RESEARCH ON THE APPLICATION OF VIRTUAL REALITY TECHNOLOGY IN THE FIELD OF OPHTHALMOLOGY

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Virtual reality technologies combine the characteristics of virtually modelled objects and immersive experience of a virtual world. Its superiority in the medical field has been revealed, and it has been widely used in ophthalmology diagnosis, rehabilitation, and remote treatment. This paper presents the current situation, challenges and future prospects regarding the application of virtual reality in the field of ophthalmology.

Keywords*: virtual reality, immersive systems, ophthalmology, development.*

OVERVIEW OF VIRTUAL REALITY APPLICATIONS IN OPHTHALMOLOGY

With the increasing sophistication of virtual reality technology, the application and adoption of this technology in the field of ophthalmology is increasing day by day. The application of virtual reality in the field of ophthalmology means that virtual reality technology is incorporated into the educational and treatment processes in the field of ophthalmology.

THE CURRENT STATE OF VIRTUAL REALITY IN OPHTHALMOLOGY

Medical education in ophthalmology

Virtual education. Theart et al. reported a method for displaying fibre structures using VR technology, i.e. using their Confocal VR software development, which allows for the conversion of section information acquired by confocal microscopy into 3D structures that can be viewed at any angle [1].

China began the first live broadcast of ophthalmic VR surgery in 2016, which originated from the Second People's Hospital of Zhejiang Province. This ophthalmic surgery, for the first time, was performed using the new VR virtual reality technology and was oriented towards live webcasting of cataract surgery. The use of VR technology allowed for immersive viewing of this surgery with internet users and students in the absence of a donor. In conventional teaching, a flat two-dimensional presentation does not feel as realistic as virtual reality technology, and without human samples for anatomical experiments, the surgical demonstration still achieved realistic results, reducing educational costs and improving its quality, as well as providing a demonstration of surgical skills.

Medical education could be enhanced if the technology was further refined to include a recording of the industry's leading surgeons for demonstration.

Virtual training. Training on virtual reality has been more widely applied and researched in China, with major medical schools having virtual simulation experimental teaching centres. Wenzhou Medical University's ophthalmic surgery simulation system can realistically simulate the surgical scene, including cataract ultrasound emulsification surgery, vitrectomy fundus laser surgery, retinal foramen ovale detachment surgery and other types of ophthalmic surgery. Through virtual reality technology control and simulation, it can set up a variety of different human eye states to simulate such surgical processes, allowing students to experience and simulate realistic donorless ophthalmic clinical surgery scenarios.

In 2017, Rector of the Belarusian State Medical University signed the Simulation and Certification Centre educational institution, designed for patients and trainees to gain experience in a safe environment. A practical training laboratory has been established at the university to integrate virtual training into all education in the current professional system.

Existing devices for the application of virtual reality in ophthalmic surgery

- EYESI Ophthalmic Surgery Simulation Teaching Training System

The current mature EYESI Eye Surgery Simulation Training System from VRmagic, Germany, was developed by a vitreoretinal surgery trainer. It has been widely used in China. The system recreates realistic surgical scenarios and simulates training for medical students, who can learn the standard operation of ophthalmic surgery, practice the handling of special situations during surgery and develop good surgical skills and habits.

In a pilot study of the posterior segment stripping module, it was found that experienced surgeons made fewer errors when operating than beginners [2]. Therefore, beginners can improve their error rate and learn the surgical skills of experienced surgeons with the aid of this device.

Fig. EYESI Ophthalmic Surgery Simulation Training System

- SimSci-Esscor® simulation technology

On 22 December 2009, IOM announced that its SimSci-Esscor® simulation technology, EYESim™, a virtual reality- based training solution, has been awarded the "Breakthrough Product of the Year 2009 Award" by Processing magazine "[3]. EYESim integrates virtual reality and other simulation technologies with a document management system to provide a highly realistic and safe training environment for ophthalmic medical researchers and students, enabling increased research efficiency and reduced learning costs.

- VisuALL portable visual care testing platform

Medical device company Olleyes is developing a virtual reality-based ophthalmic diagnostic product. The product is a head-mounted device that can detect and diagnose a patient's eye disease. The platform is based on VR and AI technology and allows for remote diagnosis. The healthcare system is not well developed in some areas, and remote VR technology allows for off-site diagnosis and treatment, so that people in different areas can receive the best possible treatment.

- Application of virtual reality in the field of rehabilitation medicine

Virtual reality also has great potential for use in the field of eye rehabilitation. Currently, clinical trials have demonstrated that VR rehabilitation can effectively improve somatic and limb movement dysfunction caused by cerebrovascular disease and improve patients' life expectance [4].

VR technology allows for eye muscle training, simulates realistic environments and can be useful in areas such as post-operative recovery from surgery.

Telemedicine. Telemedicine can be achieved using VR technology. Through the device doctors perform immersive hands-on operations, the machine synchronizes the doctor's operations on the remote patient and the results of the operation are fed back into the doctor's helmet in real time, enabling remote treatment. With the current uneven development of medical standards around the world, telemedicine not only enables precise surgery, but also better resources for people in different regions. For example, when there is no medical staff on site to guide you, people in some underdeveloped areas who need a more experienced doctor can be well-served by using VR telemedicine technology.

THE PROBLEMS OF APPLYING VIRTUAL REALITY TO OPHTHALMIC SURGERY

- The current technology is not mature enough and there are certain differences between the objects presented in the application and real objects; virtual reality applications cannot completely replace real objects.

- Current network transmission speeds are not always sufficient and there are delays, such as in the case of applying VR telemedicine to clinical

applications, which require higher network bandwidth. A significant part of the dizziness that exists in current VR headsets is due to the latency of the network.

- The legal side is currently inadequate or insufficient, some technologies are not approved by law.

- At present, there is no working model in which medicine and engineers work together. Engineers do not understand the clinical needs of doctors, and doctors do not understand what clinical applications can be achieved with current technology [5].

SUMMARY AND OUTLOOK

Research into virtual reality in the field of ophthalmology has been extensive, with some more mature devices and applications emerging. The interactivity and immersion of virtual reality systems can solve problems such as the scarcity of teaching providers in the medical field, immersive training to learn medical skills, and uneven levels of care in different regions. Its superiority in the field of ophthalmology is already self-evident.

Of course, the mature application of virtual reality to the field of ophthalmology will require continuous advances in technological and software aspects, as well as adjacent sciences.

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