

Current study on HCI based AR technology in the medical industry

Menghe Yu

Malvern College Qingdao, Shandong, China

srose79728@student.napavalley.edu

Abstract. Augmented Reality (AR) is a new technology that based on Human-Computer Interaction (HCI) can combine our real life with 3D virtual information through real-time computing and multiple sensors. It simulates people's senses, such as hearing, vision, touch, etc., bringing things that cannot be seen in reality to people's eyes, which will bring people a feeling beyond reality. It has already appeared in our lives and has applications in many fields, such as architecture. Especially in the gaming field, AR, an innovative emerging technology, is widely loved by young people. With the development of technology, the forms of AR games have also become diverse. It has also developed rapidly in the medical field in recent years. This article will discuss the current situation of AR and its advantages in the medical industry based on Human-Computer Interaction (HCI) from three aspects: doctor diagnosis, patient rehabilitation, and medical education with examples of applications. Then, this article will discuss some of the drawbacks of using AR and the problems that will be encountered in future development, and propose solutions. Finally, analysis and predictions will be made for the future development of AR in the industry.

Keywords: Human-computer Interaction, Augmented Reality, Medical, Healthcare.

1. Introduction

Augmented Reality (AR) enhances reality by overlaying 3D models in real scenes, achieving different goals. In industry, it visualizes architectural design and has great help in the field of architecture, greatly improving work efficiency. In daily life, AR can serve as a tool for us to try on clothes online, helping girls find clothes that are more suitable for them. Apps such as 'Pokemon Go' have also entered the public eye and gained widespread attention. It can be seen that AR has achieved great success in various fields and is a highly effective tool. AR is also widely used in medical treatment. There are some applications of AR in healthcare: Li Qiming et al. [1] designed and realized an augmented reality system to simulate coronary artery vessels (CAV) and the real-time HCI is realized by the gesture recognition. Ultimately, doctors can better diagnose and plan, and achieve better teaching outcomes.

Hossein Mousavi Hondori et al.'s study [2] found that the exercise performance in AR games was superior to that in PC games by testing different versions of PC and AR games on patients with chronic stroke. So, it received favor from patients. In the paper from David E. Hartigan [3], it explains that the application of AR on computer-assisted surgery (CAS) is changing orthopedic training and practice. AR can sometimes replace the position of a general teacher in the field of medical education, avoiding

financial and moral constraints to achieve effective teaching [4]. Mytherey Venkatesan et al. [5] studies cardiac surgery and 3D models using various data and images with the help of AR.

2. Current Situation of AR in the Medical Field

AR is changing our life by unimaginable way. The application of AR is growing continuously over the year. It's helpful for both doctors and patients, as well as medical education.

2.1. For Doctors

AR technology is of great help to doctors. Doctors can use AR mapping software to model the lesion site of patients, and use patient diagnostic data such as CT images to model bones and organs, even from brain imaging and blood vessels. AR visualizes abstract diagnostic results and patient data, bringing them into reality, allowing doctors to observe the model in greater detail and provide a more intuitive experience. The application of this method is of great help to doctors in diagnosis, preoperative planning, and high-precision surgery. In detail, AR can perform real-time image analysis and make more accurate measurements, allowing doctors to make comparisons more clearly. Not only has it improved the work efficiency of doctors, but it has also significantly improved the rigor and accuracy of their work. Now this technology has been applied, such as brain surgery, ophthalmic medicine, and so on. At the same time, AR can also serve as a communication platform for patients and doctors in remote areas. Through AR, the model in front of the doctor is the patient, overcoming regional barriers to achieve remote diagnosis and even basic surgical operations remotely. This also creates infinite possibilities for the employment and development of medicine. Figure 1 showed an human-computer interactive augmented reality system.

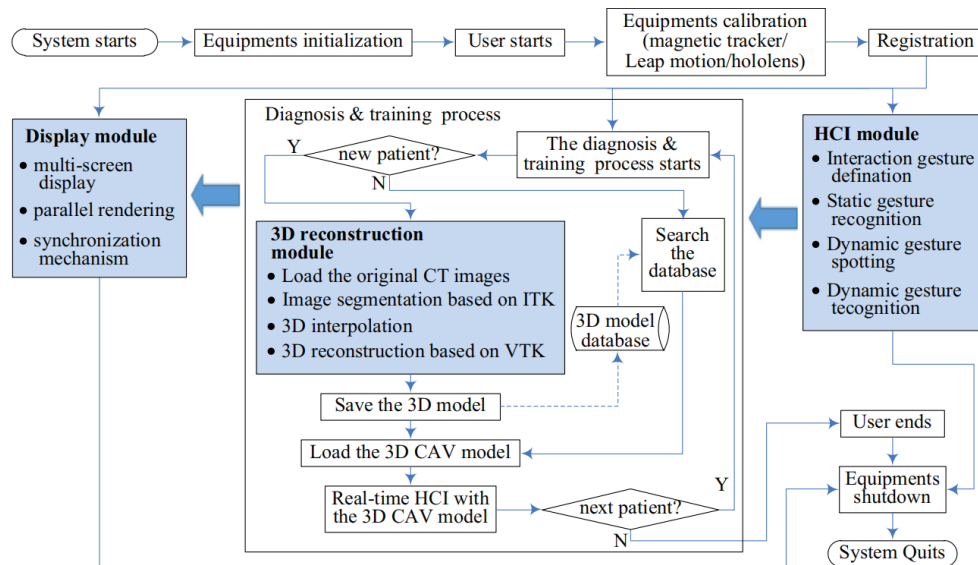


Figure 1. An Human-Computer Interactive Augmented Reality System for Coronary Artery Diagnosis Planning and Training [6].

Li Qiming et al. designed and implemented an AR system that simulates coronary artery vessels for more natural and intuitive preoperative diagnosis and planning [7]. This system renders a three-dimensional reconstruction model of the patient's coronary artery and achieves good human-computer interaction through gesture recognition. The recognition of different gestures and the execution of corresponding commands make observation and diagnosis more accurate, such as dragging, zooming in, zooming out of the model, and measuring data. This system interacts with coronary arteries in the most intuitive way, achieving a comprehensive and complete presentation.

2.2. For Patients

For patients, the application of AR also has different effects. For normal people, medicine is abstract and complex, such as CT images, magnetic resonance imaging, etc., which leads to communication barriers between doctors and patients - sometimes it is not possible to simply use language to let patients understand the condition. And AR effectively alleviates this problem. Doctors can use AR modeling to enable patients and their families to better understand the condition, such as lesion location, treatment plan, surgical planning, etc., thus enabling families and patients to have a better mindset and make better decisions.

On the other hand, AR enhances human perception of surrounding things through human-computer interaction, providing people with a surreal experience that includes not only visual perception but also auditory and tactile senses. Utilizing this feature, using the recovery plan developed by AR will make the patient's connection with motor function closer, thereby achieving better recovery results. Figure 2 showed the choice of human-computer interaction mode in stroke rehabilitation.

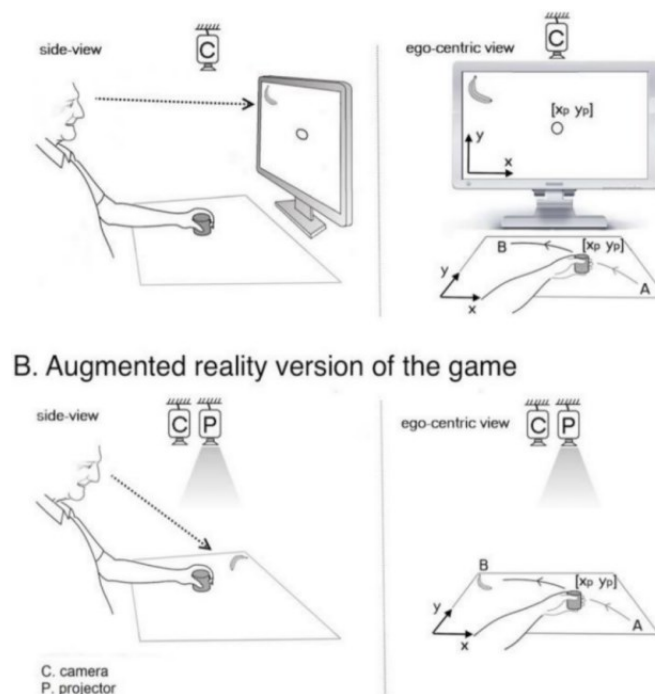


Figure 2. Choice of Human-Computer Interaction Mode in Stroke Rehabilitation [8].

This is an experiment completed by Hossein Mousavi Hondori et al. Have the patient operate the AR version and PC version of the Fruit Ninja game with their arms and score accordingly. The results showed that compared to PC games, AR games scored 21% higher. It can be seen that compared to PC games, AR lacks the process of looking up at the screen and then feedback to the arm, which is more intuitive and natural, making the connection between patients and motor function closer, resulting in better rehabilitation effects and being favored by patients.

2.3. In Medical Education

AR has many irreplaceable roles in medical education. Compared to traditional educational models, simply using pictures to display is not enough to enable students to fully understand the content, and due to the limitations of corpses, multiple students may need a corpse at the same time in a practical class, which brings great inconvenience to education. And AR has effectively solved these problems. AR displays the details of human body structure in a three-dimensional model in front of students, and human-computer interaction also achieves sensory experiences, such as touch, allowing students to more intuitively understand and feel the learning content, and avoiding the moral and economic limitations of

using corpses. Not only that, AR can also overcome regional limitations, greatly improving the quality of remote education. Not only in terms of presenting details, real-time sharing of AR 3D models can also achieve more long-distance teaching. In addition, AR can also be combined with practical exercises. Surgery has strict requirements for the operator's accuracy and attention. Through the interaction between visual and tactile senses, AR restores the true sense of touch, provides a more complete virtual environment, provides students with more direct feedback, and can better improve the quality of students' learning and practice [9, 10].

3. Development of AR in the Future

AR appears in people's vision, subtly changing our lives and bringing great improvements and extraordinary experiences to our quality of life. It has achieved great success in the field of medicine and is one of the important research objects of modern technology, with infinite possibilities.

3.1. The Problem that Using AR

Nevertheless, there are still some unresolved shortcomings in using AR. For the use of high-tech, users need a certain technical foundation to fully utilize the maximum advantages of AR applications. And also the development of AR requires a significant amount of economic and time costs, this may also require extra training costs. But the high costs will decrease with the AR's developing until this technology becomes more mature over time, the problem of high cost will be solved. Secondly, even though AR achieves comprehensive and complete virtual environment simulation through human-computer interaction technology, it still cannot compare to the benefits of practicing on corpses for teaching and research. The difference between 3D models and real human organs is inevitable and unsolvable. If the cadaver donation system is improved in the future, AR will be less likely to replace corpses in the classroom, until AR can completely replace corpses, and it also means the development of the medical field will take a big step forward. There are also doubts about the accuracy of AR medical assistance, even though high-precision measurements have been achieved, it still cannot avoid inaccuracies in gesture recognition and system vulnerabilities. If we want to solve this problem, it is essential to improve the human-machine interaction design in AR systems. For example, strengthening gesture recognition systems and inputting more gestures for training to improve accuracy. Moreover, the comfort of using AR glasses is not good, as they are heavy and not suitable for long-term wear. Of course, we can also achieve AR through a display screen, but this will greatly reduce the efficiency of human-computer interaction.

3.2. Outlook for the Future of AR

At present, AR has strong assistance in the field of medical judgment, plastic surgery, and education. In the future, AR will further improve human-computer interaction design, enhance human senses, and achieve simulations closer to reality. We also believe that AR technology will assist doctors in completing difficult and high-risk surgeries, efficiently helping patients recover, and helping medical schools cultivate more medical talents. With the development of AR, the medical field will usher in significant breakthroughs, and with the development of the medical field, AR will also gain a broader market. And also with the increasing maturity of AR technology, many problems will be easily solved such as lighter AR glasses and widely applied in different fields, bringing significant power to national development.

4. Conclusion

In summary, AR enhances people's senses of simulating reality through human-computer interaction, such as visual, auditory, and tactile senses, visualizing things, and even bringing people experiences beyond reality. It can not only be applied in well-known games, but also has extensive and important applications in medicine, which is more important to people. In the medical field, AR has extensive development in various aspects. It utilizes the technology of seamlessly connecting real and virtual information to present the required model in a more natural, intuitive, and detailed manner, completing

a more complete and comprehensive system and operation, such as remote diagnosis, remote surgery, preoperative planning, rehabilitation planning, rehabilitation facilities, and so on. This is of great help to both doctors and patients, enabling them to have higher work efficiency and better work quality, enabling patients to better understand their condition and achieve more effective rehabilitation training. It also helps to overcome economic and moral problems and cultivate more medical talents. In the future, AR will become one of the core technologies studied by high-tech personnel, with unlimited development and bringing tremendous progress to medicine, making significant contributions that cannot be underestimated.

References

- [1] Li Q, Huang C, Lv S, Li Z, Chen Y, Ma L. An Human-Computer Interactive Augmented Reality System for Coronary Artery Diagnosis Planning and Training. *J Med Syst.* 2017, 41(10): 159.
- [2] Mousavi Hondori H, Khademi M, Dodakian L, McKenzie A, Lopes CV, Cramer SC. Choice of Human-Computer Interaction Mode in Stroke Rehabilitation. *Neurorehabil Neural Repair.* 2016, 30(3): 258-265.
- [3] Verhey JT, Haglin JM, Verhey EM, Hartigan DE. Virtual, augmented, and mixed reality applications in orthopedic surgery. *Int J Med Robot.* 2020, 16(2): e2067
- [4] Moro C, Štromberga Z, Raikos A, Stirling A. The effectiveness of virtual and augmented reality in health sciences and medical anatomy. *Anat Sci Educ.* 2017, 10(6): 549-559.
- [5] Venkatesan M, Mohan H, Ryan JR, et al. Virtual and augmented reality for biomedical applications. *Cell Rep Med.* 2021, 2(7): 100348.
- [6] Lamberti F, Sanna A, Rokne J. Sensors for Entertainment. *Sensors (Basel).* 2016, 16(7): 1102.
- [7] Parekh P, Patel S, Patel N, Shah M. Systematic review and meta-analysis of augmented reality in medicine, retail, and games. *Vis Comput Ind Biomed Art.* 2020, 3: 21.
- [8] Eckert M, Volmerg JS, Friedrich CM. Augmented Reality in Medicine: Systematic and Bibliographic Review. *JMIR Mhealth Uhealth.* 2019, 7(4): e10967
- [9] Bruno RR, Wolff G, Wernly B, et al. Virtual and augmented reality in critical care medicine: the patient's, clinician's, and researcher's perspective. *Crit Care.* 2022, 26(1): 326
- [10] Jiang J, Zhang J, Sun J, Wu D, Xu S. User's image perception improved strategy and application of augmented reality systems in smart medical care: A review. *Int J Med Robot.* 2023, 19(3): e2497.