Design and key technology research of virtual training system for new coronavirus detection

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Abstract—**Aiming at the problems of large consumption of new coronavirus detection materials and high risk of infection, a virtual training system for new coronavirus detection is designed and developed based on virtual reality technology. The system establishes a 3D model of new coronavirus detection scene and medical equipment, and simulates the process of pre detection, diagnosis, wearing protective clothing and nucleic acid collection. Combined with the system evaluation function, it can effectively improve the learning interest and efficiency.The results show that the irreversible medical operation with high risk of infection and the practice that is difficult to practice on site at ordinary times can be converted into the operation that can be practiced repeatedly.It has a certain reference significance to explore the application of virtual reality technology in medical training.**

Keywords—New coronavirus detection,virtual reality; training system

I. INTRODUCTION

At the beginning of 2020, the outbreak of new coronavirus pneumonia was rapidly defined as "respiratory class B infectious diseases according to class a management" because of its highly infectious and high pathogenic rate.As a new type of respiratory infectious disease, how to effectively train medical staff in the shortest time, reduce the consumption of medical supplies and reduce the risk of infection has important clinical significance.

This system constructs a variety of scenarios of new coronavirus detection clinic through virtual simulation technology, strengthens the training of process and medical staff protection, and shows the scene combined with actual cases, so that the medical staff can achieve the training effect similar to the field training through virtual simulation technology before taking up their posts, at the same time, it can reduce the risk of infection of medical staff and the consumption of medical materials, and improve the quality of life high learning interest and effect, will have a high risk of infection, irreversible medical operation and usually difficult to practice scene into a repeatable operation

platform.[1]

II. DESIGN OF VIRTUAL TRAINING SYSTEM FOR NEW CORONAVIRUS DETECTION

The simulation system can not only watch and learn, but also have the characteristics of participation and interaction. Medical staff and students can participate in it at any time. Different decisions and behaviors will lead to different results. Virtual new crown patients will present different states according to different choices. Different rescue locations also provide different disciplines and professional experiences and feelings.Simulation training can relatively improve the rescue ability and self-protection ability of each trainee.It brings immersive on-the-spot experience for medical teaching and achieves the purpose of participatory teaching.[2]

The system realizes the applications development og PC end and VR end,including 6 scenes,11 interactive learning modules and 2 assessment modules,as shown in Figure1.Recommended configuration:CPU 8 core,memory 16GB,GPU model NAIDIA GTX1070,operating system Windows10.

III. KEY TECHNOLOGIES

A. Development of flexible algorithm in virtual environment

Pharyngeal and tonsil tissues exist as flexible bodies. In order to present the collision force feedback between pharyngeal and tonsil tissues and cotton swabs more realistically, the bounding ball collision algorithm is adopted in this study, and a Gauss distribution deformation model based on geometric meaning is proposed to complete the deformation process quickly.Gaussian distribution, also known as normal distribution, is a very important probability distribution in the fields of mathematics, physics and engineering x obey a position parameter as μ ,the scale parameter is σ,the probability density function is

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma}e^{-\frac{(x-\mu)^2}{2\sigma^2}} \tag{1}$$

When a point on the surface of an object is deformed by force, the farther away it is from the point, the smaller the deformation is, and the distribution of Gaussian function conforms to this rule. Therefore, it can produce good results to calculate the surface deformation of an object by using Gaussian function.In the calculation process, all the vertices of the model surface are traversed. According to the distance from the vertex position to the stress point, the deformation formula is used
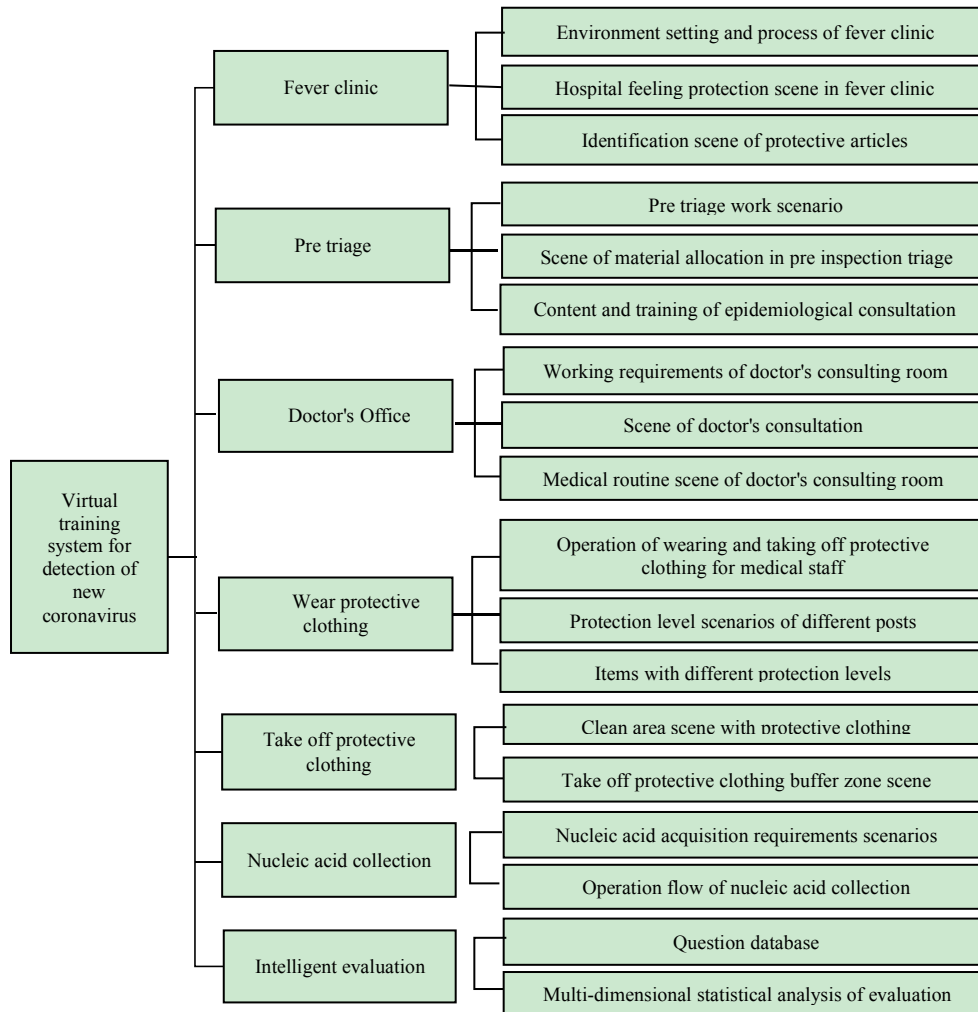
Fig.1 Functional structure diagram of new coronavirus virtual training system

$$z = \frac{D}{k}\exp\left\{-\left(\frac{l}{\beta}\right)^2\right\} \qquad (2)$$

The normal deformation is calculated and the graph is redrawn.Among them, l it represents the distance from any point on the 3D model to the force point; D represents the external force exerted on the model; β is the deformation coefficient, which is greater than 0, β the larger the deformation is, the larger the deformation is affected by the force; K is the corresponding stiffness of the vertex.At the same time, the process of swabbing secretion on both sides of palatal arch, pharynx and tonsil with cotton swab was simulated on the graphical interface.As shown in Figure 2.[3-4]

B. Modeling

In the coarse mode stage, the general shape of the object is built, focusing on the scale and hierarchy relationship to determine the basic role structure; in the high mode scanning stage, the coarse mode is refined in Maya, and then imported into Zbrush software to carry out model level subdivision and detail production.The final model is refined, focusing on accurate silhouette structure and scale, neat wiring, reasonable card line and chamfer, and detail carving in Zbrush.The specific style is made

according to the requirements of the project, striving for accurate modeling structure, reasonable description of details and high degree of structural restoration.[5]

Fig.2 Virtual operation of throat swab collection

C. Animation, motion capture

In order to achieve better authenticity of motion effect, the solution of character motion capture is adopted.In 3D space, the motion state of the character is measured and the data is saved.Measure, track and record the moving track of objects in three-dimensional space.The position information of the object movement is obtained by sensors,

and the data processing is completed by motion capture, so that the 3D role model of doctors and patients can achieve the effect of natural movement.

D. Interaction design

Interactive mode includes video, voice explanation and virtual simulation demonstration interaction.The novel coronavirus pneumonia platform is mainly based on PC virtual platform, and combined with VR experience. It realizes the whole process simulation training in 6 scenarios of the new fever pneumonia clinic in the single and network terminals.

E. Rendering

Set the animation format avi or tga in RenderSettings, and then set the Start Frame and End Frame parameters. Select the camera to be rendered. After setting, close the rendering settings window, switch to the rendering module Render, find Batch Render in the rendering drop-down menu, and click finish rendering.Clear the redundant materials and maps, open the materials panel, select Edit > Delete Unused Nodes, delete the useless materials, and then open the Textures mapping panel to find all the mapping paths and complete the mapping.The completed partial model is shown in Figure 3.[6-8]

Fig. 3 Three-dimensional model diagram

IV. VIRTUAL TRAINING AND INSTRUCTIONS

The system realizes the application of PC and VR, and studies through video, voice explanation and virtual scene demonstration / interaction.The whole process simulation novel coronavirus pneumonia clinic for fever clinic was implemented in 6 scenarios.

A. Setting of fever clinic

According to the fever clinic set up by medical institutions, the virtual scene is constructed.Interactively understand the function and layout of each room from a subjective perspective, as shown in Figure 4.Understand the design requirements of "three areas and two channels" in fever clinic.

B. Scene of pre examination and triage in fever clinic

Enter the "pre triage scene", learn the responsibilities of the pre triage from a subjective perspective; understand the necessary items of the triage; add items through the virtual simulation system.The simulation of pre examination and interrogation is used to realize the initial screening, as shown in Figure 5.

C. Scene of doctor's consultation room in fever clinic

Enter the "fever clinic scene", learn the layout of fever clinic from a subjective perspective, and simulate the

doctor-patient interaction, consultation and consultation process, as shown in Figure 6 .

Fig. 4 Setting scene of fever clinic

Fig.5 Pre-examination and triage scenario

Fig.6 Scene of doctor's consulting room

D. Scene of medical staff wearing protective clothing

Enter the scene of "medical staff wearing protective clothing", recognize the environmental facilities and the replacement process order from a subjective perspective, and click the process panel to display the graphic information of the items, as shown in Figure 7.Train the wearing process of level one to level three protective equipment, and use VR experience link to try on the articles and learn the wearing order of medical protective materials.As shown in Figure 8.

E. Nucleic acid specimen collection throat swab process

Enter the "nucleic acid detection scene" and adopt interactive teaching, as shown in Figure 9.Understand and master the knowledge points of the whole process of throat swab collection in detail.The students use the virtual handle to wipe the secretion on both sides of palatal arch and pharynx and tonsil to collect pharyngeal swab.

Fig.7 Scene of second shift area

Fig.8 Scene of wearing protective equipment

Fig.9 nucleic acid detection scenario

F. Scene of medical staff taking off protective clothing

Enter the scene of "medical staff take off protective clothing", as shown in Figure 10.The layout and function of each room in the buffer zone are perceived from a subjective perspective.Learn the process of leaving the fever clinic after the fever clinic work.
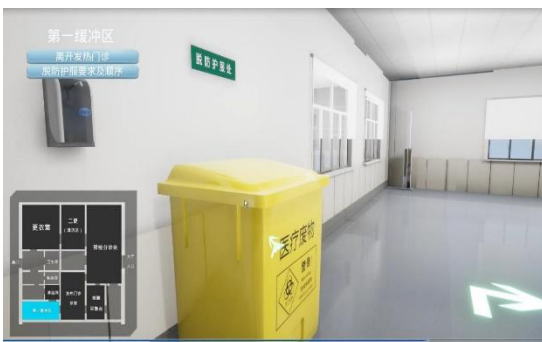

Fig.10 Scene of taking off protective clothing

In the whole training process, there are two modes for learners to choose, experimental mode and assessment mode. In the experimental mode, the system will record the completion of learners' operation process, with prompt and dynamic annotation. After the operation, the system will automatically give the complete assessment data and promotion analysis report of learners' operation; the assessment mode belongs to comprehensive training, only timing, no process prompt. After the operation, the results and corresponding analysis will be given. Both modes can choose to watch their own operation video. [9]

V. APPLICATION AND PROMOTION OF VIRTUAL TRAINING SYSTEM:

The early version of the system was run in July 2020. At present, it has served 3000 students and medical staff, and has been highly praised by many medical institutions at home and abroad.Novel coronavirus pneumonia and mobile terminals are being developed based on 5G. Relying on 5G cloud, we can establish effective resource sharing platform with medical schools and medical institutions at home and abroad, open to the public and provide online services continuously, and complete the training of new crown pneumonia screening, diagnosis and treatment and hospital protection.[10]

VI. CONCLUSION

This paper introduces the scheme design of virtual training system for new coronavirus detection and the key technology of virtual scene construction based on VR. VR technology and advanced teaching mode are introduced into virtual practice teaching, and an integrated training platform of interactive learning, roaming and evaluation is constructed, which shows the process of virtual training for new coronavirus detection. Through virtual simulation training, learning interest and effect are improved,it has great social and economic benefits to use the high-quality resources based on VR technology in education and training and expand the application scope and beneficiaries of virtual simulation system.

REFERENCES

[1] Yan Lou. Application foundation of virtual reality and augmented reality [M]. Beijing: Science Press, 2018:68-88

[2] Haitao Shi, Na Liu, et al. Current situation of digestive endoscopy training and application of virtual reality endoscopy simulator [J]. Medical education research and practice, 2018,26 (2): 358-361

[3] Yingmei Wei, Quanyuan Wu, Jiaoying Shi, et al. Collision detection in virtual environment [J]. Computer engineering and science, 2001,23 (2): 44-47

[4] Jia Liu, Aiguo Song. Research on Virtual Flexible Tactile rendering technology [J]. Journal of system simulation, 2010,22 (02): 421-423

[5] Chu RH, Zhang YR, Zhang HD,et al. Co-actuation: a method for achieving high stiffness and low inertia for haptic devices ［J］.IEEE Trans Haptics, 2020, 13(2): 312-324.

[6] Jia Liu, Tingting Guo, Yanhua Wang, Yan Lou. Teaching practice of virtual reality course in medical colleges and universities [J]. China medical education technology, 2019,33 (01): 99-102

[7] Mei Yue, Yejiang Zhang. Application scenarios of virtual reality technology in distance medicine teaching [J]. Modern distance education of traditional Chinese medicine in China, 2020,18 (21): 43-45

[8] Chengbin Gong, Qian Tang, Yayi Cao, et al. Research on curriculum reform of "material analysis technology" based on virtual simulation experiment [J]. Journal of Southwest Normal University (natural science edition), 2017,42 (11): 72-76

[9] Ran L,Lou Y*.The reform and practice of the training of computer innovative talents based on SPOC teaching model.14th International Conference on Computer Science and Education, ICCSE 2019:165-167.

[10] Ran L,Lou Y*.Research and development of the regulation training system of minimally invasive knee surgery based on VR technology. 14th International Conference on Computer Science and Education, ICCSE 2019:161-164.