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From Third Person to First Person: The VR Education Systems

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Abstract. Based on VR technology, the core task of VR education system – system simulation is reviewed. This paper analyzes the formation framework of VR education system, discusses the current development status of VR education system based on field difference classification, and compares the key problem solving techniques of VR technology to achieve the simulation of education platform. The noise reduction is based on filtering, and the noise reduction effects of median filtering, smooth filtering model and bilateral filter are compared. Compare Laplace, virtual viewpoint rendering algorithm of hierarchical image fusion, Newton iterative algorithm and so on to ensure clarity. VR education system can help students understand the abstract symbolic knowledge, provide students with a faster way to gain direct experience, break the knowledge barrier, is conducive to teaching and learning of teachers and students, and promote the development of education. Finally, several possible key directions of future research on "VR+ education" are put forward.

Keywords: VR technology · Simulation of VR education system · Review

1 The Introduction

Recently, the research on the application of VR technology in education focuses on ideological and political courses, safety education, medical education and so on. The development and application of virtual educational system resources can not only make abstract theoretical knowledge visible, help students to obtain direct experience, but also can be used repeatedly and effectively save costs. Dewey's "learning by doing" and the Cone of Experience theory prove that VR technology has a broad prospect in the field of education. This paper discusses the key construction and development status of VR education system.

2 The Framework of VR Education System

VR education system consists of data support and storage layer, logic layer and application layer [5]. The VR creation platform of the logical layer is the basis of building the

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Table 1. Comparison of VR system development software

Software	Support dimension	Programming language	Compatibility	Cross-platform	Interactive	Output support platform
Unity 3D	2D, 3D, VR, AR, MR	C#, JavaScript, Boo	optimal	optimal	optimal	mobile, tablet, PC, game console, virtual device
Unreal Engine	3D, VR	C#	good	optimal	optimal	PC, Playstation3, xbox 360
I dear VR	3D, VR	C#	optimal	optimal	optimal	PC, Web, Quest, tablet, mobile
Core	3D, VR	C++	optimal	optimal	optimal	PC
Cocos Creator	2D, 3D, VR	C++, Lua, JavaScript	good	optimal	optimal	Web, iOS, Android, Harmony OS, Windows, Mac
Virtool	2D, 3D, VR	C++	good	optimal	good	PC
VRP	3D, VR	C++	average	N/A	optimal	Microsoft Kinect for Windows, Data love, Cyber Glove, Cyber Touch, Cyber Grasp, Trackers Patriot, Liberty, Head mounted display
Quest 3D	2D, 3D, VR	C++	short	N/A	average	PC

VR education system. The mainstream VR system development platforms are compared and analyzed based on seven dimensions, as shown in Table 1.

The use of VR education system is inseparable from the device port of information reception. The VR reception and presentation devices currently used in VR education system are sorted out, as shown in Table 2.

Based on the spatial conditions of VR education activities, VR education activities were divided into two categories: close range and long range.

2.1 Close-Range VR Education System

The close-range VR education system is in a place supported by a physical environment (Xv 2015), such as schools and other educational fields, the use of VR technology to show the teaching content of the education system. Take "Wuo" VR teaching system as an example to build CUDA system framework based on GPU. The trapezoidal curve transfer function is used to realize data graphics. Different colors are used to show the difference in viewpoint [6]:

$$C_{i,new} = C_i(1 - k_{dw}) + k_{dw}(C_n \frac{d_1 - d_{min}}{d_{max} - d_{min}} + C_f(1 - \frac{d_i - d_{min}}{d_{max} - d_{min}})) \quad (1)$$

Table 2. Comparison of VR reception and presentation devices

Product		Performance					
		Resolution (binocular)	Clarity	Fluency	Tracking Situation	Interface	Wear Experience
Semi-finished product	Google Cardboard	N/A	average	average	short	N/A	rough
	Switch Labo VR	720P	good	average	N/A	N/A	general
The finished product	HTC VIVE	2160 × 1200	optimal	optimal	optimal	USB	light and comfortable
	Oculus Rift	1920 × 1080	good	average	average	DVI, HBMI, Micro, USB	general
	Oculus Quest2	1832 × 1920	optimal	good	optimal	USB-C	light and comfortable
	Pico Neo2 lite	3840 × 2160	optimal	optimal	optimal	USB	light and comfortable
	Play Station VR	1920 × 1080	optimal	optimal	optimal	HBMI, USB	light and comfortable
	Leap motion	N/A	optimal	optimal	optimal	USB	light and comfortable

Based on Leap Motion sensor and high-precision frequency, 3D coordinates of the hand and other limbs are constructed to obtain accurate 3D coordinates to ensure the simulation of scene interaction. Abstract knowledge is materialized, and students interact and "contact" with knowledge directly, but the placement of projection screen is limited by space. The literature [6] takes the computer as the presentation medium of VR teaching resources, reducing the space requirements, and using 5G to transfer resources, students learn with the help of computers and VR glasses. Many VR education systems realize the transmission of educational information and content based on Browser/Server (B/S) mode, but there is a bottleneck in the hardware terminal, most of the systems only support single-player mode, and the problem of hardware and software compatibility makes it impossible to use resources repeatedly. The literature [7] based on LAN and 5G cloud, the VR education system architecture realizes the learning mode of fast information transmission and download and multi-person participation without time and space constraints. Multiple mainstream browsers ensure the output and feedback of information, and multiple GPU virtual environments meet the individual needs of learners. The above system construction focuses on the fluency of educational information transmission and reception. In addition, the system mainly presents descriptive data, which makes it difficult for teachers to make value judgments.

The common problem of the close-range VR education system is that the setup and processing links are complex, and teachers need to be trained to use the system. Data transmission has a high requirement for network, but 5G network has not achieved full coverage, resulting in delayed transmission and short learning experience.

2.2 Remote VR Education System

Distance VR education system is supported by distance education technology [1], the use of VR technology to achieve remote two-way interactive virtual learning education system. Foreign countries use Second Life to build research distance teaching space [3, 8], most of the research in China ([18], Yuan 2021) stay in the stage of resource creation and application. The literature [1] reveals the problems of remote VR education system: the rendering of VR effect and the control of video playback. It proposes to use OpenGL ES of Android system to complete the video rendering work, and use GL Surface View module to present teaching content on the surface. The literature [18] uses Rummii virtual teaching space, YouTube VR live streaming platform, ZOOM video conference system and related hardware are used to build a distance teaching framework, provide three kinds of teaching scenarios, break the defects of local area network in interesting virtual teaching, and realize the "close" interaction between teachers and students. To guide students in different places under the Internet to establish a knowledge system and realize knowledge transfer [18]. However, the development of live broadcast teaching activities is limited by the network, and teachers need to consider how to choose or focus on a variety of scenarios to ensure the achievement of teaching objectives.

3 Key Technologies of the Simulation of VR Education Platform

The simulation of VR education platform is determined by the quality of VR video and image. Image noise, blur, overlap, artifacts, holes and so on are the reasons that lead to the degradation of image quality. In view of the above reasons, the relevant solutions are discussed.

3.1 Image Denoising in VR Education Scene

Image noise is one of the reasons for reducing image quality. This section summarizes the current mainstream methods of image denoising in educational scenes. Taking filtering as the basis point, the smoothing filtering model is proposed as follows [14]:

$$f = <f, d_{\gamma o}> d_{\gamma o} + R_f \tag{2}$$

The literature [22] with bilateral filters:

$$g(i, j) = \frac{\sum_{kj}^{n} f(k, l) w(i, j, k, l)}{\sum_{kj}^{n} w(i, j, k, l)} \tag{3}$$

Combined with the analysis of gray similarity, edge-preserving denoising is realized. On the basis of median filtering: the image is processed by point cloud [12], the second denoising, adding a threshold to establish the extreme median filtering algorithm [14], eliminate noise wave points. The filtering based denoising method is to preserve the detailed features of the image and optimize the neutralization of the denoising, and the quality of the image is less improved. Noise Filtering in Small Area VR: The uniformly distributed pixel level of VR laser imaging in a small area is proposed as follows [13]:

$$f_R(z) = \begin{pmatrix} f_x(z) \\ f_y(z) \end{pmatrix} = \begin{pmatrix} h_x^* f(z) \\ h_y^* f(z) \end{pmatrix} \tag{4}$$

The literature [9] combined with wavelet decomposition method, pixel color matrix is constructed. The literature (Zhou 2015) based on spherical crystal backlight imaging, the simulation software SHADOW processing is used to reduce noise. The above methods achieve noise reduction in small areas and improve the processing accuracy, but the workload is increased and the pixel distortion is faced [24]. Visual communication technology is used to generate 3D images, remove noise and ensure edge display (Huang 2020). The above algorithms are effective for image denoising, but affect the clarity of the image itself.

3.2 Image Definition of VR Education Scene

The clarity of the educational scene image is based on the optimization of the detail area, highlighting the overall advantages. The causes of low clarity include image blurring, overlap, artifacts, holes, and the destruction of texture details and edge structures. Image blurring: Using Laplace (WeiChi 2021):

$$f_3(x, y) = \frac{sf_2(x, y)}{sx^2} + \frac{sf_2(x, y)}{sy^2} \tag{5}$$

The blurred image is sharpened to highlight the details and edges, and the position of the defect structure is processed by pixel and phase transformation to reconstruct the pixel association and compare the strength (Xv 2021) to enhance the details and improve the picture quality. Image Overlap, Artifacts, Holes: The literature [10] introduces depth information in priority calculation to avoid problems such as overlap, the literature [15] suppress false extensions of foreground textures in blocks to be filled, the overlapping and artifact problems are solved by the depth map and the maximized inter-class variance algorithm [20]. Virtual Viewpoint Rendering Algorithm Based on Hierarchical image fusion [2]:

$$endl_v(u, v) = \begin{cases} Iv(u, v), & Iv(u, v) \neq 0 \\ BIv(u, v), & Iv(u, v), = 0 \end{cases} \tag{6}$$

Image artifacts are eliminated, layered fusion is used to fill the void, and depth information is introduced to solve pixel overlap. Complementary viewpoints are used to erase the artifacts, and double visual cavities are filled based on the forward mapping of different viewpoints [2]. Texture Details and Edge Structure: This paper [11] proposes an edge-oriented interpolation algorithm, which uses eight-direction edge detection with adaptive threshold to divide the image region, adjust the proportion of texture details freely, and preserve the texture details and edge structure.

The literature based on Newton's iteration method [21]:

$$\phi(Z) = Z - \frac{f(Z)}{f'(Z)} \tag{7}$$

Consider the maximum diameter and sequence block specification parameters, enhance texture details but have low processing efficiency.

4 Conclusion

This paper discusses the framework of VR education system construction in recent years, the system comparison based on field differences and the key technologies of system simulation construction. The common problem existing in the current VR education system is that the setting and processing links are complex and the application is affected by the network. In addition, the preset application is idealized. Three aspects may be the focus of VR+ education, including "VR+ education" ethics research, standardized VR+ education platform building framework research, VR+ education system learning effect evaluation research.

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