Application of VR in ophthalmology clinical teaching

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Abstract: With the continuous application of Virtual reality technology (VR) in medical teaching, disease diagnosis, surgical simulation, rehabilitation medicine, telemedicine and other medical fields, virtual medicine came into being. The rapid development of virtual medicine has brought new weather to the medical field, and also provided new means, new methods and new platforms for ophthalmology teaching. The rapid development of information technology makes the application of VR in ophthalmology teaching more and more extensive. This paper proposes an optimization design scheme for the application of VR in the clinical teaching of ophthalmology. Through the analysis of the eye structure based on the principle of refraction, the VR is used to build a clinical teaching simulation system. Finally, the simulation test analysis is carried out. The simulation results show that the algorithm has a certain accuracy, which is 7.45% higher than the traditional algorithm. As a new technology, VR, with the continuous development of computer and Internet technology, its application in the field of medical education will have a significant impact on medical education, accelerate the speed of medical transmission, and its advantages for training medical students will be fully demonstrated, and its application will be more and more extensive. The VR teaching method can promote the homogeneity of medical education and assessment, thus shortening the training cycle of medical talents, reducing the training cost and reducing the risk.

Keywords: Virtual reality; Ophthalmology Department; Clinical teaching，Application

1 INTRODUCTION

The traditional mode of ophthalmology clinical teaching mainly relies on oral teaching by teachers, combined with hand gestures, wall charts, models and other means and tools. There are many shortcomings in the intuitiveness, visualization and interactivity of teaching[1]. In addition, the number of students in medical colleges and universities has increased significantly, the instructors are insufficient, the teaching funds are tight, and the more severe doctor-patient relationship makes it impossible to carry out some clinical teaching experiments that should be set up[2]. There are also problems such as patients' unwillingness to cooperate with teaching due to their own health concerns or privacy protection, which leads to unsatisfactory clinical teaching effect of ophthalmology. It is increasingly difficult for ophthalmology interns to directly participate in the invasive examination and treatment process during clinical practice [3]. This situation will inevitably lead to a decline in the quality of medical education and will affect the level of ophthalmic medical services in the future. All these indicate that the existing

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teaching methods and means can no longer meet the needs of modern medical teaching, and the clinical teaching of ophthalmology should also follow the trend of reform.

VR refers to the user's interactive experience with the virtual three-dimensional world through the head mounted display and wearable devices [4]. At present, in the field of medicine and education, the relevant applications of VR technology mainly include the following aspects: (1) VR surgery live broadcast or VR surgery demonstration video recording. Different from traditional live surgical broadcast or surgical teaching video, after wearing the corresponding VR display device, the experiencer is like standing in a real operating room, and can rotate in all directions to watch the panoramic view of the operating room, and can flexibly switch between the surgeon's perspective, the visitor's perspective, and the patient's perspective. In this way, the experiencer can visit the surgery according to their own needs and watch how the assistant team cooperates with the surgery. (2) Virtual learning environment. (3) Auxiliary skills training. VR technology is used for simulation training. Compared with practical training, it has the advantages of avoiding security risks, saving school running costs, and stimulating students' interests [5]. In view of the advantages of VR, this paper uses VR to build simulation system, in order to reduce the cost of algorithm implementation.

VR has been introduced into the clinical teaching of ophthalmology, which provides a new and effective learning environment for interns by building an eye anatomy simulation system, a simulation system for various clinical features of ophthalmology, and a simulation practice training simulation system [6]. Teaching practice shows that the application of VR in ophthalmology clinical teaching has a positive significance for improving the quality of ophthalmology teaching [7]. The perfect combination of medical treatment and VR technology will subvert the traditional medical education experience and greatly improve the accuracy, practicality and flexibility of medical education [8]. In this paper, the reconstruction model of the optimal design of the development path of the characteristic cultural industry is established, and the fuzzy feature quantity of the optimal design image of the characteristic cultural industry is extracted. Its innovation lies in:

(1) In this paper, VR is used to build simulation system in order to reduce the execution cost of the algorithm.

(2) This paper constructs the key feature quantity of the optimized design image in the application of VR in the clinical teaching of ophthalmology, and realizes the optimal design and optimal recognition of the application of VR in the clinical teaching of ophthalmology by using the principle of refraction.

The research framework of this paper is as follows:

The first section is the beginning. It mainly describes the research background and value of the subject, and puts forward the research purpose, method and innovation of this paper. The second section describes the subject literature, summarizes it and puts forward research ideas. The third section is the research method, which is mainly about the optimization design method of the subject combining refractive principles and VR. The fourth section is the experimental part. This part has carried on the experimental verification in the data set, and analyzed the performance of the model. The fifth section is the conclusion and prospect. This part mainly reviews the main contents and results of this study, summarizes the research conclusions and points out the direction of further research.

2 METHODOLOGY

2.1Analysis of Eye Parameters Using Refractive Principles

The roaming and immersion technology in VR is applied to the three-dimensional medical anatomy human body data set, and the first generation of medical simulation system is produced [9]. The first generation medical simulation system focuses on the geometric information of human organs, plays a very important role in teaching and medical staff training, and provides a more intuitive and emotional training environment [10]. The anatomical structure of the eyeball is the basis of ophthalmology teaching [11]. As the eyeball structure is complex and precise, students generally feel difficult and confused when learning. The anatomical model of the eyeball is constructed by using 3ds Max to make the teaching process of the abstract ophthalmic anatomical structure vivid and vivid, so as to promote students to understand and master knowledge more accurately and comprehensively. For example, in the study of the structure of the anterior chamber angle, the teacher used the virtual three-dimensional anatomical structure of the eye and some multimedia animation materials to let students intuitively and stereoscopically learn the composition of the anterior chamber angle, the relationship between the position, size, shape of the structure of the anterior chamber angle and the surrounding tissues, and let students dynamically observe the aqueous humor circulation. In this way, students can not only fully grasp the structure, but also understand its function.

The eye is a very important and sophisticated organ in human body, and it is the window for people to obtain external information. The optical system of the human eye is a complex biological combination. The outermost layer of this system consists of the anterior cornea, anterior chamber, lens structure, aqueous humor and retina which have a fovea before being processed by the brain. Myopia, hyperopia and astigmatism caused by ametropia are common diseases in ophthalmology. Although it will not bring great pain to patients, it will affect their normal life and study.

Analyzing the structure of the human eye, it is found that the human eye is an ellipsoid with irregular shape. As far as the cornea is concerned, it is a thin film with thick edges in the middle. According to the eye parameters of the precision model, as shown in **Table 1**, the cornea model is established. Because the cornea of the precision model is axisymmetric, and the loading mode is also symmetrical.

Table 1 Geometric parameters in corneal model

Radius of anterior corneal curvature	7.7mm
Radius of posterior curvature of cornea	6.8mm
Anterior chamber depth	3,1mm
Central corneal thickness	0.5mm
Limbic thickness of cornea	1.1mm
Mark ring diameter	6mm

According to the refractive principle of human eyes, the expression of human eye refractive power is:

$$D=(n_2-n_1)/r \tag{1}$$

Where:

n_2 ——Refractive index of cornea

n_1 ——Refractive index of air

r ——Radius of curvature of cornea

For a specific human eye, n_1 and n_2 are certain constants, because the radius of refractive curvature of the cornea r is the main parameter affecting the corneal refractive rate.

Differentiate equation (1):

$$dD = -\frac{n_2 - n_1}{r^2} dr \tag{2}$$

Under the premise of r deformation,

$$\Delta D \approx -\frac{(n_2 - n_1)\Delta r}{r^2} \tag{3}$$

The change rate of corneal refractive power D η is

$$\eta = \left|\frac{\Delta D}{D}\right| \times 100\% \approx \left| -\frac{(n_2 - n_1)}{r^2} \bullet \frac{r}{n_2 - n_1} \bullet \Delta r \right| = \frac{|\Delta r|}{r} \times 100\% \tag{4}$$

It can be seen from Formula (4) that the change rate of corneal refractive power D η is approximately the same expression as the change rate of corneal radius of curvature after corneal surgery, that is, the change rate of corneal radius of curvature after surgery can accurately reflect the change of corneal refractive power and express the degree of correction of corneal refractive power after surgery.

2.2 Design Optimization of Simulation System Based on Virtual Reality Technology

Although VR technology still has many problems to face in the field of ophthalmology teaching, the positive effect of VR technology on the teaching of fundus vascular diseases cannot be ignored. First of all, students understand that the symptoms of patients with eyeground vascular disease are relatively abstract through the description of teachers or books. VR technology can build three-dimensional scenes to simulate various fundus vascular diseases, such as macular degeneration, retinopathy, choroid, etc. Secondly, medical students can not master the detection equipment of ophthalmology in clinical practice, and can not fully understand the changes of ophthalmic diseases. VR technology can simulate the characteristics of different diseases. Students can repeatedly observe the morphology of lesions, and deeply experience the changes of blood vessels under the disease state. Finally, due to the limitation of clinical practice samples, medical students can hardly personally experience the feeling of surgical treatment for the eyes during the practice. VR technology can simulate the vascular state of eye lesions. For example, under the condition of senile wet macular degeneration disease, students can simulate the injection of anti vascular drugs into the vitreous body in a virtual environment to improve the clinical practice ability of ophthalmology students. The application of eye clinical teaching based on VR technology can stimulate the learning interest of the students in hospital regular medical training, improve the teaching environment, and significantly improve the students' mastery of theoretical knowledge and clinical practice skills.

The characteristics of the development of medical simulation system: (1) The object described is a human organ, which is relatively complex, involving a large number of modeling calculations and optimization algorithms. The amount of calculation is huge, and the selected development tool is required to have excellent computing capacity. (2) The simulation system is different from the general scientific calculation, it also needs to have a better visual effect, which is convenient for users to operate and at the same time gives users a pleasant feeling. Therefore, this requires that the selected development tools have better visual development capabilities. (3) The medical simulation system is different from the general simulation software. It needs to improve its functions with the development of technology and the increase of clinical data over time, which requires that the development tools we choose should have good technical support and continuity.

According to the actual needs of corneal virtual simulation system, the simulation system mainly includes interactive simulation, simulation calculation, database management and other modules. They are organically linked through the cornea database to realize all the functions of the medical simulation system software for semiconductor laser corneal thermoforming hyperopia treatment. The structure of the virtual simulation system is shown in **Figure 1**. Among them, the scheme prediction module mainly includes the calculation of surgical parameters, the calculation of corneal thickness and the calculation of corneal refractive power. The interactive simulation module includes the simulation of surgical principles, two-dimensional simulation demonstration and three-dimensional simulation demonstration. The database management module is mainly used to input and save some basic patient information, corneal feature information, surgical parameter information and postoperative examination information of patients.

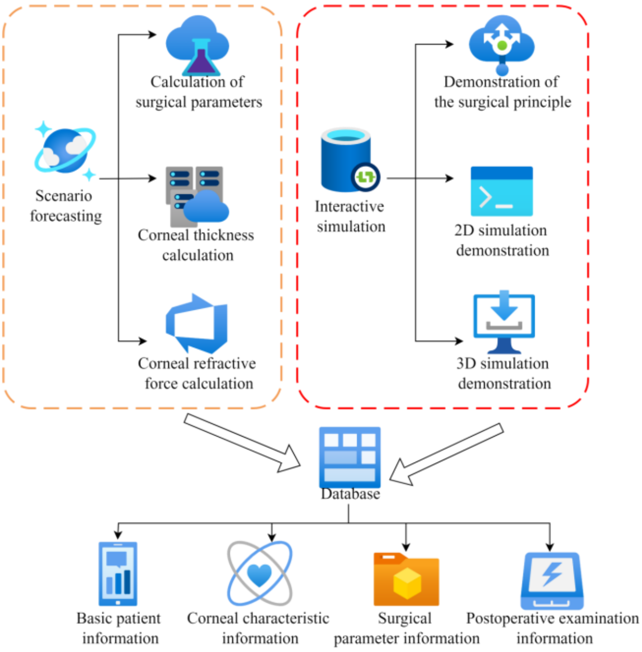

Figure 1 Functional Structure of Virtual Simulation System

According to the basic information of the patient's corneal characteristics and the basic parameter information of the semiconductor laser, the surgical plan is formulated through simulation calculation, that is, for the individual patient, the laser energy parameters, the diameter of the photocoagulation zone and the number of photocoagulation points are determined. After the surgical parameters are determined, the refractive power and the refractive power of the whole eyeball can be calculated by predicting the radius of corneal curvature after surgery. Then, according to these parameters, enter the interactive simulation module, and through two-dimensional simulation and three-dimensional simulation, you can intuitively demonstrate the postoperative effects.

The 2D simulation is mainly based on the standard eye geometric parameters to establish the 2D model of the eye. Considering that laser keratoplasty only changes the shape of the outer surface of the cornea, the front end of the eye, to correct hyperopia, physical changes only occur on the outer surface of the cornea before and after the operation. Therefore, in the process of two-dimensional modeling of parametric eyes, more attention has been paid to the changes in the shape of the outer surface of the cornea. The outer surface of the cornea uses a B-spline curve with flexible features, and other feature lines are described by rigid lines.

When constructing the outer surface of the cornea, the radius of curvature inside the corneal photocoagulation area becomes smaller, while the radius of curvature outside the photocoagulation area becomes larger. Therefore, a B-spline curve with control points is used to control the shape of the curve. The layout of control points is shown in **Figure 2**.

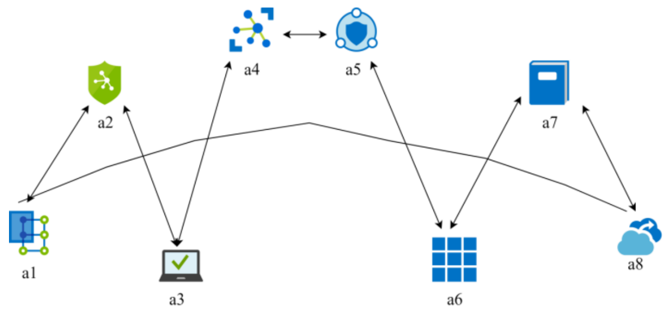

Figure 2 Schematic Diagram of 2D Simulation

3 RESULT ANALYSIS AND DISCUSSION

In the clinical teaching of ophthalmology, it is generally difficult for students to learn because of the small size of the eyeball, the complex and fine structure, the difficulty in obtaining anatomical eyes and the long learning curve of micromanipulation. In the traditional teaching process, it is difficult for teachers to directly show the eyeball anatomy, physiological metabolism, disease onset process, surgical procedures, etc., so as to strengthen students' understanding of the teaching content. The actual teaching effect is poor. This study introduces VR technology into the clinical teaching process of ophthalmology and evaluates the teaching effect, so as to investigate the application value and application space of VR in clinical teaching of ophthalmology.

With the application of high resolution virtual reality video, its characteristics of high resolution and high frame rate lead to the increase of coding complexity, which brings great challenges to video coding. In the intra frame coding of virtual reality video, it is necessary to traverse each size of CU, calculate the prediction mode of PU in CU one by one, find out the optimal prediction mode and calculate the rate distortion cost, so as to obtain the optimal CU partition mode. Although this coding method can obtain the optimal CU division method, due to the high resolution of virtual reality video, it brings a huge amount of computation to intra coding. After studying the texture features of LCU and their relationship with LCU depth, a fast CU partition algorithm based on LCU depth prediction is proposed.

Generally speaking, CUs with simple content will occupy less bits after encoding than CUs with complex content, while CUs with complex content often need to be divided into smaller CUs to encode them. This chapter judges whether to terminate the CU ahead of time and continue to divide it downward according to the number of coded bits of the CU, so as to reduce the computation in the encoding process. In the projection process of format virtual reality video, the high latitude area will have redundancy due to stretching, and after reverse projection, the high latitude area will be restored to the spherical surface, greatly reducing the area. Therefore, the coding quality of the high latitude region has little impact on the overall video quality, but the high latitude region consumes the same computing resources as the low latitude region when encoding. This section further optimizes the algorithm based on this feature. When encoding, we can consider making the CU in the high latitude region stop dividing as early as possible, so as to further reduce the computational load during the coding of virtual reality video frames, and thus improve the coding speed.

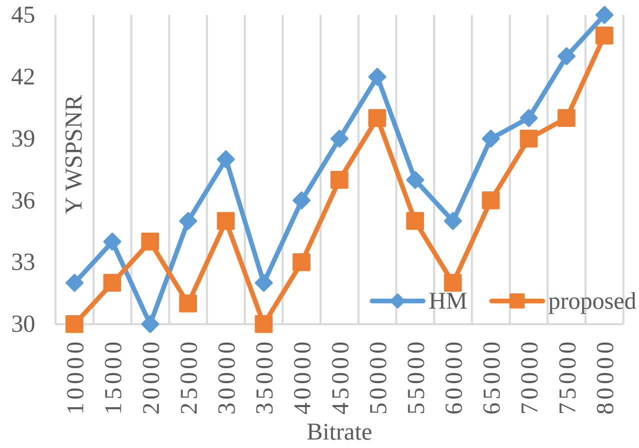

Figure 3 Distortion Rate Curves of Broadway under Different QPs

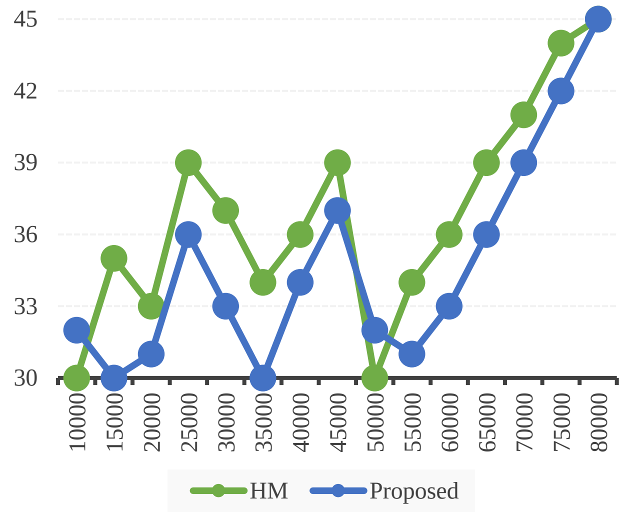

Figure 4 Distortion Rate Curves of PoleVault under Different QPs

Figure 3 and Figure 4 show the distortion rate curves of the test sequence Broadway and PoleVault under different QPs, respectively. The QPs of the four points are 40, 25, 38 and 28 from left to right. It can be seen that the smaller the quantization step is, the higher the video quality loss of this algorithm is. This is because the smaller the quantization step is, the more complex the CU structure of LCU division is, so there will be more misclassification of LCU.

In order to make the training set data more suitable for the video to be encoded, this section divides the video to be encoded into training frames and prediction frames. When encoding the prediction frame, the classifier is used to predict the depth of LCU with the data of the training frame, reducing the iteration range when dividing the CU, so as to reduce the calculation amount of virtual reality video coding.

4 CONCLUSIONS

This paper proposes an optimization design scheme for the application of VR in the clinical teaching of ophthalmology. Through the analysis of the eye structure based on the principle of refraction, the VR is used to build a clinical teaching simulation system. Finally, the simulation test analysis is carried out. The simulation results show that the algorithm has a certain accuracy, which is 7.45% higher than the traditional algorithm. This result fully shows that the construction of a simulation system for various clinical features of ophthalmology and a simulation practice training simulation system provides students with a novel and effective learning environment, which is conducive to the improvement of clinical teaching quality and the development of modern educational technology research. VR will become the mainstream of network multimedia development in the future. The characteristics of medical education determine that the teaching system supported by VR will be a breakthrough in the application of educational technology in medicine. In the field of medicine， Has its particularity， More emphasis on real-time and feedback of simulation process， Therefore, in the process of virtual simulation It is also necessary to further consider the information feedback of force interaction during surgery implementation and the rendering speed during display. Therefore, the real-time display speed needs further research.

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