MICROWAVE INTERVENTION SIMULATION TEACHING REFORM BASED ON CDIO ENGINEERING EDUCATION MODEL

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ABSTRACT

Aiming at the problems of large demand, high cost and irreversible clinical training in medical colleges and universities, this paper introduced the CDIO education concept into the experimental teaching reform practice of microwave intervention, and combined with VR technology to reform the teaching system, teaching content, teaching methods and means of microwave intervention. The practice shows that the microwave intervention simulation teaching based on CDIO education model can effectively improve the teaching quality and cultivate students' awareness of independent learning, innovation, engineering practice accomplishment and teamwork spirit. CDIO is an innovative mode of international engineering education and talent training, which penetrates the educational concept of "Conceive - Design - Implement - Operate" into each teaching link, organically integrates related courses and guides students to actively explore, communicate, collaborate and practice. In order to achieve the cultivation of students' independent learning and exploration ability, comprehensive practice and innovation ability, interpersonal team ability, team spirit and professional ethics, it has been used by many educators to guide the reform and practice of vocational education, and has achieved good results (Xu Juanling, 2019). Virtual simulation experiment is a new form of experimental teaching method, teachers can optimize the experimental teaching content and timely feedback the results in the virtual environment, combined with the actual situation. The integration of CDIO engineering education model into virtual simulation teaching is conducive to the optimization of experimental teaching system. Virtual simulation experiment design is carried out in accordance with the four levels of conception, design, implementation and operation, which can continuously cultivate in layers and enhance innovation ability. This optimized virtual simulation experiment teaching has a clear teaching guiding role in cultivating students to acquire knowledge directly and explore new knowledge in virtual situations. Based on the new medical interference mode of microwave intervention and its virtual simulation experiment as the research carrier, this paper designs a complete virtual simulation system of microwave intervention based on the CDIO teaching mode throughout, and has made remarkable achievements in the training of doctors and medical students.

KEYWORDS

CDIO Medical Model, Microwave technology, Education, Unity3d, HoloLens, Standards:1,3,5.

LIMITATIONS OF TRADITIONAL MEDICAL TEACHING METHOD OF MICROWAVE INTERVENTIONAL THERAPY

Mechanism of microwave ablation and traditional teaching methods

Microwave is a kind of high frequency electromagnetic wave with a frequency of 300-30000MHz and a wavelength of 1-1000mm. It has been widely used in the medical field since the 1960s and in the treatment of cancer since the 1980s. Microwave radiation can cause charged ions and water molecules in tissues to oscillate and produce high heat. Microwave ablation mainly uses thermal effect. Microwave makes polar molecules in tumor tissues rub with each other in high-speed vibration to generate heat energy, and microwave retention and hot spots appear at the interface of high-moisture and low-moisture tissues, resulting in high heat in tumor, histone degeneration, coagulation and necrosis, and killing cancer cells. Microwave ablation is to transdermal or direct puncture a special microwave needle into the central region of the tumor or the opposite edge of the tumor. There is a "micro microwave oven" with the size of 1mm on the microwave needle. The microwave magnetic field released by the microwave needle can make the surrounding molecules rotate and heat up with friction at high speed, so as to coagulate, dehydrate and necrosis the tissue and achieve the purpose of treatment. However, the teaching method of this subject is very traditional in medical colleges, with group experiments, single teaching form and small experiment scale. Usually, a human model can be used to conduct theoretical research by recognizing body structure parts. Therefore, students cannot participate in the whole process of understanding and preparation of the condition of microwave interventional surgery. As a result, the results of the experiment are not ideal, and the students lack initiative and their practical ability cannot be fully improved. Thus, authoritative and lecture-based teaching is no longer appropriate, and authoritative and lecture-based teaching is in urgent need of improvement (Yu Fajun, Wang Shuanghong, Lin Manman, 2020).

CDIO teaching mode can fully reflect the objective law of talent training, elaborate the knowledge system on the construction of the teaching system of talent training in a hierarchical way, break through the traditional teaching mode of microwave ablation mechanism, and overcome the drawbacks of the current teaching situation.

Unable to provide adequate experimental equipment

Malignant tumor is the main object of microwave interventional therapy technology, and it is also an effective way for tumor treatment in recent years. Medical students should be familiar with and master the use of ablation needle and ablation range data in the learning process, and microwave interventional ablation is only a means of adjuvant therapy. For novice doctors and interns, practical operation must be fully taken into account. Imaging monitoring and treatment target organ acceptance degree, and this technology has certain limitations for frequently occurring stovestors (Wu He, Ge Qi, Zhang Ping, Sun Ling, Yang Yang, 2013), such as the selection of indications for liver tumors, tumor size, data, adjacent hilar structure, location of blood vessels, intestines, gallbladder, diaphragm, liver capsule, etc. should be considered, while the school laboratory is fixed, students cannot achieve diversity changes in the prosthesis experiment. Unable to provide adequate experimental preparation. At present, the average staff population in Chinese hospitals is much larger than the number of facilities in hospitals. Meanwhile, the junior doctors in hospitals will not let them use patients as experimental objects, so there is no place for them to practice their professional skills. Therefore, in order to solve this problem, this project makes a design that is not limited by location and time. A medical VR virtual simulation project that allows users to learn multiple

modules as long as they have the equipment. At the same time, minimally invasive technology is developing rapidly in China, and all major hospitals in China have created new minimally invasive technology departments. This paper fits the development direction of Chinese hospitals, and the microwave interventional therapy related technology used can, on the one hand, enable interns to quickly start working, on the other hand, enable more ordinary people who do not know minimally invasive technology. Experience the blessings brought by this technology (Yu Hang, Guo Yahui, Cheng Yuliang, Xie Yunfei, Qian He, Yao Weirong, 2021).

CONSTRUCTION OF EXPERIMENTAL PLATFORM OF VIRTUAL SIMULATION SYSTEM OF MICROWAVE INTERVENTIONAL THERAPY

Microwave Interventional Therapy, as a medical education project, aims to show the most real surgical process to the experience-makers. The project functions are closer to reality by including pre-medical history inquiry and drug and device-related operation preparation. And the wrong operation of the experiencer during the operation will be timely fed back to the experiencer. With the reform of the education system and the application of VR technology in the teaching direction, new teaching demands continue to emerge, which is a brand new development opportunity for VR technology in the medical field. Microwave interventional surgery is an important branch of clinical medicine (Lu Yanjun, Xu Tao, 2018), which requires physicians to have strong practical ability and application ability, learn a lot of theoretical basis, cultivate excellent clinical skills, and have enough practical experience.

The design and implementation of "Microwave interventional therapy" system based on virtual reality technology can just reflect the reality in the simulation in the field of medical teaching, complement each other to learn, can ensure that the user simulates the real scene for surgical simulation operation, so that not only can increase their experience in the learning process, but also can not be limited to the location and time factors. CDIO focuses on fully cultivating students' practical ability in the teaching process, allowing students to fully participate in the teaching process and personally experience the significance of the four keywords of conception, design, implementation and operation, laying a solid foundation for them to become microwave ablation interventional physicians in the future (Li Chunfang, Zhong Haixu, Qiu Pingsheng, 2021). Based on the CDIO concept of modern engineering education, teachers are required to fully change their roles. While improving teachers' engineering practice ability, personal professional quality, interpersonal skills, and the ability to build products, processes and systems are also improved (Edström K, Malmqvist J, Roslöf J, 2020). In addition, the teaching ability of teachers should be further improved to enhance their ability in providing integrated learning, applying active experiential learning methods and assessing student learning. Virtual simulation technology can quickly realize the transformation of teaching mode by applying technological advantages (Wu He, Ge Qi, Zhang Ping, Sun Ling, Yang Yang, 2013).

System architecture design based on CDIO mode

Based on the CDIO teaching model, the Microwave Interventional Therapy system is divided into two operation modules, namely basic teaching of surgical process and virtual reality operation module of surgical process simulation. The basic teaching of surgical procedure includes the teaching of surgical theory, the test of professional theoretical knowledge of tumor ablation and the practical simulation of surgical procedure. The virtual reality operation module of surgical procedure simulation includes the virtual simulation operation of microwave interventional therapy. The basic teaching of surgical procedure includes introduction of basic

knowledge of microwave intervention, introduction of ablation equipment, introduction of ablation position and surgical video display (Qian, C., Zheng, B., Shen, Y., Jing, L., Li, E., Shen, L., Chen, H, 2020). Surgical procedure practice simulation includes operational practice simulation. The virtual simulation display of ablation equipment includes the virtual simulation display of microwave needle under endoscope. The virtual simulation operation of the surgical process includes the anesthesia process and the virtual simulation operation of the input particles into the ablation needle. According to the result of demand analysis, this system client mainly includes login interface, teaching part and practice part. Teaching mainly realizes two teaching methods, namely text teaching and video teaching. Text teaching also includes theoretical chapter teaching and equipment model display. The surgical practice part is the surgical simulation of microwave interventional therapy, including patient preparation (signing informed consent, explaining possible complications, explaining the purpose of surgery to patients and their families), preparation of inspection items (preparation of instruments and equipment, preparation of drugs, preparation of treatment equipment), and finally the operation (Wu Fufei, Dong Shuangkuai, Wang Hong, Zhu Dan, Huang Zonghui, 2020).

The specific process is analyzed according to the system function modules and the system architecture diagram is obtained, as shown in Figure 1.

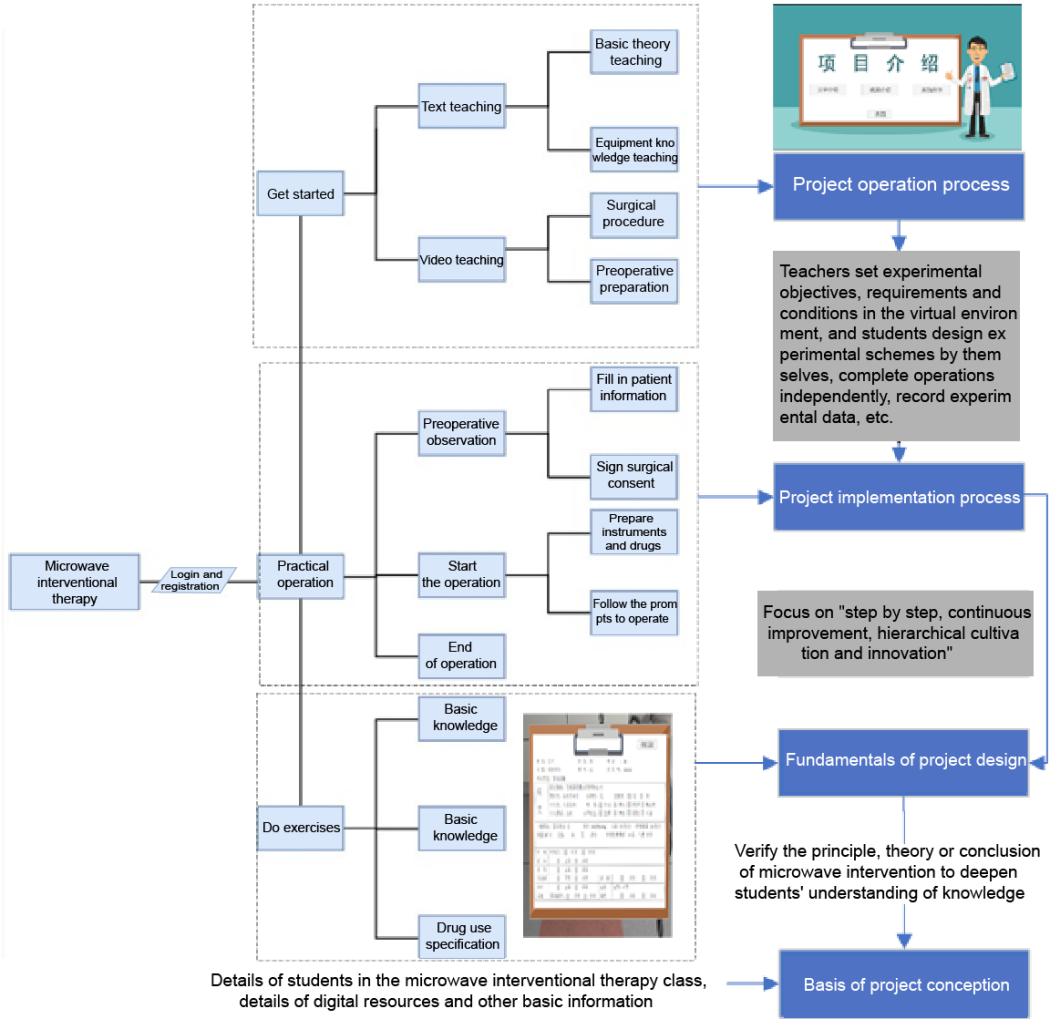

Figure 1. System architecture diagram

The simulation operation module of microwave interventional therapy is divided into three functional modules, as shown in Figure 2.

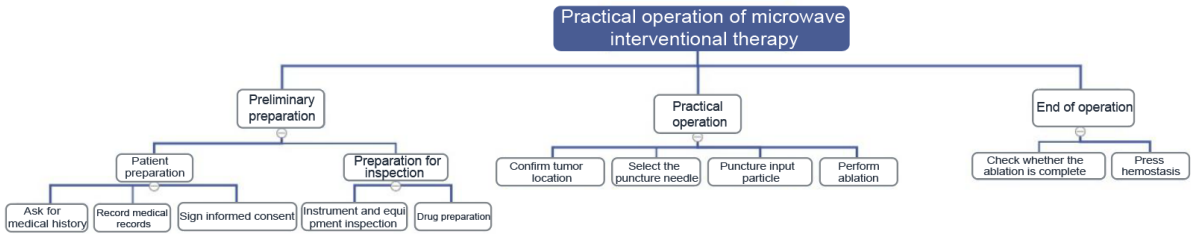

Figure 2. Function module diagram

In order to achieve the real operation effect, this module is added. The VR controller simulates the operation with human hands. The overall operation process is divided into: preliminary preparation (patient preparation and material preparation), practical operation (simulates the real operation process), and the end of operation, with obvious signs indicating how to proceed to the next step.

The CDIO mode was designed by the operation simulation function module

The analysis and design of each module of the practical simulation of Microwave Interventional Therapy, the overall architecture of the system is divided into three parts according to the M-VC design specification of model, view and controller. The system architecture diagram of Microwave Interventional Therapy is drawn, as shown in Figure 3.

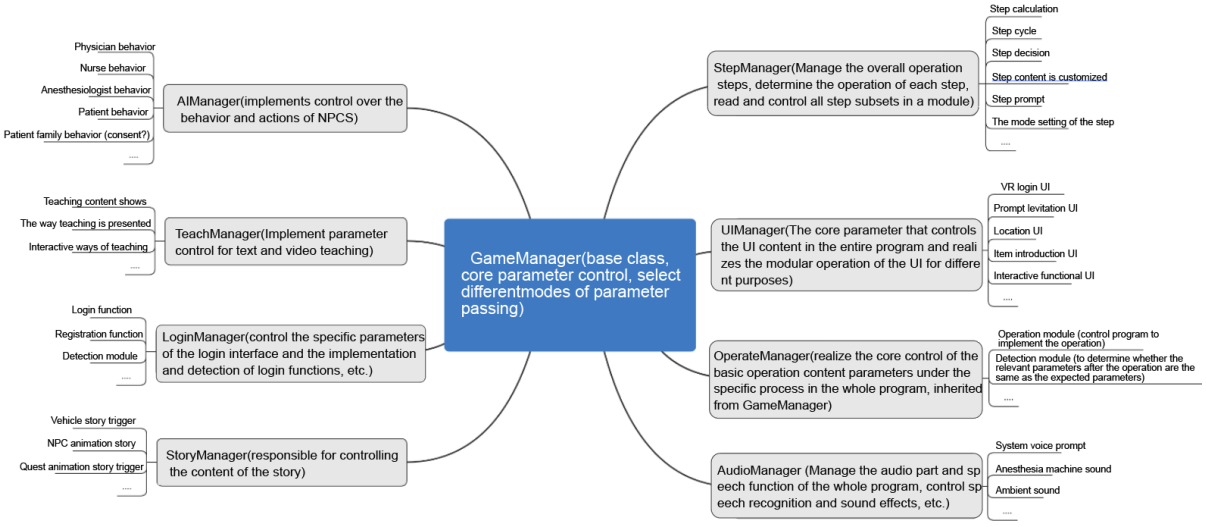

Figure 3. System architecture diagram built in CDIO mode

APPLICATION EFFECT AND PROMOTION OF VIRTUAL SIMULATION SYSTEM

The core idea of "Microwave interventional therapy" system is to combine traditional clinical tumor surgery with virtual simulation, with the help of virtual reality technology, to solve the

problem of traditional tumor surgery, students lack of practical experience. To a certain extent, it plays an important auxiliary role in clinical operation. Through the integration of virtual reality technology, virtual simulation operation is liberated from the traditional keyboard and mouse operation of flat display. The practical significance of virtual simulation operation is realized (Xu Ming, Yang Tao, 2020).

Microwave Interventional Therapy belongs to medical education project. Based on the analysis of the distribution proportion of existing medical APP users, it mainly targets internship students and professional doctors. Microwave Interventional Therapy transfers the content of books to the project. It is an interesting and convenient project to learn through simple video learning and easy to practice in the interactive way. It is more realistic in creativity and scene design as much as possible. Experiencers can fully understand and learn during the experience (Xu Mengxi, Lu Ali, Zhuang Yan, 2022). Microwave Interventional Therapy system is a virtual simulation software with microwave interventional therapy simulation operation as its main content. The main purpose is to increase the interest, sense of reality and immersion of traditional medicine teaching through the integration of emerging technologies and emerging disciplines. In terms of software design ideas, students are guided by a correct cognitive process from theoretical knowledge, teaching videos, to simulation operation and the final virtual simulation operation. Gradually deepen the students' learning and memory of knowledge. In addition, with the aid of new equipment, it can increase the training opportunities for trainees and novice physicians before the actual operation. At the same time, solid training can also provide powerful technical support for novice physicians before the operation and relieve the tension in the actual operation process. In the process of project practice, students' teamwork ability, expression ability, professional ethics, integrity and professional quality have been greatly improved. However, due to the limitations of the site, closed-loop learning, assessment and experience of virtual simulation experiment project in CDIO mode are carried out, and in-depth research and design are conducted to design and implement experimental projects fully adapted to the practical education of microwave interventional therapy engineering. In the process of implementation, teachers' engineering ability and teaching ability have been improved correspondingly through continuous improvement. The construction of virtual simulation experiment project based on CDIO engineering education mode has effectively improved students' learning enthusiasm and effect, as well as their engineering ability, innovation and entrepreneurship(Wang Yangping, Yong Jiu, Wang Wenrun, Yue Biao, 2019). Due to the advanced technology, high cost and irreversibility of microwave interventional therapy, there are few mature reference cases in China. This teaching reform and practice can provide reference for relevant majors in application-oriented undergraduate colleges.

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BIOGRAPHICAL INFORMATION

Li Xiang is an associate professor at the Dalian Neusoft University of Information ,a CCF member. Currently has a master's degree in design and is a phd candidate in electrical and computer engineering-artificial intelligence. She is the Industry 4.0 Judge of the People's Republic of China Vocational Skills Competition, the internal auditor of the National Military Standard, the official certified lecturer of Unity3D engine, and the deputy director of the Digital Media Technology Department of the Neusoft Institute of Information School of Digital Art and design. It mainly teaches human-computer interaction technology, interactive device design, game physics, virtual reality development and other courses.

Zhang Mingbao is an associate professor of Dalian Neusoft Institute of Information.At present, he is a doctor of electronic and computer engineering. The research direction is animation, virtual simulation and digital twin. He is currently serving as the Deputy Dean and Head of Animation Department of Digital Art and Design College of Dalian Neusoft Information Institute. During this period, there were more than 18 projects guiding college students ' innovation and entrepreneurship training programs, and 16 projects hosting or participating in provincial and above education and scientific research projects, including one humanities and social science research project of the Ministry of Education and one key natural guidance project of Liaoning Province. Published 5 national high-level papers, 12 E papers, 2 SCI papers, 5 CDIO conference papers, obtained 12 software copyright and utility model patents, and published 11 works.

Chu Dongyang is a junior student majoring in digital media technology at Dalian Neusoft Institute of Information. She entered the university in 2020. After professional study, she went to Associate Professor Li Xiang's studio of the university to do projects for extended study.

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