Implementation Of Medical Pendant Interactive System Based On Virtual Reality Technology

Hanyang Li¹, Dini Duan² and Zhisheng Zhang¹*

¹ School of Mechanical Engineering, Southeast University, Nanjing, Jiangsu Province, 210000, China
² School of Mechanical Engineering, Southeast University, Nanjing, Jiangsu Province, 210000, China
*Corresponding author’s e-mail: oldbc@seu.edu.cn

Abstract. Nowadays, virtual reality is in the stage of rapid development. Rational application will improve the immersive feeling of human-computer interaction. This paper discusses the construction of interactive experience learning system from two perspectives of platform interaction experience and user demand. This system can provide the operation and practice platform of medical tower related equipment, and build a realistic medical environment based on Unity3D and HTC Vive. The base station of the equipment realizes the real-time positioning of users through the signals transmitted by the handle, in order to ensure the effectiveness and immersion of user interaction, and providing information such as equipment introduction, operating instructions, precautions and emergency operation tips of the medical tower. In order to improve the learning efficiency of users, the learning progress of users is recorded in real time, the tactile feedback device on the handle is used to prompt users when they make mistakes. This system provides an interactive platform for medical staff and professionals to learn and train medical hanging towers. It is also expected to serve as the basis for further research on virtual reality technology in the medical industry and improve people's interactive experience in the virtual environment.

1. Introduction

In recent years, the medical pendant has become more and more important in the application of various departments in hospitals. The medical pendant is widely used in the operating room, intensive care room, emergency room and other departments of the hospital, and it is one of the indispensable medical equipment for medical staff to treat patients. Borsci et al. [1] proposed that the working efficiency of medical staff decreases due to the unreasonable operation mode design of medical devices and the unfamiliarity of medical staff with the use process. Blandford[2] et al. analyzed the probability of safety accidents caused by medical staff unfamiliar with the operation of medical pendant through the use of data records of medical pendant equipment and cases of medical accidents. Lin et al [3] found that many of the reasons for medical events are the operating failures of medical devices.

Nowadays, virtual reality technology presents a booming trend. With the continuous development and upgrading of equipment and technology, virtual reality technology has been applied in many fields. Zhang Yuan [4] analyzed the application of virtual reality technology and proposed that it is precisely because users can experience the sense of actual use of products in virtual scenes and effectively improve product usability that the application field of virtual reality technology shows a trend of
continuous expansion. Feng Yuliang [5] introduced in detail the successful application of virtual reality in different fields, such as improving visual effects in real estate sales exhibition, assisting high-end machine maintenance knowledge learning and new interactive forms in social software.

The above research can represent that the application of virtual reality technology in the field of medicine can exert great potential. From the above problems existing in the use of medical pendant, the combination of virtual reality technology can not only help people solve the problem of medical pendant learning and training, but also bring good interactive experience for medical staff.

2. Related Research

Sapkaroski et al [6] proposed an iterative development method and found that medical students using simulation tools had higher perceived scores for clinical and technical skills improvement than medical students who did not receive training.

Jimenez et al [7] studied radiation therapy-based medical device virtual environment (VERT) operational learning systems, for radiotherapy education aimed at providing learners with access to knowledge and skills in an interactive, risk-free environment opportunity.

Zhang Liyu et al [8] proposed that combining virtual reality for equipment use training not only effectively improves the nursing effect of medical nursing equipment on patients, but also helps improve the operation of medical staff. Liu Xiaohong et al [9] validated the effectiveness of virtual reality in medical teaching. In summary, the application in the medical field shows that virtual reality technology has played a huge role in improving medical standards.

3. Medical pendant interactive system based on virtual reality technology

3.1. User research of the system

This system is a usability platform for helping users to effectively learn and train. To enhance the user experience, the system design should be user-centered, and the products should be better served by in-depth research on target users. This paper conducts user interviews and combines the characteristics of different user model types, and finally obtains two user models of the system: professional user and inexperienced user. The characteristics of different user models are shown in Table 1:

| User model type  | User characteristics                                                                 |
|------------------|--------------------------------------------------------------------------------------|
| Professional user| The user's purpose is clear, and hope to enrich the knowledge of medical pendant through exercises;  
                    | Want to standardize the level of the operating medical pendant;                       |
|                  | Require the detailed description and richness of the equipment description information in the system;  
                    | Be able to record learning progress;                                                 |
|                  | Interested in virtual reality technology;                                            |
| Inexperienced user| Want to learn the operation method of the device in the system;                      |
|                  | Want to contact different types of equipment;                                       |
|                  | Hope to improve the operation level through practice;                                |
|                  | More enthusiasm and initiative;                                                     |

3.2. User task flow

The system is divided into a server system and a user information interface. The server system is mainly divided into two categories: user operation input and userspace positioning. The user's real-time location in space is provided by the system-bound HTC Vive base station. The user operation flow chart in the system is shown in figure 1. It can be known from figure 1 that users can choose the operation module to enter according to their own requirements, and they can choose the learning or practice module. Therefore, the information navigation page should be at the first level of the system.
3.3. Information architecture design
According to the different needs of users, the system provides different function modules on the home page. For example, novice users are more likely to choose learning module and device explanation module, and provide users with learning progress query. Figure 2 shows the information structure of the system, which provides five modules, each containing different types of information forms.

4. System Implementation
The system is connected to the HTC Vive through a computer program generated by the Unity3d. Figure 3 shows the system implementation process. By using Unity 3D for system development, the implementation process can be roughly divided into two parts: virtual reality system construction part and virtual information interface design part. Virtual reality system construction is to import the 3d model of the medical pendant and other related products into Unity3D and conduct the matching of operation keys on the HTC VIVE handle with the target object. The part of virtual information interface design mainly refers to the interactive design of the information display page based on virtual reality technology in the system.
Figure 4 shows the system user interface. According to Mike Alger [10], in the virtual reality environment, the presentation of interface information is the most concentrated part of the user's visual perception. The focus area of the user's vision takes up one-ninth of the 360° virtual environment and is located in the center of the interface, with a size of 1200×600 pixels. The design style of navigation interface adopts card layout, which is placed in the center of the user's field of view.

Figure 5 is the system toolbar show up interface; The system toolbar is placed in the lower-left corner of the user, so as not to affect the user's main view. The introduction information of medical equipment is displayed on the right side of the object, in line with the visual browsing path of the user from the object to the information; The operation prompt message appears at the top of the interface center and does not affect the interactive view during the user's operation.

The main interface functions of the system are as follows:

a. Interaction between users and medical pendant. The user selects the medical pendant part to operate in the scene, and when the user selects and presses the button, the part will automatically play the model animation bound by the part, and the user can understand the operational approach of the part object through the interactive animation played.

b. The user moves in the scene. Users can walk around in virtual space and browse according to their own preferences. In addition, when the user wants to quickly browse the spatial information in the scene, the position of the ray direction can be positioned by the handle button, and the fast movement can be realized by the instantaneous transmission.

5. Conclusion
This paper concerns a medical pendant interaction experience system based on virtual reality technology, which helps medical personnel to carry out the operation learning and practice of medical pendants, and provides new training methods for medical staff. In this paper, the interactive
experience system provides an immersive and interactive teaching and training approach for medical staff, which can carry out human-computer interaction operations such as medical pendant training. In the system, advanced virtual reality interaction equipment can be used to realize real-time positioning and tactile interaction feedback for the operator. During the operation of each model of the medical pendant, the user can experience a more realistic three-dimensional environment through the handle operation. This system also provides an effective learning method for the students in the nursing major of medical college. The effective application of the medical interactive experience system to the teaching field has important practical significance for reducing the occurrence and prevention of medical accidents.

References
[1] Borsci, S., Buckle, P., Uchegbu, I., Ni, M., Walne, S., & Hanna, G. B.(2017) Integrating human factors and health economics to inform the design of medical device: a conceptual framework. In EMBEC & NBC 2017, 49-52.
[2] Blandford, A.(2013) Interactions "in the wild": Explorations in healthcare. Contemporary Ergonomics and Human Factors, 3-6.
[3] Lin, Laura, Kim J. Vicente, and D. John Doyle.(2001) Patient safety, potential adverse drug events, and medical device design: a human factors engineering approach. Biomedical informatics 34(4), 274-284.
[4] Zhang, Y.(2007) The study and application of usability in product design based on virtual reality. (Doctoral dissertation).
[5] Feng Y.L. (2017) VR virtual reality design research. Chifeng College (Natural Science Edition) (05), 131-132.
[6] Sapkaroski, D., Baird, M., McInerney, J., & Dimmock, M. R. (2018) The implementation of a haptic feedback virtual reality simulation clinic with dynamic patient interaction and communication for medical imaging students. Medical radiation sciences 65(3),218-225.
[7] Jimenez, Y. A., Hansen, C. R., Juneja, P., & Thwaites, D. I. (2017) Successful implementation of Virtual Environment for Radiotherapy Training (VERT) in Medical Physics education: The University of Sydney’s initial experience and recommendations. Australasian physical & engineering sciences in medicine, 40(4), 909-916.
[8] Zhang, L.Y.,Luo Y. M.(2017). The development of virtual reality in nursing education. General Surgery 15(16), 1931-1934
[9] Bi, H. J., Wang, H. L.(2016) Thoughts on Integrating Medical Virtual Reality Teaching into Diversified Instructional Design. Psychologist 22(24), 263-264.
[10] Alger, M. (2015) VR interface design pre-visualisation methods. Online video clip. YouTube, 4.