Immersive Technology for Medical Education: Technology Enhance Immersive Learning Experiences

Mathuwan Srikong, M.S.*, Panita Wannapiroon, Ph.D.*

**Medical Education Technology Center, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, **Division of Information and Communication Technology for Education, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok, Thailand.*

ABSTRACT

Immersive Technology was a trend of the interesting technology in presentation, demonstration, imitation. These techniques could be used in medical education. This article would present immersive technology knowledge which consisted of Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR). Immersive technology could also be applied to medical education in 5 parts such as Treatment, Education, Rehabilitation, Training, Surgery, and equipment for medical education media development.

Keywords: Immersive technology; virtual reality; augmented reality; mixed reality; immersive learning experience (Siriraj Med J 2020; 72: 265-271)

INTRODUCTION

The rapid development of technology takes part in the daily life and technology for changes, opportunities, a new relationship (This article will tell about immersive technology.), the development of assessment, connection, imitation of 3-dimensional graphics to classroom to promote the virtual learning by using many instruments. Applying the virtual technology to education urges learners to analyze, solve problems and enhance skills especially for; Immersive Technology for Medical Education. This technology can increase efficiency in learning such as anatomy which is difficult and complicated. Learners can understand and decide effectively which can decrease the mistakes and boost proficiency in learning. Immersive technology for medical education is an application of wireless network in classroom or laboratory. Learners can gain experience, urge their attention in virtual condition. This technology is also the creative design for the development of medical education.

Meaning of immersive technology

Immersive Technology means experiences and reactions of Virtual Reality (VR). This technology is an important approach that takes parts in the publication of knowledge in science for nonscientists and motivates students to the laboratory. It can change the processes of working in the laboratory and urge development in science.[1] Impression in technology (immersive technology), this technology can apply technology to 3-dimensional different data such as Virtual Reality (VR) and Augmented Reality (AR) for providing 3-dimensional conditions on the computer. Learners can understand the immersive

Corresponding author: Mathuwan Srikong
E-mail: mathuwan.sri@mahidol.edu
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ORCID ID: http://orcid.org/0000-0003-0150-596X
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objects in the real world.[2] Impression in the attention of technology in real-world and virtual conditions.[3] Impression of technology consists of Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR). Learners can apply this technology to react and control. The continuity of immersive and physical condition depends on the levels of immersive condition. Learners can learn through virtual digital content to practice risky situations in the classroom and laboratory under safe conditions.[4] Instruments for immersive technology can train basic knowledge automatically without pressures from patients.[5]

In conclusion, immersive technology means imitation the virtual instruments in a real situation that can show on the computer. This technology applies Virtual Reality (VR), Augmented Reality (AR) to Mixed Reality (MR). It can create an impressive experience to urge attention which can react and control this immersive situation.

Immersive technology

Immersive technology is a technology in the virtual world that is quite similar to the real world. Immersive Technology cover to AR, VR and Mixed Reality (MR).

Kinds of immersive technology

Augmented Reality (AR)

Augmented Reality is a form of Virtual Environment (VE) in the synthesized condition. Augmented Reality (AR) is the increase of realistic things more than virtual reality. AR will imitate the virtual objects then overlap them to the real objects which are in the same area.[6] The activation of technology in real-world and immersive world purposes to create the perfect new condition from computer.[7] The view of physical condition and the real world can be edited by adding more information about the reality of each person from the computer. This information may be applied to create experience for each person in real condition.[8] It is the modern technology that has various displays such as message, number, alphabets, symbol or graphic as well as the view of users in the real world. The augmented reality has the real-time relationship to the immersive condition.[9]

As a result, In AR objects are enhanced in the interactive experience compared to in standard virtual reality.

Virtual Reality (VR)

Virtual Reality is a condition that is created by software then present to users. This kind of reality will imitate the steps of operation in real-time processes. Virtual Reality (VR) can be used to demonstrate the steps of operation by using the computer to train, show the models of anatomy and many processes of operation from stereo laparoscopy. The forms of Virtual Reality – Internet of Thing (VR-IoT) will increase in the future because they can apply the capacities in the real world.[10] Virtual reality can be created by 3-dimensional computers. It consists of reflection of real-world to make objects to be similar to real objects and it also improves processes then applies to the teaching materials, learning as well as medical training.[11] Virtual Reality is a model in the synthesized condition to create a real-time virtual world by using computer graphics. This system can react in many ports in censor perception then react to users in gestures and commands. The important factor of virtual reality is to record the data of users then create the virtual world immediately. It is the reacted graphic connection.[12]

Mixed Reality (MR)

Mix reality is the combination of elements and perception between the physical and digital worlds.[13] This reality will be impressive when it combines Augmented Reality (AR) and Virtual Reality (VR). AR is the combination of synthesis and realism then blends the physical world to data in the computer. Users can know, react to the condition. Virtual Reality (VR) is the immersive reality from the computer which may not related to the real world.[14] The combination of reality will combine the Augmented Reality (AR) and Virtual Reality (VR) in application which can be edited in the real world. There are many ways of combination between Augmented Reality (AR) and Virtual Reality (VR) in an application.[15] Mix Reality (MR) is the combination of 2 kinds of technology: Augmented Reality (AR) can add more information to the experience in real-world and Virtual Reality (VR) will imitate the situation from computer to urge users to experience.[16]

In conclusion, Mixed Reality (MR) combines 2 realities such as Augmented Reality (AR) and Virtual Reality (VR). It imitates the condition which is overlaps by synthesized objects in the same area.

Elements of Immersive Technology

Immersive technology consists of these elements. Immersion is an impressive experience. Users will wear a headphone kit which is designed to protect the light outside the room. Stereoscopic vision will imitate 3D vision. Motion capture, this feature will capture the users' motion accurately.[1] The virtual world will imitate the area by using the computer to be similar to the situation in the real-world then imitate the physical and

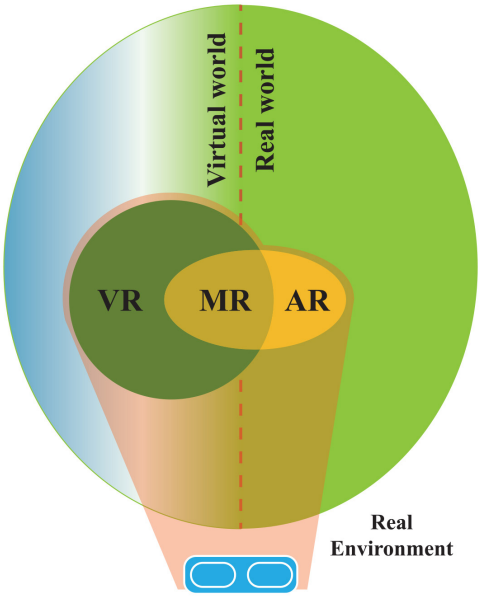

Fig 1. Simplified representation of the Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR)
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mental condition of being in the virtual world. Sensory feedback, this feature will give feedback according to physical positions. Interactivity will work when the system reacts to users.[17] This part will work when the system connects Head Mounted Display (HMD), Headphones for sound to the system for headphones and decreasing noise. Applying immersive technology in 3D condition will experience users to impress in the virtual world.[18] Elements of software will be different in the virtual environment and the real environment.[19]

Immersive Learning Experience

Technology in education began to focus on the Augmented reality (AR) and Virtual Reality (VR) because of the ability to support immersive learning teamwork and teaching through treatment to interact with the computer. It is used in various types of training programs and is especially useful for the participation and motivation of learners. It is an effective technology to support learning. To enhance the learning experience can be applied to medicine from a study of Immersive Learning Experiences: Technology-Enhanced Instruction. Users report increased engagement with informal learning environments.[20] In the study of immersive learning for enhanced organic chemistry instruction, the system design and development with immersive and immersive virtual reality technology for teaching organic chemistry in the environment encourage participation, motivation and high interest within an immersive environment, users are disengaged from physical disturbances and systems and can, therefore, be useful for resolving important problems of student participation.[21] In the study of caregiving between careers and the development of communication abilities in the healthcare professional curriculum through realistic, realistic experiences participants have learned positively, feel their status and show empathy through immersive experiences. Understand technology and want to learn in an environment that is updated with technology. There is an increased awareness of learning through virtual reality.[22] Therefore, Immersive technology learning is the application of technology to create immersive learning experiences for future studies.

Applying Immersive Technology to Medical Science

This part will tell about the latest development and challenges in the future of Mix Reality (MR) which is interesting to medical science development. There are 5 forms of applying immersive technology to medical science[23] as following;

Treatment

The advantage in medical science: Educational virtual reality videos in improving bowel preparation quality and satisfaction of outpatients undergoing colonoscopy: protocol of a randomized controlled trial. The protocol of research was randomized experiment. The result found that virtual reality video could imitate the experience of intestine preparation improvement to patients. Virtual Reality (VR) could enhance their concentration and result. Moreover, it reduced the patients' anxiety before operation.[24] but its efficacy is closely related to the quality of bowel preparation. Poor patient compliance is a major risk factor for inadequate bowel preparation likely due to poor patient education. Such an education is usually provided via either oral or written instructions by clinicians. However, multiple education methods, such as smartphone applications, have been proved useful in aiding patients through bowel preparation. Also, it was reported that a large proportion of patients feel anxious before colonoscopy. Virtual reality (VR Mix reality (MR) usually applied to the operating system. However, there were some complicated medical instruments. This limitation could decrease the proficiency and it is not suitable for the operation in real situations. Doctors identified the position of wounds from virtual reality which was the combination of the operation by virtual images from recording data and operation in real situations. This approach analyzed the position of wounds before operation. It reduced the risk and improved the security in operation.[25]

Education

The advantage in medical education: Applying the virtual reality in medical education. This project was successful in applying the invention for physical therapists and nursing curriculum. The result found that Virtual Reality (VR) was a part that could help students to understand some symptoms related to age and it could increase the attention to elderly persons in vision and Alzheimer's disease.[26]

Rehabilitation

The advantage in rehabilitation for medical science: Connection in medical science to Virtual Reality (VR) and Augmented Reality (AR). This work was a combination of Augmented Reality (AR) and Virtual Reality (VR). Specialists used 2D and 3D data for analyzing the operation and communicating between specialists and patients. Case study: Planning for dental implantation by using Augmented Reality (AR) in mobile phones and tablets for dental students. The processes was shown in a display above the patient's head. Endoscopy operation could combine the surgeries' hands to show the positions in anatomy and Augmented Reality (AR) could restore patients in therapy by physical therapists. Patients could give comments to this system.[27] Designing the virtual system to enhance the emotional skill for autism spectrum disorder children purposed to check whether their faces were appropriate to each situation. These children would be evaluated skills which they practiced in Virtual Reality (VR) to the real world. The result found that skills which they practiced in Virtual Reality (VR) could transfer to the real world and their progression was developed when they did not use Virtual Reality (VR).[19]

Training

Study of effect of cataract operation to the errors after cataract operation by the first- and second-year trainees. This research studied the error in the capsule after lens during operation which might cause complications; for example, Retinal detachment during operation which caused the rate of vision for patients decreased. The result found that virtual reality in ophthalmology was efficient to the patients who were done cataract operation. The rate of complication after cataract operation decreased by 38%.[28] Application of virtual reality in clinical medical science in training some approaches to manage the patients' painfulness and mind symptoms. Virtual Reality (VR) could increase the patients' obsession which was similar to the virtual hypnosis to make patients endure the painfulness.[18] The efficiency of virtual reality training in orthopedic surgery approved that Virtual Reality (VR) was an instrument for the development of orthopedic surgery techniques.[29]

Surgery

Doctors could use Augmented Reality (AR) as the instruments for training the surgery which showed the patients' view. It was beneficial to medical science in the operation room. They could check some qualifications by their bared eyes which could not look in MRI or CT scanning. On the other hand, doctors could use Augmented Reality (AR) to access data.[6] The trend of applying virtual reality and imitating situation was to use in the operation in the virtual situation from the computer then transferred it to patients by using Virtual Reality (VR). Every situation was created by calculating and Augmented Reality (AR) to overlap the virtual objects from the computer to give alternative views of operation. It enhanced the efficiency of the operation.[30]

In conclusion, applying immersive technology to medical science had 5 categories: treatment, education, rehabilitation, training, and surgery. This technology could create the virtual situation in different contexts.

Instruments for developing immersive in medical science

At this time, the development of software in medical science recognized to the combination of medical photographing to a more realistic image. 3D structured objects are important to solving clinical problems. Complex imitations can be create to show how 3D objects are in a given situation. In processing, doctors need to have knowledge of anatomy and physiology as well as relational and physical qualifications. The 3D graphic is the main element in the accuracy of imitating a 3D image. The important things for medical science focus on reality and real-time reaction. Software package for these calculations is ANSYS software kit (Ansys Inc., Canonsburg, PA, United States). Creating 3D models are done by SOLIDWORKS software (Dassault Systems, Concord, MA., United States) and creating mechanical objects and imitation (Materialize NV, Leuven, Belgium) for anatomy virtual model.[31]

The most famous instruments for developers for creating applications are Unity 3D and Unreal engine. They can create the immersive model like Virtual Reality (VR) and Augmented Reality (AR) as following; Unity 3D (Unity Technologies, San Francisco, CA, United States) The platform which is flexible for calculating 3D graphic is Unity. This application has various instruments for editing and showing examples in real-time. It is available ON Windows Mac and Linux for a virtual experience. This application can use script to develop

content which can reach each other.[32] Unreal Engine (Epic Games, Cary, NC, United States) is a well-known graphic application. It is not complicated. Moreover, this application is available for free which is a good thing for 3D graphic development. Basis of this application can apply to solve the complicated reasoning, presenting anatomy data in 2D and 3D to help the users to understand the overall condition while the real-time 3D graphic is appropriate to the anatomy.

Planning, pre-analysis, advising on the operation and after the operation, caring can be seen by 3D microscope in Augmented Reality (AR) and Virtual Reality (VR) to encourage the surgeons who purpose to the operation and anatomy by applying optical navigating system or electrical magnet to follow the real-time operation as following; Dextoscope (Braco): processing about planning the operation and applying AR in 3D objects and it can react to users. The database will be registered automatically for creating images. The surface will be divided to categorize the structure to determine the relationship in anatomy. Immersive control is easy to use. It can adjust to display each object to get the best images. The system uses controller and stylus which overlap keyboard and mouse which cause the reaction and management of images to work more accurate. Interface of image shows the relationship of complicated anatomy. Dextoscope can create AR stereoscopic in the 3D world by overlapping the 3D analysis image to the correct position of skin and bones and it can also find the position of diseases. HoloSurgical (Chicago, Illinois, USA): The navigation system for AR and AI operation. This application can correct the limitations about the navigation system for operation and AI system. ARAI uses AR-state-of-the-art to overlap the 3D image in hologram type for the patients' anatomy. Doctors can understand the 3D anatomy structures and complete patients' anatomy structures. This system decreases the complexity of operation. The navigation system HoloSurgical ARAI will scan before operating with AI and its algorithm of this application to know the anatomy structure. VPI Reveal is the 3D creating kit for medical science data. VPI presents the real-time volume analysis for CT and MR data in a 3D monitor. This application is also available on desktop platforms and mobile phone which is easy to use. VPI Reveal can work on the different processes for 3D scanning by using any input which doctors use such as the keyboard and touchscreen mouse. The navigation system and processes in the 3D monitors are supported by various display systems then present the patients' hologram to scan the data and model. Synaptive Medical (Synaptive Medical Inc., Toronto, Ontario, Canada) is a platform for applying to neurosurgery. Neurosurgeons can understand clearly when they look at the images and find the possible ways for neurosurgery. This platform has many ways to work according to the hand-free combination of accurate MR images and it shows the real-time structures. It also has a function that solves the complex reasoning for surgeons by using 3D images with automatic evaluation and 3D graphic rendering. As a result, they can plan before the operation.[33]

Instruments that apply immersive technology in medical science for medical practitioners

Augmented Reality is the technology which users can interact between virtual objects and real life. The applications can provide real experience and virtual objects to users such as Google Glass, Microsoft HoloLens because these objects can overlap to the immersive world. Augmented Reality (AR) is different from Virtual Reality (VR) which facilitates users to experience a virtual experience such as Oculus Rift, HTC Vive. The instruments for Augmented Reality (AR) and Virtual Reality (VR) have the monitors which have headphones. Headphones can interact between users and the computer. Microsoft HoloLens is the headphone kit which will overlap virtual objects to the real condition of users to have various experiences. According to the research "Study of Effect for immersive technology by using Microsoft HoloLens Anatomical Pathology", specialists in this area investigated by wearing HoloLens kit and command them in the far distance. This program also provided a real-time diagram, description and voice-command. 3D primary sample in pathology could be viewed in hologram. Users could access to the pathologist for asking advice in their interesting area such as advice during operation. This advice could apply to improve the searching in pathology and the slides navigation would evaluate in pathology.[34] Another research was "Study of Result in anatomy in learning to the achievement of the medical practitioners in the topic: neuroanatomy". This research collected virtual objects and approved users to interact by using mobile phones. Learning via mobile phones could facilitate students to learn and they could also access media in every time they wanted to access.[35]

Instruments that apply immersive technology in medical science for patients

The instrument will present the virtual model of the laboratory which is developed for patients. Patients will be operated in angiogram which will use the photographing system to investigate patients' blood heart vessels. They can know about the processes of operation in virtual

condition, so their fear is decreased. The patients can interact with the virtual object via the wireless controller. Doctors introduce patients by using the recorded script. When patients follow the processes, they will describe some side effects to patients. After that, doctors will ask patients to put their hand up. Interaction part: This part will facilitate patients to respond easier by using the button "trigger" to interact. It is their natural movement to grab and move objects according to the processes by doctors. Patients will focus on processes which happen in the virtual world instead of focusing on the real world. Design part: Patients will in the virtual condition to see what they want to interact with. It needs a limited area. Technique part: The Imitated situation in the laboratory is developed by Unity game engine, C# programming, and Autodesk Maya. They can produce a 3D model in medical science and there is some equipment to create a soundtrack.[36]

Example of applying immersive technology to medical science in ophthalmology

Applying immersive technology to medical science in ophthalmology, virtual reality (VR) instruments in retinal surgery and cataract surgery proceeds by using the 3D microscope in operation. During the imitation process of the microscope, instruments will be controlled by a pedal with a virtual interface platform that imitates retinal surgery and cataract surgery. It starts from basic surgery to complicated surgery until solving side effects. Doctors can evaluate, analyze the results of students' skills according to many indicators then summarize to scores and announce to them to show their achievement. These results can improve the skills according to students' difference.

CONCLUSION

Virtual technology is a new strategy in medical science. This technology will imitate situations that rarely happen in a clinical experiment. It is a complicated skill which needs to practice a lot of time until users will be expert and solve problems according to medical ethics. Doctors will be more confident in operation. By the way, rapid development of hardware, software and programming skill for immersive media can facilitate doctors to work. Patients can respond in real-time method and doctors can apply these responses to the studying in each branch in medical science.

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