Development of Vehicle Fault Maintenance System Based on Unity3D

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Abstract. With the rapid development of computer and artificial intelligence technology, the application scene of technology has changed from two-dimensional space to three-dimensional space. In the field of vehicle fault maintenance, virtual reality technology can provide a variety of solutions. With the increasing technical content in armored vehicles, it is urgent to train a group of professional maintenance personnel for maintenance operations. This paper analyzes the common problems of armored vehicle system and the method of simulation maintenance. It uses 3d max and Maya software to model and introduce the model into Unity3D to build the scene. Finally, C# language and VRTK were used to write scripts to realize human-computer interaction, and the maintenance system was constructed through testing. By constructing this system, various practical problems in the maintenance training of armored vehicles are solved.

1. Introduction
The most striking feature of virtual reality technology is that users can enjoy realistic virtual environment experience without being restricted by the real environment. Therefore, virtual reality technology has a huge application prospect. At present, the technology has been successfully applied to military, medical and other fields and has been highly recognized. From a technical point of view, as shown in Fig. 1, the virtual reality system has three basic features of immersion-interaction-imagination, which emphasizes the leading role of people in the virtual system [1].

![Figure 1. Virtual reality system features](image)

The three-dimensional world environment created by the virtual reality system can provide the user with an immersive feeling. The advanced hardware technology provides technical guarantee for the good interaction process between the user and the virtual object, especially in the harsh conditions of natural conditions, users can perform the work without entering a harsh environment [2]. With the
increasing use of some advanced technologies in armored vehicles, a large number of people with professional knowledge and rich experience are needed to operate. At present, due to the rapid technology update, the main problems in training specific vehicle maintenance personnel are as follows: the training process is time-consuming and costly; The vehicle is few, cannot achieve everybody to undertake actual operation; Training standards are inconsistent.

Based on the above background and the application potential of virtual reality technology, this paper simulates several common faults of armored vehicles and designs a vehicle fault repair system based on Unity3D. Firstly, the vehicle is modeled in general using MAYA 3D software, and the internal parts of the vehicle are modeled using 3d Max 3D software. Use the Unity3D development platform to build the scene, import the established model, and render and optimize the entire scene. Finally, the corresponding model algorithm is written using C# script and the human-computer interaction function is realized by VRTK. By designing the system, the maintenance personnel can be simulated to carry out the maintenance of relevant armored vehicles in the virtual space, so as to realize the purpose of relevant training.

2. Vehicle 3D modeling

2.1. Vehicle appearance modelling

Considering that in the vehicle exterior modeling, in order to improve the realism of the scene, it is necessary to highlight some details of the vehicle model. This paper uses MAYA modeling software as the manufacturing tool of the vehicle appearance to achieve good visual effects. MAYA software is a well-known 3D modeling and animation software under Autodesk. Its main application subjects are films or games that need perfect special effects, animations and modeling. The designed models are more detailed and the animation works are more exquisite [3]. By imitating the actual armored vehicle, the 3D modeling of the whole armored vehicle model was completed in MAYA 2016. The specific steps are as follows:

- First of all, make the reference diagram of the object perfect, and import the three views into Photoshop software for modification, the length, width and height of each view are one-to-one correspondence.
- The three views are respectively imported into the camera position map corresponding to MAYA, and then the half contour of the vehicle is drawn on the side view and the image is complemented by the principle of symmetry, as shown in Fig. 2.

![Figure 2. Three view of the vehicle](image)

- Because some parts of the system need to be active, but the constructed model belongs to a static and complete model. The parts similar to the hood need to be separated from the whole, and this
effect can be achieved by deleting the corresponding layers in the completion diagram, as shown in Fig. 3.

2.2. Engine modelling
Considering that 3d Max has great advantages in model optimization, texture rendering and fineness, engine modeling can take advantage of several plugins in 3d Max to improve modeling efficiency, and the modeling of engines and other parts does not require detail. In this paper, 3d Max 2012 software modeling software is used as the production tool of fine vehicle parts to achieve good visual effects. 3d Max is software developed by Autodesk to perform 3D animation rendering or 3D modeling on a personal computer. The advantage of this software is that the required computer configuration is very low, you can get the required functions by installing different plugins, the unique modeling steps can give the model more space to modify, and at the same time have high light and shadow processing effect, and the powerful rendering is also one of its features [4]. The built engine model is shown in Fig. 4.

3. Unity3D platform

3.1. Model import
Since the model that can be imported into Unity3D scene can only be downloaded from Unity store or files in .fbx format [5], the model constructed in 3d Max and Maya is in .max and .mb format by default, so it must be converted into the .fbx format in these software, then imported into the Assets of Unity3D, and then dragged into the Unity3D scene from the Assets of the model. Then move the position of the model in the scene, or adjust the size and rotation Angle of the model in Inspector, and adjust the material type to the rigid body, so as to prevent conflicts in motion. The overall model built in the completed Unity3D is shown in Fig. 5.
3.2. Scene and environment establishment

In the function realization of the system, using Unity to build 3D simulated maintenance scenes is a very important part of the vehicle fault maintenance system. The virtual scenes required for maintenance are made up of two-dimensional and three-dimensional objects. We can create something directly using Unity3D, such as terrain and simple original objects.

Unity 3D provides a very powerful terrain editor, Terrain, which makes it easy to create terrain scenes that are similar to the actual ones. In order to be closer to the actual scene, EasyRoads3D plugin was used in this paper to build the road model in the scene. EasyRoads3D is an identity-based plugin in Unity3D. Click the menu bar GameObject → Create Other → EasyRoads3D to add the road model. The panel of EasyRoads3D is shown in Fig. 6.

EasyRoads3D also provides some other functions, such as creating some objects in the surrounding environment, or some collision objects such as walls and buildings. The model created by EasyRoads3D plugin is shown in Fig. 7.

4. Software system design

4.1. Programming language selection

The script defines the basic interactions, behaviors, and rules of everything in the scene. Unity 3D supports three scripting languages: JavaScript, C#, and Boo. C# inherits the powerful functions of C

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**Figure 5.** The vehicle that modeled in Unity3D

**Figure 6.** The panel of EasyRoads3D

**Figure 7.** The model created by EasyRoads3D plugin
and C++ while removing some of their complex features. C# itself has very powerful language features and is more suitable for in-depth development than JavaScript [6]. C# combines VB's simple visualization operations with the high operational efficiency of C++. The rich library resources enable programmers to quickly write a variety of applications based on the MICROSOFT .NET platform. So this paper chooses VS2017 for development. Mount the C# script to the desired object, and a script file appears at the bottom of Inspector, as shown in Fig. 8.

![Figure 8. Import the C# script](image)

The unique script import mode in Unity3D is modular programming, so that the program does not need to pay attention to the sequence when writing, and the detection can be conducted step by step, which not only reduces the global crash caused by some errors, but also simplifies the programming process [7].

One thing to note is that although these C# scripts are mounted separately on the object, these scripts are run at the same time when running, which is feasible in the syntax of the program, but can cause confusion with objects with the same name.

4.2. Use of VRTK

The full name of VRTK is Virtual Reality Toolkit, formerly known as Steam VR Toolkit. VRTK can realize most of the interaction effects in VR development. Developers only need to mount several scripts and then set related properties to realize the functions we want. Due to the open source nature of VRTK, on the one hand, developers can drill down into the code to see how it interacts with the native SDK. On the other hand, developers can modify the code according to their own project requirements and quickly develop functions that meet their own needs [8]. And VRTK covers many common solutions, such as: movement within a virtual space, touching, grabbing, and interacting with objects.

In this paper, VRTK is used to firstly realize the function of VR device simulator, only use the mouse and keyboard to move around play area and interacting with objects without the need of VR controls, using this simulator can reduce the complexity of writing and debugging programs. Add empty objects to the scene and mount the corresponding VRTK scripts on these empty objects, and import the arm model into the controller. The corresponding settings and effects are shown in Fig. 9-10:
VR movement usually uses transient motion to solve the problem of vertigo and little real space. The core of the function is to transfer the player's position to where the laser is pointing. The script should be placed on the handle's prefab by default. After the Q key is pressed, a ray is emitted from the corresponding controller. When colliding with other objects, there will be a cursor pointer to determine whether it is a valid transfer point. After releasing the Q key, the transfer is completed, as shown in Fig. 11:

In some scenes, the hood needs to be opened, and the object is characterized by a certain Angle of movement around the fixed axis. DEMO 006 of VRTK can realize the function of opening and closing the door. The script is modified in this paper and applied to the above object. When the controller touches the hood, the object will be highlighted. Click the right mouse button to open the hood, and click again to restore the original state. The script and effect are shown in Fig. 12-13:
5. System testing and discussion
When testing related systems, it is mainly a comprehensive test of whether it can implement the corresponding functions. In this paper, the logic of the software system is tested. The system adds three faults in a scenario in advance to detect whether there are scene loss, key conflicts, and invisible faults during system operation. A total of 100 tests were conducted. The statistical information is shown in TABLE I, which can preliminarily determine the stability of the system.

| Operation                     | General Situation                                           | Accuracy (%) |
|-------------------------------|-------------------------------------------------------------|--------------|
| Call VR simulator             | Sometimes there is a slight lag on entering the scene, and then the system stabilizes. | 92           |
| Open the hood                 | Sometimes the hood can't be opened because of mold penetration. | 97           |
| Oil shortage fault diagnosis  | Same as expected                                            | 100          |
| Exhaust pipe blockage fault diagnosis | Same as expected                              | 100          |
| Non-electric battery fault diagnosis | Same as expected                                       | 100          |
6. Conclusion and Future Work
Through the study of virtual reality technology, this paper constructs the vehicle fault maintenance system, details the overall design of the system and how to use various plugins to quickly and efficiently implement the corresponding operations, which provides a reference for the virtual training of maintenance personnel.

Moreover, even if the corresponding vehicle has technical innovation, only the system needs to be improved to solve the problem that the equipment is not real-time.

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