Data layer: to provide basic data support for the system, including three-dimensional data (ship model, equipment model, tool model, role model, disaster model, etc.), two-dimensional data (various pictures, text data), audio and video data (video, Background music, etc.), training data (training process data, training results data).

b). Service layer: is the core of the system, through the data layer data and system function requirements analysis, functional simulation integration and re-development, the formation of specialized processing of various types of information services components.

c). Functional layer: Based on the service layer to achieve the system core application functions, including fire tool display, ship roaming, simulation and training evaluation.

d). Performance layer: that is, the system of human-computer interaction interface, and functional layer through the connection, to achieve the visualization of the system operation.
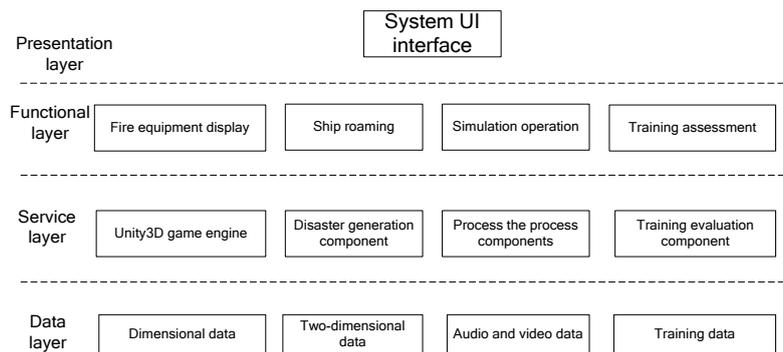
Figure 1. System overall architecture diagram

3. Research on key technology

3.1. Construction of Ship Fire Scene Based on Unity3D

For the simulation training system, the realistic training scene is very important point. According to the analysis of the relevant data, the fire model is the knowledge kernel of the fire simulation training, and the fire scene of different states is simulated by changing the parameters of the model. The construction of the ship fire scene mainly includes the general model of the characteristic compartment, the fire model and the role model. Unity3D virtual reality engine has the system development efficiency and flexibility, and the development of the system can be released in Windows, Web, Andriod, IOS and other platforms, to achieve a cross-platform needs.

The main processes for creating a ship fire scene based on Unity3D include: data collection and processing, feature pod modeling, fire modeling, scene integration and optimization, as shown in Figure 2.
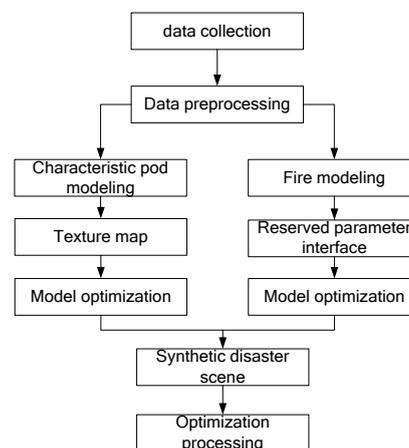
Figure 2. Construction of Ship Fire Scene Based on Unity3D

a). Data collection and processing: the need to collect the data, including the characteristics of the ship's cabin three-dimensional data, environmental texture data, different cabin prone to fire location, type and other data. The data collected should be preprocessed, including the determination of the disaster occurrence point of different cabin, the size of texture mapping and so on.

b). Feature pod modeling: According to the collected 3D data and environmental texture data, 3DMAX polygon modeling method is used to model the feature pods according to the size data, add the UV modifier to the model, and add the texture. After the model is completed, the FBX plug-in is used to export the model to form the basic environment of the cabin.

c). Fire Modeling: Use Unity3D's particle system to build different types of fire models, including solid fire, oil fires, gas fires and electrical fires. At the same time, write script reservation parameters interface for controlling the size of the fire, dangerous areas and the speed of death and so on.

d). Scenario Integration and Optimization: The fire model and the feature pod model are integrated in a random way so that the disaster scenarios are different for each training session.

3.2. Collision detection technology

In the simulation training system, collision detection technology has been the development process of the difficulties. It requires the system to be realistic according to the situation of the scene in the scene to simulate the results of the real world, such as the characters cannot penetrate the wall, the human eye cannot be seen, the fire extinguisher particles to act on the flame and so on.

In this training system, the use of the camera to follow the role of the method, therefore, in the role of moving, the camera is likely to be blocked by other models. There are two general treatment methods, one is to block the model becomes transparent, one is to change the location of the camera. Due to the characteristics of the training system, the system uses the second method. The specific process is as follows:

a). From the role of the head, the trunk of the camera to launch a ray;

b). To determine whether the first object that the two rays collided with is the camera;

c). If one of the results is not a camera, it indicates that there is a block between the character and the camera, and the camera is moved to the position of the collision point; if the camera is both the camera does not change the position.

3.3. Training evaluation system

The training evaluation of the ship fire simulation training system is mainly carried out from the four aspects of extinguishing effect, completion time, safe operation, searching for items and personnel. The four aspects are given different weights and proportionally calculated, and the training is carried out quantitatively.

a). Fire effect, the weight of 25%: complete fire for the full score; the fire is not reduced to 0 points; the fire becomes smaller, according to the corresponding reduction in the fire to the points.

b). Completion time, weight 20%: is the time to complete the fire fighting the use of time to measure. In general, if it is completed within 300s is 20 points, less than 600s to complete the time the shorter the higher the results, more than 600s then only 10 points.

c). Safe operation, the weight of 20%: is the completion of the task in the process of dangerous operation, whether the correct use of tools to measure. Safe operation according to the actual situation to set, for the deduction operation, there will be deducted action according to the requirements of deduction, deduction to 0 points only.

d). Search for items and search staff, the value of 25%: the task is completed during the search and rescue part of the measure. By placing a certain number of files and injured persons randomly in the scene, the final search and rescue task completion is the evaluation value.

The results of the entire training: fire extinguishing effect + completion time + safe operation + search items and search staff. Out of 100 points, 80 points or more for the excellent, more than 60 points for the pass, 60 points for the following failed. Safe operation can also set the key indicators, if not reach the key indicators can be directly judged as unqualified.

4. System implementation

Based on the above analysis and research, the system development and implementation, the system of business logic processing with C #, Javascript technology, C # language scripting environment for the VS2010, 3Ds Max software production model, three-dimensional simulation engine using Unity3D 5.5.0, Implementation of the most important technologies are: scene roaming technology, physical effects simulation technology and scene switching technology. The system process is shown in Figure 3.
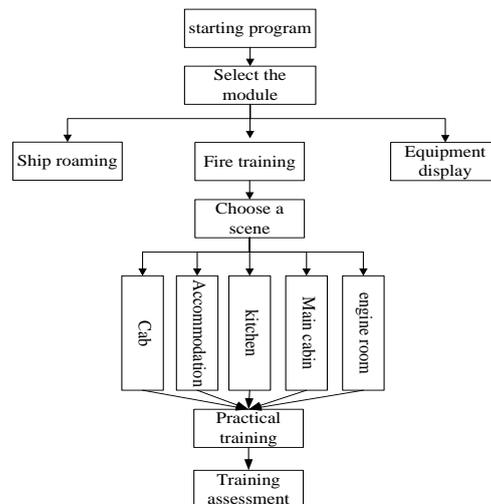
Figure 3. System flow chart

The 3DS Max software is used to model the shape of the model by using the polygon modeling technology, NURBS modeling technique and subdivision surface modeling technology. The texture editor is used to give the surface texture and texture of the model. And then into the built-in model into Unity 3D, Unity 3D system will automatically add the transformation component for the model, by controlling the transformation of components of the component variable position, rotation, and scale to achieve motion modeling. Physical modeling relies on Unity 3D's built-in physics components. The physics component contains multiple classes that can simulate rigid bodies, flexible bodies, joints, and forces. Drag the classes in the physics component to the model and set the relevant parameters to implement the physical modeling. The system uses the collision detection algorithm to detect whether there is a contact between the model, cross-penetration phenomenon. Unity 3D provides original collapses based on AABB detection, mesh-based grid colliders and composite colliders. When used, choose a different collider depending on the shape and purpose of the model. The concrete realization of the system is shown in Fig.
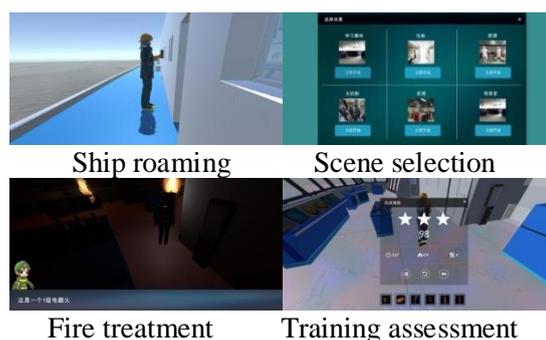
Figure 4. System screenshots

5. Summary
In this paper, the Unity3D engine is applied to ship firefighting information training, and a virtual scene of ship fire is built. The ship fire simulation training system is realized and can be used for fire training and evaluation of crew. The next step will be to develop a more realistic fire model and proceed to study the fire spread model based on Unity3D to improve the authenticity of the scene. This article hopes to initiate, for Unity3D technology in fire simulation training to provide useful reference and direction.

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