

# Analysis of the role and value of Three-dimensional panoramic virtual reality technology — Take surgery as an example

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**Abstract.** With the development of surgical medicine and people's more requirements for disease treatment, as well as the realistic demand of reducing errors and reducing surgical risks based on accurate surgical operations. Three-dimensional (3D) panoramic virtual reality technology is applied to surgical operations to meet the needs of different patients. This article discusses the interactive immersion experience of surgery, 3D simulation of surgical process, operational accuracy and other aspects. The purpose of this study is to explore the role and value of the simulation exercise of panoramic photography in the virtual surgical environment for the application of real surgery, start to discuss the details of the operation process, improve the probability of success of surgery, and reduce doctor-patient disputes. Based on the above research, the application prospect of 3D panoramic virtual reality technology in the field of surgery and medicine is prospected.

## 1 Introduction of 3D panoramic virtual reality technology

Panorama, derived from the Greek language "can be seen", as the name suggests, panorama is a full range of real scenes. The birth of the panorama dates back to the 19th century. In the Application and Development of 360° Panoramic Technology, Quan Zhenghuan mentioned that the biggest innovation about panorama in the 19th century is the birth of panoramic camera. The legendary Crikut used a fan-controlled clock mechanism to shoot 360° images using 10-inch film. By 2004, when Google opened the panoramic map, the panoramic photography was gradually well known. Panoramic photography from birth to development, although the history is not long, because of its own technology and art fusion characteristics, formed a unique form of development. The early panoramic painting prompted people to have great interest in big visual images. With the development of science and technology, the electronic industry has shown its powerful impetus, which has injected new vitality to photography. On the basis of constantly innovation of photographic equipment, computer image software makes image become more magical.

In the 21st century, the world began to enter the age of digitalization and informatization. Computer technology and Internet technology penetrated into all fields of public life. Through digital simulation or live display, a virtual 3D space was set up to realize that you can watch in 3D virtual environment without leaving home. The panorama of unknown places is vivid, vivid and detailed. 3D panoramic virtual reality is widely used and has become an effective means to expand the business scope and improve the competitiveness. In addition, its development cost is not high and the market demand is huge. It brings

the audience the interactivity and immersion that traditional graphic video does not have, and sets off its own wave in the market. This time, we mainly discuss the application of intelligent and minimally invasive panoramic photography in surgical operation, which is composed of computer-aided navigation system composed of 3D panoramic virtual reality technology, imaging technology, information science, robotics technology, remote control technology and other high-tech combination.

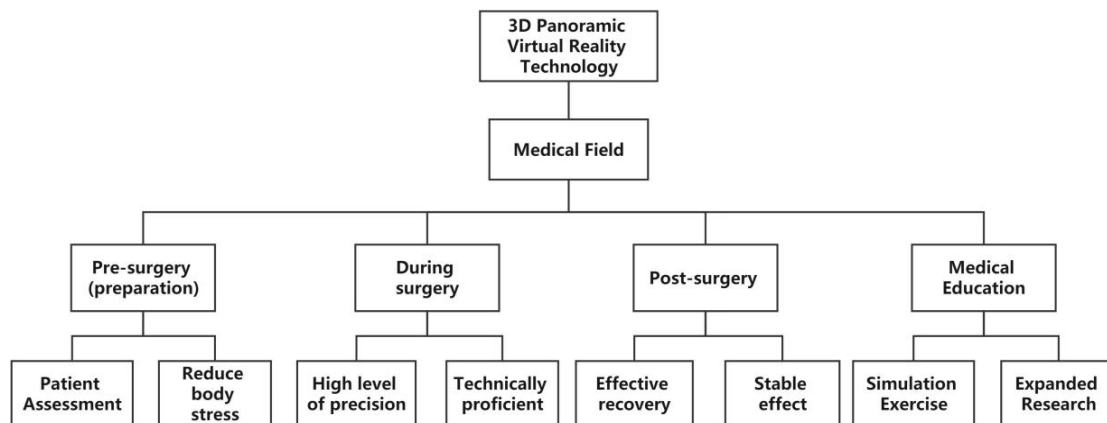
## 2 Technical barriers and requirements of surgery

Surgery emphasizes the treatment of diseases by hand operation, and the scalpel is the symbol of surgery. This suggests that there are many objective or subjective effects in surgery. For example, in surgical orthopedic surgery, there are some difficult problems at present. For example, first the external structure of the human body is complex, and corrective surgery requires the precise reconstruction of these subtle structures. Two, it should have good shape and stable effect. Successful surgical orthopedic surgery is not only a good shape, but also a 3D sense, which requires that the ear bracket carved by the doctor should be both beautiful and realistic, and have high stability. The internationally accepted methods for correction of ear deformities, or the anatomical units are insufficient and the shape is distorted; Or, although the shape meets the requirements, it causes complications such as peripheral skin necrosis. Three, the high requirements for doctors. Doctors should not only have very rich experience in clinical operation, but also be able to control the three layers of stent, fascia and outer skin very carefully. Once there is deviation, the stent will be exposed and the

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operation will fail. Due to the high difficulty of the operation, only a few doctors in China can successfully carry out the operation. Even in the United States, only a few plastic surgery experts dare to shoulder the responsibility. Four, insufficient blood supply often occurs. Due to the lack of blood supply, the affected limb, tissue necrosis and stent exposure fail from time to time, which is also an important reason why many new stents are difficult to popularize. To solve the problem of blood supply in a breakthrough, the stent needs to have the function of blood vessels and blood supply, participate in human blood circulation, and have lasting vitality, so that the survival period of the reconstructed tissue is together with the life of patients. More important point is the

doctor-patient relationship, the current contradiction can not be ignored. On the other hand, there are two main reasons for the increasing application of image technology: first, the acquisition of images is more convenient. With the continuous progress of science and technology, the collection of medical images has become more convenient and accurate. Compared with the traditional, method of data accumulation that often takes several years, it only takes a few seconds to photograph a medical image, which can reflect the general condition of the patient's body and become the direct basis for doctors to diagnose the patient's condition. Second, the technology of image processing is relatively mature.



**Fig. 1.** The main scope of the role of 3D panoramic virtual reality technology in the medical field.

With the continuous accumulation of industry image data and the continuous improvement of big data and algorithm analysis ability, the intelligent image recognition algorithm can quickly compare and analyze the current image and the image in the database, and give a fairly accurate conclusion. **Figure 1** shows the main scope of 3D panoramic virtual reality technology in the medical field. Over the past decade, panoramic photography has become a new opportunity in the medical industry. not only to improve the patient experience, but also to effectively improve surgical efficiency and reduce medical risks. And improve the surgical accuracy and reduce patient pain, reduce surgical injury and facilitate postoperative recovery, reduce intraoperative radiation and protect patient safety. In medical education and clinical practice, panoramic photography has great application prospects. It maximizes the potential of panoramic photography in surgery, enabling doctors to establish a customized 3D simulation environment to provide preoperative management (such as virtual simulation surgery).

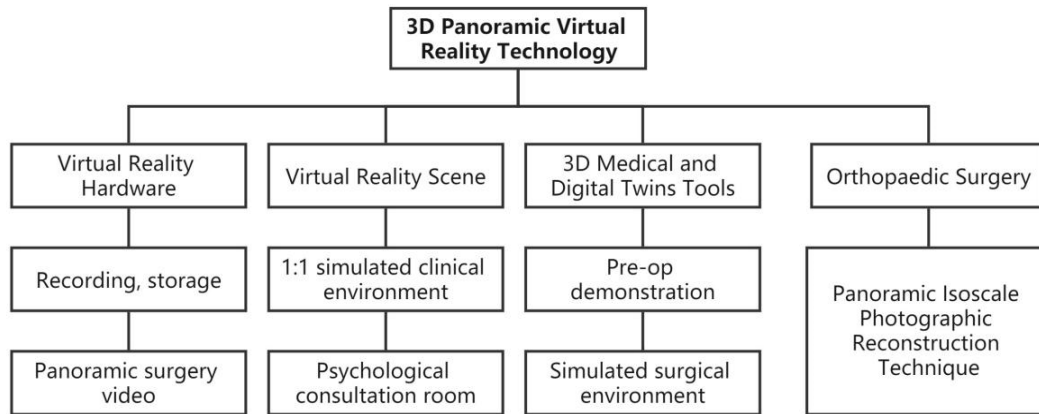
### 3 Application of 3D panoramic virtual reality technology in surgery

3D panoramic virtual reality technology applied to surgery is very important to let the doctors have more precise assessment of the patient's condition, which is conducive to reducing the failure rate, especially in

orthopedic surgery. The image is displayed on the computer and the model is reconstructed on the computer, and the panoramic isometric photography technology belongs to the computer image technology, which can form a realistic isometric image of the surgical site, and the patient can understand the local anatomical structure and related aspects through the isometric image before the operation. Pathological changes can help the doctors to further evaluate the patient's condition. On this basis, the surgical design can be carried out, the surgical approach and surgical method can be selected, the bone block to be fixed and the position of the plate to be placed, the type of the plate and the length of the screw, needle orientation and needle entry position should be determined. Choosing the appropriate surgical method can not only reduce the economic expenditure for patients, but also reduce the pain of patients during the operation and improve the success rate of the operation [1]. In fact, simply put, orthopaedic surgeons use the combination of panoramic photography technology and computer to reconstruct the detected image with computer image technology to understand the complex structure of the lesion. For example, when a patient had an ankle damage, it is usually taken with regular X-rays, CT, or NMR. X-ray is a technology developed by direct irradiation, which is a plane projection examination of a certain part of the body. CT is a kind of inspection technology that scans the human body in layers through high-tech equipment. It is a continuous multi-layer spiral scanning inspection of a certain part of the body. If the X-rays and CT are not easy to show the real

situation, And NMR, while advantageous in observing the exact picture of the disease. But the surgical plan cannot be directly determined, and panoramic and other proportional photography technology can let doctors clearly understand the stereoscopic structure between the patient's diseased tissue and the surrounding tissue, and then classifies the disease through the 3D image, which is conducive to the doctor's operation on the patient. After the finalization of the plan, surgical simulation is carried out, and the details of the operation can be grasped through virtual images, such as the accuracy of the position of the surgical screw for ankle fracture, position and direction of the screw injection needle, etc. Not only improve the success rate of operation, it can also reduce the complications and sequelae caused by surgical errors. Assuming that there is no panorama and equal-scale photography technology on the original basis, no 3D image reconstruction on the computer, no 3D model construction, no more detailed image observation, and no surgical simulation, then the surgical failure rate will be too high, and the patient will suffer a lot. During the operation, due to insufficient understanding of the condition, the original fracture may be aggravated during the operation, resulting in a new fracture; or the operation may fail due to infection during the operation. And, when undergoing surgical treatment, there are many important fractures around the ankle joint. Neurovascular injury should be avoided during surgery. Therefore, preoperative surgical simulation combined with panoramic photography and computer can help reduce the possibility of surgical failure and reduce surgical errors. Besides, 3D panoramic virtual reality technology can also play an important role in the correction of patients with spinal and lower limb deformities. Generally speaking, to take a complete X-ray photograph of the spine or lower limbs, you must take all the bones involved, such as the cervical and thoracic vertebrae, lumbar vertebra, pelvis, thigh-bone, knee-joint, tibia and fibula and other multiple times. Then the films are taken together or superimposed for measurement and diagnosis. But for a variety of reasons, the resulting distortion of the X-ray image. As a result, doctors can cause misdiagnose or have some errors in the diagnosis. Even eventually failed the patient's corrective surgery, or it is to affect the correction effect. If a patient with spinal or lower limb deformity performs panoramic and other proportional photography, the CT or X-ray uses a computer and has a 3D image, so as to conduct surgical simulation to help doctors improve their proficiency and take measures to face various emergencies in the real operation. Moreover, the panoramic bone map of the

whole spine or the whole lower limb is very critical in the clinical diagnosis and treatment of spinal and lower limb deformities. The accurate judgment of the deformity site is used to help doctors to develop the surgical plan [2]. Combined with the application of 3D reconstruction image technology help orthopaedic surgeons to strengthen the understanding of surgical anatomy, it can through the computer simulation design incisions, approaches, osteotomy planes. And the position of the prosthesis, etc. can also be used for the operation of the full simulation practice, to shorten the real operation time, to reduce the difficulty of operation [3]. Furthermore, for traditional surgery, the deterioration of the doctor-patient relationship lies in the fact that patients and patients' families do not understand the unknown surgical process, and the surgeon is not skilled for the first time, which can be solved by panoramic technology. Using the computer to calculate the site of each data, reuse computer simulation modeling, and using panoramic technology to build a large realistic surgical environment, the doctor can conduct the simulation operation, thousands of times skilled, and practice possible problems, to find a solution to the problem. Then doctors can give patients and their families satisfactory answer. During the doctor's practice of panoramic technology, panoramic photography can be used to record the doctor's process. First, it can be applied to patients and their families, so that they can be more intuitive, or even feel the operation. Reducing their fear of the unknown also brings about an understanding of the difficulty of doctors' surgery. The doctor-patient relationship will be slightly relaxed, leaving doctors and patients no longer on the opposite side. Panoramic photography of doctors' operations can also be placed on the Internet for the study of other related majors. During the process of doctors' proficiency time after time, they can speculate on possible situations and rehearse possible situations one after another, can solve the problem of timely consultation, and reduce the operation unknown accident. It also brought more complete backing for patients. The videos and solutions of these drills can also be provided to medical students and fellow doctors for learning. This kind of learning is no longer paper, but a grand and all-round surgical learning. Addition to immersive mobilize facial cut body feeling, more is a kind of learning doctor thinking. Consultation when encountering difficult problems will be the new medical students to open medical thinking, and it will also teach doctors who are not skilled in medicine. This is not only an application of panoramic photography, it benefits from a large, multi-faceted group.



**Fig. 2.** The application of 3D panoramic virtual reality photography technology in surgery.

Combined with the content explained in **Figure 2**, it is mainly the application of 3D panoramic virtual reality photography technology in surgery. The application operation of medical 3D panoramic virtual reality includes the following aspects. First, virtual reality hardware. Includes panoramic HD video recorders, controllers, trackers, and other types of hardware to enter an immersive, highly simulated digital environment. Such devices are designed based on clinical practice application, which need to consider the convenience of patient use, and should be applied in surgery, dental treatment, psychological treatment and other scenarios. For example, the HDMI output interface of the endoscopic laparoscopic device and the camera of the surgeon and the nurse are respectively connected to the different HDMI input interfaces of the panoramic video recorder. The screen can have two pictures at the same time, and the operation can be done while explaining for postoperative learning and analysis and viewing by the patient's family. Second, virtual reality scenarios. Providing an immersive 1:1 simulated clinical environment and providing an experience close to the real environment, virtual reality technology provides a new bridge of communication between doctors and patients. Common medical panoramic photography scenes include operating rooms, physiotherapy rooms, and outdoor environments for psychological counseling. Third, 3D medical and digital twin tools. Preoperative diagnosis demonstration, surgical tools for treatment, and various detection equipment can be displayed in virtual reality through the 3D digital form. Doctors can build the virtual scenes through the 3D modeling software, and patients can understand the disease situation and treatment plan through video communication with the doctor [4]. Digital twin technology help 3D modeling to achieve higher accuracy and accuracy to ensure identical with the real world to predict various emergencies in advance. Digital twin technology can 1:1 build human organs, tissue structure, and even microbial environment [5]. This provides physicians the opportunity to learn new skills and update existing technology without posing any risk to the patient. Significant results in surgical simulation, treatment of fear symptoms, and surgical training. The spread of digital twin technology is also very fast. It can be shared with two-dimensional codes or links generated online through

a professional panoramic production platform, and can be displayed synchronously on mobile phones, computers and other terminals. With the popularization of the fifth generation of communication technology, medical 3D panoramic virtual reality can be used at one time, and its transmission speed will be faster and more high-quality high-definition. 3D panoramic virtual reality compared with the traditional media, superior point is its good interactive in terms of user experience. Reconstructed any part of the virtual scene can be cut, and users can according to their own ideas by operating the mouse, keyboard, touch screen, analysis, decomposition, zoom, rotation to transform reconstructed medical 3D model digital scene [6].

It is the responsibility of the medical personnel to heal the wounded and save lives, The application of 3D panoramic virtual reality technology in medical treatment is even more important to the development of the medical field. It can start with the application of medical specialty teaching to make the course easier to immerse in it, and feel the charm of medical surgery. It is also possible to establish a macro doctor's thinking for the inexperienced trainee doctors who are new to the medical industry, and to have a more immersive consideration and feeling for surgical treatment through 3D panoramic virtual reality technology; For doctors in remote areas, it is helpful. It is an opportunity to learn about intractable diseases and can provide patients in remote areas with better medical technical support. Its role can also untangle the mystery of difficult medical diseases. Let medicine no longer be full of mysteries, no longer have a hostile idea to medicine. For patients and their families, they can also enjoy better medical assistance and carry out surgical treatment under comprehensive consideration

#### 4 Medical application prospect of 3D panoramic virtual reality technology

From a deeper understanding of the internal structure and principle of large medical imaging equipment, 3D panoramic virtual reality technology also has its own unique advantages. The teaching mode of traditional medical imaging is mainly lecturing. Many practical teaching projects of medical imaging are high-risk, high-investment and difficult to achieve. Moreover, most of the

teaching imaging equipment in medical schools is eliminated from hospitals. Due to the aging of the equipment, these equipment can only explain the basic equipment principle, positioning of imaging technology and other technologies, and medical science cannot access high-end image post-processing technology. Nowadays, the imaging equipment is constantly updated and more and more intelligent. Many of the equipment is not suitable for large teaching volume, expensive price, and many restrictions on closed use conditions. For example, when using MRI equipment, many interns can only rely on the book data in their minds, and cannot deeply perceive the working principle and internal structure of the magnet. Using the original medical equipment and 3D panoramic virtual reality technology, can through the virtual simulation system into the internal imaging equipment, and intuitively watch the process of split assembly equipment, clearly see equipment structure, and then operate and use it. 3D panoramic virtual reality realizes the seamless connection between equipment principle and system perception, so that medical professionals can better engaged in the field of learning and research.

In addition, in many poverty-stricken areas around the world, due to the limitation of medical level, timely surgical treatment is often unavailable due to the lack of medical resources and treatment programs. By synchronizing the collection of publicly available 3D panoramic photography materials onto the open source network of medical resources, the use of virtual reality technology can help students create a vivid and realistic learning environment, so that students can enhance their memory through real feelings, and independent learning is easier for students to accept. This way is easier to stimulate students' interest in learning, and more can form a knowledge base of valuable experience in the medical field for better popularization and transmission. Medical practitioners in poor areas can also carry out real drills on simulated human tissues and organs in virtual space, and students can feel the feeling of scalpel cutting into human muscle tissue and touching bone, so as to make up for their own defects and deficiencies in operation. Let more doctors in poor areas get more medical resources to perform more detailed operations and save more lives, let patients get equal opportunities for treatment, let the medical level gradually reduce due to regional disparities, and let more vulnerable groups get effective treatment. With the continuous expansion of the open source and shared 3D panoramic photography database resources, the arrival of the 5G era, the rapid development of virtual reality technology and the continuous improvement of

hardware equipment, it will also be more beneficial to achieve the common improvement of medical technology worldwide.

With the continuous development of Three-dimensional panoramic virtual reality technology and its application in the medical field, the new mode of medical surgery, medical diagnosis and teaching will also have a broader application prospect, bringing infinite possibilities for the vision of future medical technology.

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