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Analysis of Teaching Scene Design Based on VR Technology

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***Abstract*—In view of the present situation of limited teaching and training venues and insufficient equipment of communication specialty in colleges and universities, the scene model of communication specialty posts is constructed by using virtual reality technology. Through model rendering and application software programming, a virtual reality terminal device can be imported into the wearing of virtual reality equipment, which enables users to immerse in the virtual scene of communication posts, and provides technical support for teaching and training in colleges and universities. Practical results show that VR technology can solve the problem of resource shortage in teaching very well.**

Keywords—Virtual Reality; Teaching Scene; Three-dimensional Reconstruction; Resource shortage

I. INTRODUCTION

Aiming at the new requirement of war training in the development of virtual simulation, this paper studies the system architecture design of information communication virtual reality scene display from five aspects: three-dimensional scene generation technology, realistic virtual fusion rendering technology, complex entity behavior generation method, parallel interaction technology between virtual and real-world and evaluation method of virtual reality simulation system. It is applied to the development and integration of simulation visualization system with high immersion, high coupling and strong interaction[1].

II. SYSTEM ARCHITECTURE DESIGN

Aiming at the military training requirement of virtual simulation development, this paper studies the system architecture design of information communication virtual reality scene display from four aspects: system three-dimensional scene generation technology, realistic virtual fusion rendering technology, complex entity behavior generation method and virtual reality simulation system evaluation method[2].

A. Application of 3D Scene Generation Technology

According to the actual teaching environment and the technical conditions of virtual reality in colleges and universities, it is proposed to implement virtual reality scenes in communication professional workplaces, including program-controlled computer room, optical terminal computer room, TV and telephone conference room, satellite station, command post, data link ground station, oil engine room, etc., covering the overall scene, external scene and internal scene. Using the method of three-dimensional reconstruction based on multi-view theory, the camera parameters are calibrated and optimized to restore the geometric structure of the three-dimensional point cloud of the scene and reconstruct the three-dimensional mesh model of the scene which can be used in virtual simulation.

B. Application of Realistic Virtual Fusion Rendering Technology

In order to improve user's immersion and realism, satisfy the visual perception requirement of sharing illumination environment and forming occlusion relationship in virtual reality environment, the environment and illumination conditions, high dynamic changes of scenes, display characteristics and human visual perception characteristics are fused and rendered to construct a virtual reality environment with geometric consistency, illumination consistency and synthetic consistency.

C. Application of Behavior Generation Method for Complex Entities

The behavior of complex entities in the scene is analyzed. According to the behavior characteristics of entities, motivation set is added to the entity model, which changes from the traditional behavior mode determined by tasks, environment and individual state to the new behavior output mode after adding motivation. The motivation updating mode and behavior selection logic are designed to realize the real-time simulation of complex individual behavior.

D. Parallel interaction technology between the virtual and real world

By means of gesture interaction, voice interaction and virtual-real fusion interaction, the interaction is more natural and concise, and the user's immersion is enhanced.

E. Application of Evaluation Method for Virtual Reality Simulation System

In the design and evaluation of virtual reality simulation system, considering the influence of human factors and following certain design principles, the virtual reality system is designed and evaluated from the basic tasks of

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vision and hearing. At the same time, the experimental results of human engineering, psychology and cognitive science are used to guide the design of application. This paper evaluates the availability of virtual reality simulation system based on time and accuracy, as well as noise, delay and azimuth errors.

To sum up, the design process of the information communication virtual scene display system is as follows: firstly, the behavior database of complex entity model is established, and the behavior selection logic is implemented by using the motivation calculation function to form the entity action generation subsystem; secondly, the scene is generated dynamically and real-time by the multi-view based three-dimensional scene reconstruction technology; secondly, the high fidelity fusion rendering based on the perceived characteristics of human eyes is applied. Dyeing technology completes the generation of virtual reality environment; using gesture interaction, voice interaction and other multi-channel interactive means to achieve the natural interaction of virtual reality simulation system; finally, using credibility evaluation and usability evaluation methods to evaluate the effect of the system.

III. KEY TECHNOLOGIES OF SYSTEM

A. Visual-based Non-contact 3D Scene Rapid Reconstruction Technology

1) Camera calibration and optimization

Camera calibration and optimization is the process of determining camera internal and external parameters. The calibration accuracy has an important impact on the quality of follow-up three-dimensional reconstruction. Before camera calibration, it is necessary to model the camera imaging process. In this paper, a perspective camera model with radial distortion is used, which can be used to model common digital cameras and wide-angle cameras. The internal parameters of the camera include the focal length, radial distortion factor and so on. The external parameters of the camera include the global attitude information of the camera.

After obtaining the image sequence of the scene, it is necessary to extract and match the image feature points. In order to overcome the disadvantage of illumination and viewpoint to the greatest extent, this paper uses scale invariant feature transformation features with better comprehensive performance to detect and match image feature points. The feature points extracted by this feature have good distinguishability and repeatability, which lay a good foundation for multi-view image feature matching.

2) Point Cloud Reconstruction Technology Based on Multi-view Stereo Matching

Because of the changes of viewpoint and illumination, the lack of texture and other factors, the appearance of points in the three-dimensional scene is quite different in different views, which brings great challenges to stereo matching. The process of calculating the pixel correspondence among multiple views is called multi-view stereo matching, which is the key to generating dense three-dimensional point clouds. Most of the existing multi-view stereo matching vision methods needs additional information such as depth search range and bounding box, so they have some limitations in application. In this paper, a multi-view stereo matching strategy based on fragmentation is adopted, which includes three main steps: matching, diffusion and filtering[3]. The diffusion and filtering operations are executed iteratively until the pre-set termination conditions are met. As a whole, the normal direction and location of each segment are optimized. This optimization strategy simplifies the optimization process to a great extent and is conducive to the segmentation of reconstruction tasks. Of course, since each fragment is reconstructed and optimized separately without considering the neighborhood information, the normal direction of the fragment reconstructed by the above method may not be consistent with the spatial geometry. Especially when the normal initial value deviates greatly from the optimal normal value, it may fall into the local optimum.

3) Grid Surface Model Reconstruction Technology Based on Point Cloud

The accuracy of the three-dimensional image has an important influence on the quality of subsequent three-dimensional reconstruction. In order to solve the problem of generating 3D mesh model of scene based on point cloud; this paper adopts the method of surface reconstruction of three-dimensional point set based on region growth. First, seed triangle is selected, and then the surface of point cloud is reconstructed step by step. The construction process of seed triangle is as follows: firstly, the characteristics of point cloud are analyzed, the spatial distribution of point cloud is sorted out according to spatial index, then several starting points are set according to the distribution of point cloud, then the nearest points of each starting point are searched, and the starting points and their nearest points are connected as one side of the seed triangle to be selected. Taking the midpoint of the edge as the center of the sphere and the K times of the edge length as the radius, the searching sphere is established, and every point in the searching sphere is traversed. The triangle is formed with the known edge to verify whether there are other points in the smallest outer sphere of the triangle. If it does not exist, the triangle is the seed triangle to be selected to verify whether the triangle is on the surface of point cloud data, and if it meets the requirements, the seed triangle is constructed.

B. Research on Fusion Rendering Technology with High Fidelity Based on Human Eye Perception Characteristics

1) Delayed shading rendering

According to the principle of graphics, in order to satisfy the requirement of the fidelity of environment reconstruction and the consistency of brightness perception of the image eventually displayed on the hybrid reality

display device, it is necessary to perform secondary light effects and light adjustment characteristics on the basis of one-time rendering calculation of the illumination characteristics of scene objects. The specific method is based on a primary image rendering, real-time statistical calculation of the entire image characteristics, optical effects, brightness adjustment and high adaptability dynamic calculation, and then re-rendering to form the final display of the realistic image[4][5].

Delayed shading technology is that the simulation only needs to submit scene geometric elements once in the cycle, and the attributes of each pixel (geometric location, normal, diffuse reflection, mirror reflection coefficient, material and other attributes) are stored in the geometric memory for subsequent rendering. On the basis of geometric buffer, each pixel in illumination stage, post-processing stage and final stage is colored independently. Post-processing is implemented by pixel buffer, which reduces the interaction between graphics card memory and rendering channel and improves efficiency.

2) High Dynamic Rendering and Special Effect Rendering

Traditional hardware-accelerated rendering systems can only produce low dynamic range rendering results. For scenarios with high brightness sources (sun, lighting, etc.), rendering results are often seriously distorted. The main reason for this problem is that the scene has a high dynamic range. In order to solve the problem of insufficient dynamic range, a floating-point light map can be created for each surface in the virtual scene. Each pixel represents the light intensity of the corresponding position on the surface. Rendering a scene bound to a floating-point illumination map into a floating-point texture with the same screen size can improve the brightness contrast of the pixels[6].

Affected by environmental light, lighting and other factors, it is easy to appear local halo and light saturation. This saturation is related to human vision. High-pass filtering is used for the highlighted part of floating-point texture memory. After scaling, the filtered image is blended horizontally and longitudinally, and then fused with the original image to form saturated special effects.

C. Multichannel Parallel Interaction Technology between Virtual and Real World

1) Gesture Interaction Technology Based on Hidden Markov Model

Gesture recognition can be divided into three steps: first, gesture modeling, namely acquisition of gesture image, speed, direction and other information; secondly, gesture analysis, that is, the collected gesture data are processed according to the characteristics of gesture recognition methods; finally, the classification algorithm is used to classify and recognize the processed data.

One of the difficulties in gesture modeling is how to define the beginning and end of an independent gesture. Through the analysis of dynamic gesture, this paper uses a method based on the change rate of gesture speed and direction to solve this problem.

2) Speech Interaction Technology Based on Hidden Markov Model

Compared with gesture recognition system, speech recognition system is more mature. HMM is widely used not only in human motion, but also in speech recognition.

The system includes five parts: preprocessing, feature extraction, reference model, pattern matching and post-processing. Pre-processing includes gain control, pre-filtering, A/D conversion, pre-emphasis, windowing and other operations. Before analysis and processing, we must find out the part to be analyzed from the speech signal, which is endpoint detection, and it is also one of the hot topics in speech recognition. Feature parameter extraction refers to extracting the parameters representing the speech signal characteristics, such as short-term amplitude, energy, zero-crossing rate, autocorrelation function, LPC coefficient, etc. Each reference pattern corresponds to each recognition in the vocabulary of the system. The feature parameters of the unit; pattern matching is to measure the distance between the test pattern composed of the features of the word to be identified and each reference pattern stored in the system.

3) Virtual-Real Fusion Interaction Technology

Virtual-reality fusion technology has always been a hot and difficult issue in the field of human-computer interaction. The most difficult part is the matching of virtual objects in the interaction process. It requires accurate object tracking and positioning technology to achieve seamless fusion of real scene and virtual scene. The tracking and positioning technology in this paper mainly includes two parts: the tracking of position and attitude of operating equipment and the tracking and positioning of human body in the interactive process, which makes the operation seamless and enhances the immersion of the system.

IV. MAIN FEATURES OF THE SYSTEM

A. Strong immersion

Students are just like visiting the actual communication scene. Because the system is a wearable VR device, compared with the traditional virtual reality system, the user's immersion is stronger. Moreover, the system designs scene rendering and multi-channel interaction, improves scene rendering fidelity and user experience, deepen students' learning impression, and effectively improves the teaching effect.

B. Rich in Functions

It can satisfy the teaching training, and has the functions of communication system introduction, virtual scene browsing, analog communication system work and free operation. It can completely replace the real-time teaching under the condition of less installation. It is convenient for students to comprehensively understand the whole

information communication system from the system. Compared with theoretical knowledge explanation and picture and video visit teaching, the system can provide students with a lifelike experience. The multi-functional information and communication virtual reality scene display environment have changed the situation that students only have abstract theoretical knowledge. Through the virtual reality teaching demonstration, students can adapt to their posts faster after graduation.

C. Good Benefits

In the past, the construction of teaching and training sites was expensive and easily lagged behind the speed of innovation of military scientific and technological equipment. The development of virtual reality system can effectively solve these problems and can develop a variety of virtual reality applications based on wearable VR equipment for military purposes. It is conducive to the students of communication specialty to understand the communication system as a whole and understand the whole system of their specialty. What kind of role to play is more specific and intuitive to the study of this major, and the military and economic benefits are very considerable, which has important military teaching significance.

V. SUMMARY

In the practice course of the spring semester of 2019, teaching contents such as organization and application of communication equipment operation based on VR technology were added. Questionnaire survey and actual assessment show that students can also better complete the learning task under the condition of shortage of equipment resources. Therefore, teaching scenario design based on VR technology should be promoted in a wider range and more specialties.

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