The Construction of 3D Virtual Driving Scene of Police Wheeled Armored Vehicle

Caoshan Wang [a], Ning Shan, Huafeng Lei

Engineering University of PAP, Xi'an 710086, China

[a]515026339@qq.com

Abstract

To realize the simulating driving training of WJ-03 type police wheeled armored vehicle, based on the Multigen Creator modeling platform, this paper built the 3D visual model of wheeled armored vehicle and the real time driven 3D visual simulation scene by the key modeling technologies, built the 3D model of terrain, roads and armored vehicles; integrated all of the models reasonably, constructed the 3D virtual driving scene of armored vehicle in real time. This paper also displayed the effect of virtual panorama and viewpoint roaming scene. The result showed that the virtual scene built in this paper can simulate the real environment better, which provides a good condition for the virtual driving training of armored vehicles.

Keywords

Virtual driving; 3D virtual scene; Multigen Creator.

1. Introduction

At present, the armed police force still adopts the traditional real vehicle, live fire training method in the training of wheeled armored vehicle driver and vehicle mounted weapon and equipment operator. As to this method, not only the training cycle is long, the training efficiency is low, with more security risks, high fuel consumption, serious pollution to the environment, the wear of vehicle is also more serious, but also it is affected by the weather and the training ground largely; in addition, some mistakes in training may also pose a threat to the driver and the operator's safety. Thus, the backward training methods and limited training facilities have seriously affected the training efficiency and training quality of the driver of wheeled armored vehicle and the operator of vehicle mounted weapon equipment in the armed police force.

In view of this, the article based on the Multigen Creator modeling platform, compared to that the rendering texture of 3DS Max is poor, the SoftImage3D is not easy to use, the function of Lightwave3D is not perfect, the models and actions are not realistic, the lighting rendering and animation function of AutoCAD is relatively weak, Maya is not used widely and so on. The multigen Creator has many advantages such as superior performance, reliable system, good stability, it use the data format of Open Flight to ensure the relationship between the performance of real-time three-dimensional and interactive, with more conversion tools of data format, it can make full use of the existing database of other modeling tools, with powerful API function library, integrates the polygon modeling, vector modeling and accurately generating functions of large area terrain, meanwhile it is available in two versions of the high end SGI workstation and the low end PC machines, so this paper chooses the Multigen Creator as modeling platform. This paper built the 3D visual model of wheeled armored vehicle and the real time driven 3D visual simulation scene by the key modeling technologies of it , to create a three-dimensional virtual environment for the user to "experience" real vehicle driving sense and create conditions for the virtual driving of armored vehicle.

2. Process of scene modeling

Because the scene area of armored vehicle driving is relatively large, the types and quantities of models involved in the scene are also more; we must consider how to establish each model, how to clarify the relationship between models, and how to reasonably organize the distribution of each model in the scene database; and these problems are related to the construction quality of the scene model database, affect the real-time drawing, rendering of the models, as well as the refresh rate of the image frame, which also seriously affect the efficiency of the system. Based on the above considerations, combined with the main model elements in the driving scene of armored vehicle, such as terrain, roads, buildings, street lights, traffic lights, as well as armored vehicles and so on [1]. Fig.1 shows the construction process of virtual driving scene of armored vehicle and the modeling process of scenes.

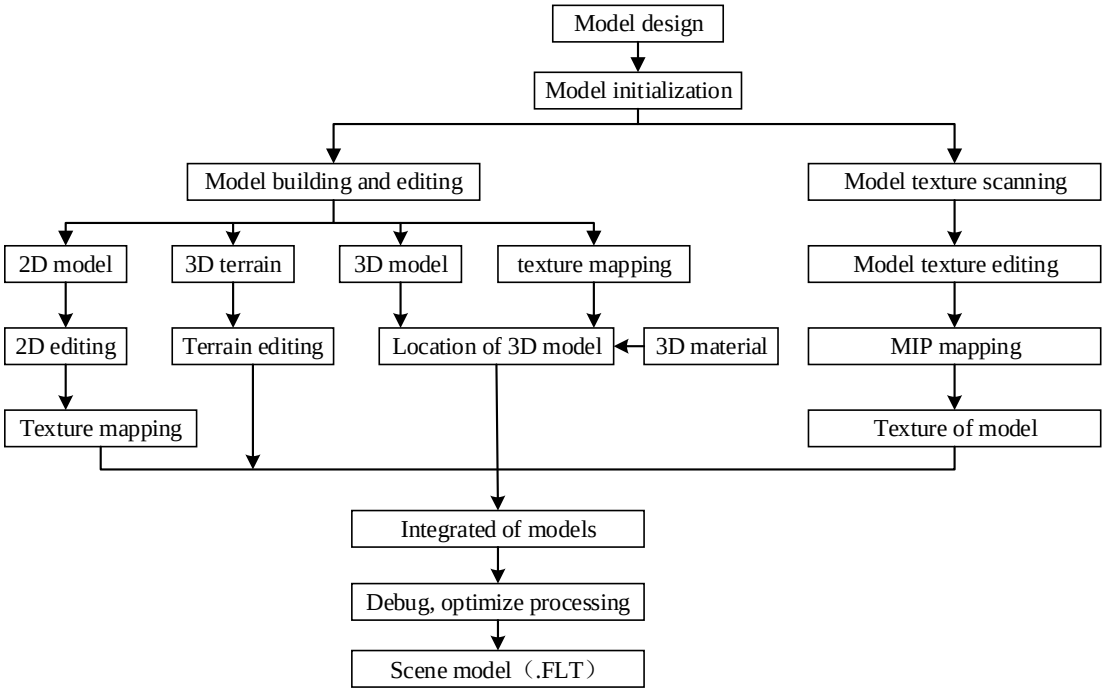


Fig.1 Modeling process of scene models

3. Structure organization of the scene model database

3.1 Structure classification of the Database

When the visual simulation system renders the scene, it must determine which model nodes are in the visual range, which are out of the visible range in real time. The model nodes which are in the visual range will be drawn by the system; otherwise, they will be removed. Obviously, the organization structure of scene database influence the performance of visual simulation system greatly.

In general, according to the different organization structure of the model database, it can be divided into three types[2], namely, the linear structure, the logical structure and the spatial structure.

(1) Linear structure

In the linear structure, all the “o” nodes of the model database are located under the same node “g”, and at the same level. When the system is running, all the nodes are traversed and accessed; it will increase the burden on the system, reduce the rendering speed of the scene. Fig.2 shows the ways of organization.

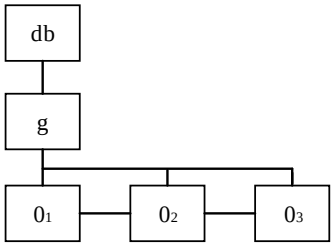


Fig.2 Linear structure of database

(2) Logical structure

This is a method of organizing the hierarchical structure of the database according to the types of models. For example: all the buildings are put in the group, all the plants are put in groups, all vehicles are put into a group. But when the system is running, there are often a variety of models in the current scene; so, in the choice of a model of visual range, the system must traverse all the models, and then select the model nodes required at present. Also, such disadvantages also exist for other required nodes of model. Therefore, the advantages of organizing model database in accordance with the logic structure are: the groupings of models are clear, which is facilitate to unified management; the disadvantages are: it takes a lot of time to eliminate the invisible model nodes when the system draws a scene, which will seriously affect the rendering speed of the system. Fig. 3 shows the organization mode of the system.

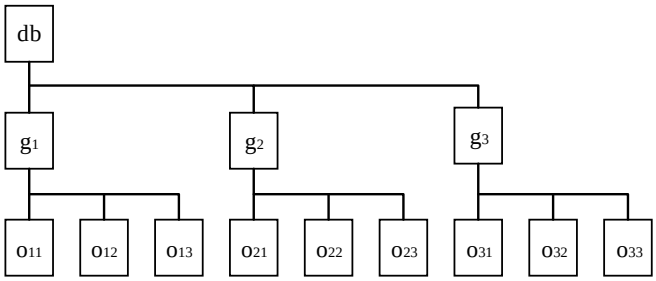


Fig.3 Logical structure of database

(3) Spatial structure

This structure designs the database nodes in accordance with the geometric position of model objects in 3D visualization scene. The current simulation scene always has certain physical properties, when a model node in the scene database is stored according to the spatial structure, simulation system will be able to quickly eliminate the “o” nodes which are outside of the visible scope, thus, greatly improve the efficiency of the system. Therefore, in the construction of 3D virtual scenes this structure is often used to organize the database. Fig 4 shows one organization mode of the structure.

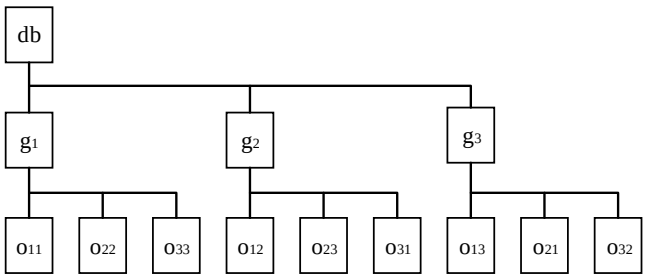


Fig.4 Spatial structure of database

3.2 Database architecture of armored vehicle driving scene

As a simulated driving environment of wheeled armored vehicles, the driving scene is composed of many visual model objects which are integrated into a scene model database following certain relationship and order. In the simulation driving scene database of this system, according to the type of model constructed, they are mainly divided into three class: landscape model, static model and dynamic model, and all of these models are based on the data storage model of OpenFlight (.FLT) . The static

model is called by the landscape model or dynamic model in real time. Fig.5 shows the data base organization of virtual driving scene of the system.

4. Construction of scene model and wheeled armored vehicles

In the construction of 3D scene simulation, we generally need to complete the two aspects of the content. On the one hand, the establishment of the whole virtual scene of the terrain; on the other hand, the establishment of cultural characteristics of the terrain surface, and refer its external to terrain model database. This section is the key technology of Creator modeling, to construct some important models of wheel type armored vehicle simulation driving scene, and 3D visual simulation model of wheeled armored vehicle.

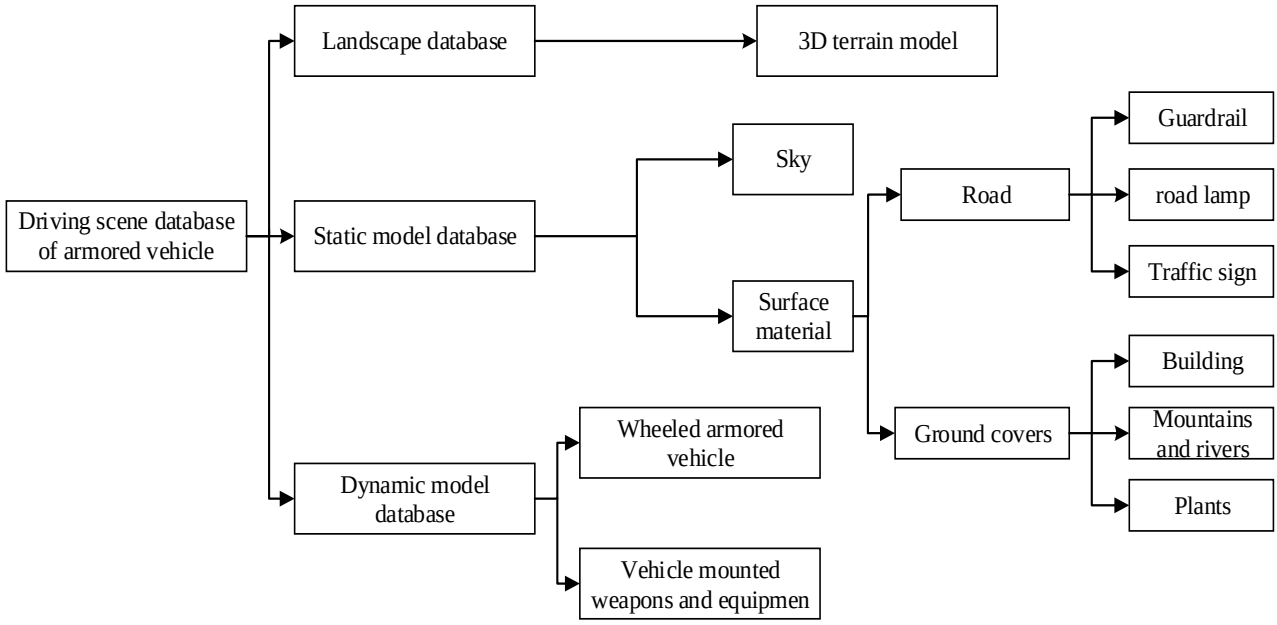


Fig.5 Database organization of driving scene

4.1 Construction of terrain

Terrain modeling is based on the actual characteristics of the earth's surface, according to the scale and the conversion algorithm, and select the appropriate earth projection method to simulate the fluctuating state of the the earth surface by the computer, to get the corresponding polygonal set of terrain, and map the terrain texture picture which has been obtained to the surface. The terrain mainly displays the overall outline of the virtual scene, which includes the real terrain and simulated terrain. Real terrain is the re display of realistic terrain, it satisfies the requirements of high fidelity. For real terrain, Firstly, it is based on the Digital Elevation Model (DEM) of the real world; secondly they are transformed into the Digital Elevation Data (DED) special used for the Creator; and finally they are ported to the Creator, and combined with the detail level of the simulation terrain and the total number of polygons, convert DED to various terrain polygon control parameters that is needed. While this system is just a visual need for terrain, it does not need to reproduce the real terrain, so the author can use manual modeling method of Creator to construct the conceived state of topography and landscape. At the same time, in order to facilitate modeling and reduce the workload of modeling, we can build the simulated terrain to the planar terrain without elevation; then establish different road conditions on the planar terrain (straight road, curved road, ramps, etc.), and combined with the simulation driven platform to realize the collision detection of armored vehicles and the surrounding environment, complete the visual drive of the armored vehicles under different road conditions.

In the construction of terrain simulation, firstly, the area of the terrain must be better planned; secondly, the polygon mesh of terrain can be established on the tracking surface by using the Polygon tools in the Creator/Face toolbox; finally the collected surface texture picture can be applied to the terrain mesh,

thus the construction of the terrain is completed. Fig.6 shows the polygon grid view of the plane terrain model (3.079km2 * 3.006 km2) under the modeling environment of Creator; Fig.7 shows the the topographic effect after the treatment such as the addition of cultural features and texture observed under the Creator 3D Veiwer.

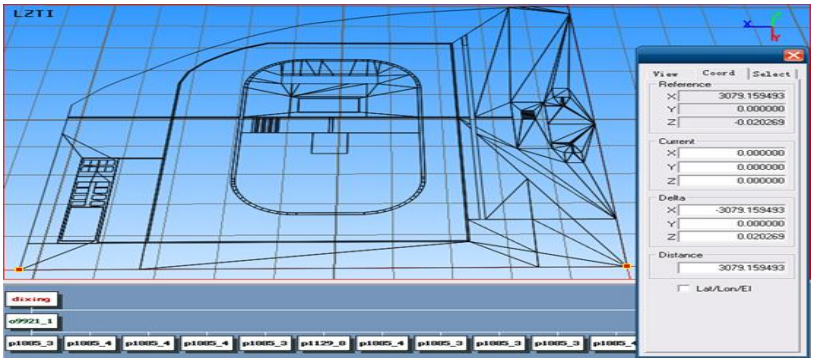
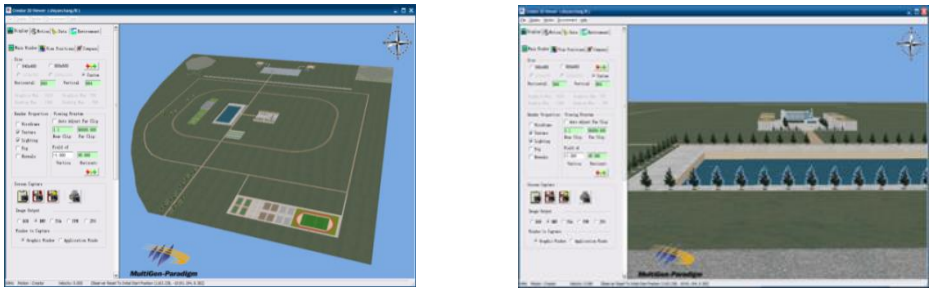


Fig.6 Polygon mesh of terrain



(a) Overall terrain (b) Local terrain

Fig.7 Topographic effect after treatment

4.2 Construction of road

The road is an important part of the virtual scene, it not only provides a running environment for the driving armored car, but also provides the basis for the collision detection of armored vehicles under different road conditions, meanwhile it create a different road conditions for the drivers under the driving environment.

(1) The construction of conventional roads

Usually, armored vehicles are driven in normal road conditions, such as the general gravel, cement, sand road, greensward. When building this kind of road, firstly, build a terrain mesh by the Creator/Face toolbox in Polygon tools; secondly, the surface textures of different roads are mapped onto the terrain polygon mesh, by using three point or four point mapping method, to obtain the conventional road as shown in Fig.8. In the figure, they are respectively the gravel, sand road and greensward obtained by the three point mapping method.

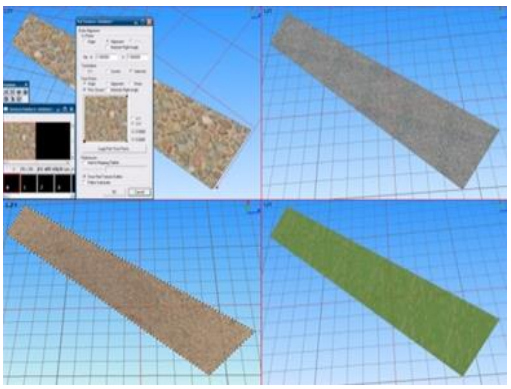


Fig.8 Road model

4.3 Construction of wheeled armored vehicles

Because this topic takes the existing "WJ03" type wheeled armored vehicle of the armed forces as the research object, so the two-dimensional image is used as the background image, to construct the 3D model of the wheeled armored vehicle of the system. At the same time, it also provides a reference for the development and implementation of the basic functions and effects of the system. On the reference grid plane of the Creator, on basis of the parameters of the WJ03 type wheeled armored entity, he key technology and its related modules (face, body, image, rotation, etc.) of Creator modeling are used comprehensively to design and construct the 3D model of main components of the wheeled armored vehicle as shown in Fig.9.

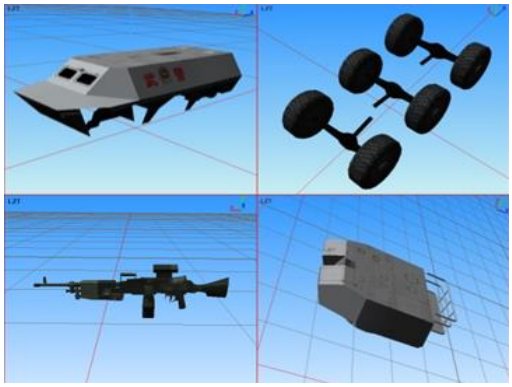


Fig. 9 Main parts model of wheeled armored vehicle

When the constructions of the model of the main components are completed, all of them will be integrated into a model database by the use of external reference, that is, to form a full view model of wheeled armored vehicles as shown in Fig.10; Fig.11 shows the view of CAD.

Fig.10 Model of wheeled armored vehicle

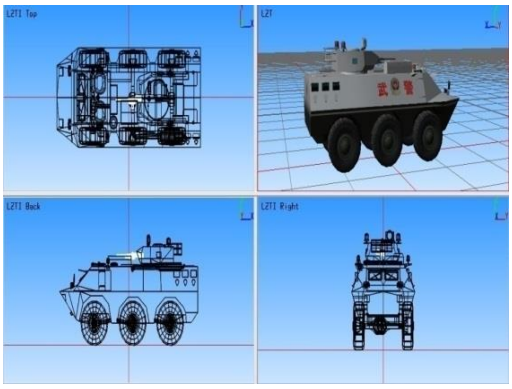


Fig.11 CAD view of wheeled armored vehicle

4.4 Integration of the Model

In the developing process of this system, when the construction of the models needed are completed, then they are restructed as the simulated driving scene model database of the visual simulation system. At this time, the method we use are not the traditional replication, but the external reference technology of the Creator to complete the recomposing process of the models in the virtual scene.

The use of external reference technology has the advantages that it is easy to add and replace the models, easy to organize and manage the scenes, as well as saves memory occupation and so on. The only disadvantage is that you cannot edit the model, if necessary, you must operate in its original database. Fig.12 shows the door, surrounding walls and the two hill model cited in the virtual scene. Fig.13 shows the panorama of the virtual scene; Fig. 14 shows the effect of the simulation scene when the user's viewpoint roaming in real time.

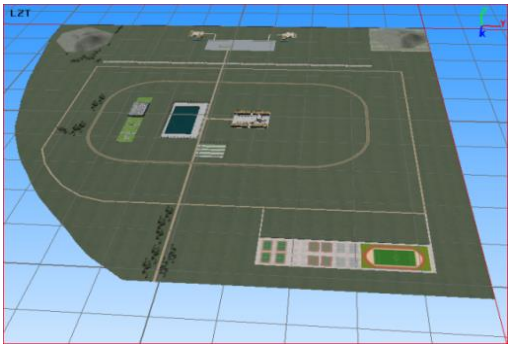


Fig.12 Doors hills by external reference

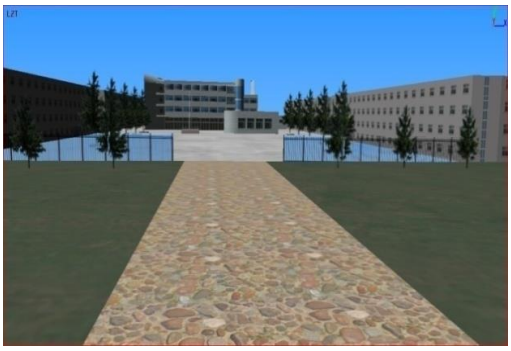


Fig.13 Panorama of the virtual scene

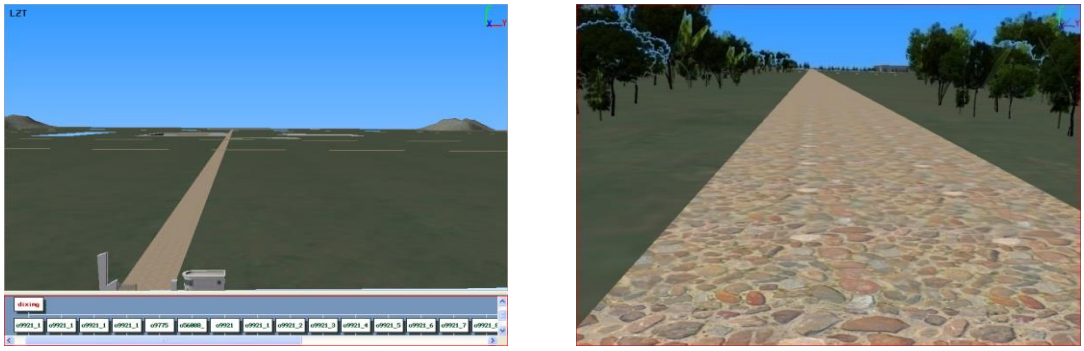


Fig.14 The scene effect of the viewpoint roaming

5. Test of the simulation results

In order to ensure the fidelity of the models, the experimental test is designed, the experimental system mainly consists of three parts: the visual display device, vehicle simulation driving device, the console and so on.

Among them, the visual display device mainly consists of cylindrical projection screen and three projectors, etc.; the main function is to present the visual driving image of the armored vehicle to the drivers in real time, so that they can response interactively. The vehicle driving simulation device mainly consists a driving simulation cockpit, control computer, displacement sensor and six DOF motion platform; the main function is to allow users to experience personally on the scene of “the real car driving”, and according to the movement of the six degree of freedom platform, make the visual graphics computer render and refresh the visual simulation of armored vehicle in real time. The console, as a core part of the system, includes the main control computer, the real-time simulation computer, KVM switch, visual graphics computer(a total of five left, middle and right scene and left, right rear view mirrors), sound controller, power supply controller as well as other equipment and cable; the main function is to achieve the mutual cooperation between the various console equipment through the Ethernet. The fidelity of the model is proved good, by comparing with the actual scene. Fig.15 shows the diagram of physical connection.

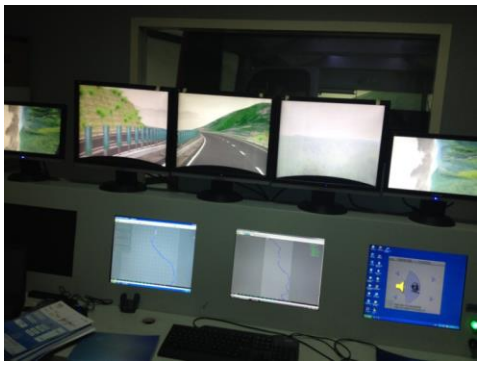


Fig.15 Diagram of physical connection

6. Concluding remarks

Firstly, this paper discussed the necessity of constructing the virtual driving scene of wheeled armored vehicle, described the modeling process of the scenes, and analyzed the organization structure of the scene model database; secondly, the paper constructed the models such as the sky, terrain, roads, buildings and wheeled armored vehicle; finally, the paper integrated the models reasonably, and showed the effect of the panorama of the virtual scene and the simulation scene when the user's viewpoint roaming in real time, and laid a good groundwork for real-time drive of the model database in the follow-up armed police armored vehicle virtual driving visual simulation platform.

References

[1] Chen Ming. Research on Virtual Simulation of Vehicle Test Field Based on MultiGen Creator [D]. Xi'an: Chang'an University, 2007.

[2] Xiao Yu, Liu Hongyi, Yang Ming. Research on Database Optimization Technology of Visual Simulation Model [J]. Modern Electronics Technique, 2007 (21): 92-94.

[3] Wu Hao, Su Weimin, Gu Hong, et al.Multi-target tracking with variable number in disturbing environment [J]. Journal of Applied Sciences, 2012, 30 (3): 263-269.

[4] Wang Wenjian, Shi Ying, Ren and so on, based on virtual reality scene simulation of large-scale scene [J], Journal of Shanxi University (Natural Science), 2014,37 (1): 64-69.

[5] Liu Xuewei. The Construction and Realization of 3D Scene Simulation System Based on VR - GIS [D]. Jinan: Shandong University, 2010.

[6] ZHAO Qi-feng, TIAN Chuan-yan, HU Jun-zhao, ZHANG Tong, et al.Optimization Design of Aircraft Visual Simulation Model Based on Multigen Creator [J]. Computer Measurement & Control, 2015, 23 (10): 3494-3497.Pan Weijun, Xiong Feng, Qiu Wenbin, and Wang Xuan. Visual Simulation Airport Training System Based On C919 Performance [J]. IEEE Workshop on Electronics, Computer and Applications, 2014, 78-81.

[7] Seung Yoel Kim and Yoon Sang Kim. A Virtual Driving System for Enhancing Efficient Driving Style [J]. International Journal of Multimedia and Ubiquitous Engineering, 2012, 7(2): 291-296.

[8] Franck GECHTER, Jean-Michel CONETET, Stephane GALLAND, et al. Virtual Intelligent Vehicle Urban Simulator: Application to Vehicle Platoon Evaluation [J]. SIMPAT, 2012, 24(15): 103-114.

[9] Aykent B, Merienne F, Paillot D and Kemeny A. Influence of Inertial Stimulus on Visuo-Vestibular Cues Conflict for Lateral Dynamics at Driving Simulators [J]. J Ergonomics, 2013, 3 (1): 1-7.

[10] Abdul-Hadi G. Abulrub, Alex N. Attridge and Mark A. Williams. Virtual Reality in Engineering Education [J]. IEEE Global Engineering Education Conference, April 4-6 2011: 751-757.

[11] Meng Qinghua, Gao Wei, Guo Xi, et al. A Study on Dynamic Collision Detection of Armored Vehicle in Visual Simulation [J]. AASRI Conference on Computational Intelligence and Bioinform atics, 2012, 6(7): 505-511.

[12] Hafner Polina, Hafner Victor, Ovtcharova Jivka. Experiencing physical and technical phenomena in schools using virtual reality driving simulator[C], 1st Tnternational Conference on Learning and Collaboration Technologies, LCT 2014-7:50-61.

[13] Du Y, Gao Y.Fault Detection and Isolation for Low Hardware Re-dundancy Flight Control System [J]. Journal of Energy and Power Engineering, 2014 (8):543-550.