AR AND VR APPICATIONS IN HEALTHCARE

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Abstract: Virtual Reality (VR), Augmented Reality (AR) and Head Mounted Displays (HMDs) are revolutionizing the way we view and interact with the world, affecting nearly every industry. These technologies are allowing 3D immersive display and understanding of anatomy never before possible. Augmented and virtual reality are transforming the practice of healthcare by providing powerful and intuitive methods of exploring and interacting with digital medical data, as well as integrating data into the physical world to create natural and interactive virtual experiences. These immersive technologies use lightweight stereoscopic head-mounted displays to place users into simulated and realistic three-dimensional digital environments, unlocking significant benefits from the seamless integration of digital information with the healthcare practitioner and patient's experience. This seminar explores some of the current and emerging technologies and applications in surgery, therapeutic approaches in rehabilitation, pain management, and psychology, their benefits and challenges around immersion, spatial awareness and cognition, and their reported and projected use in learning environments, procedure planning and perioperative contexts.

I. INTRODUCTION

While closely related augmented reality (AR) uses elements of VR and superimposes them on to the real-world environment in the form of a live video displayed on the screen of an electronic device, virtual reality (VR) is a technology that immerses the user in a synthetic 3-dimensional (3D) environment via wearable screens in the form of VR headsets. Both augmented reality (AR) and virtual reality (VR) are intended to give people an experience that stimulates their visual and auditory senses by simulating the environment[2].

Modern simulation models like VR and AR are currently improving medical education. With virtual reality, users may interact with buildings in 3D and in real time. The user can have a realistic and engaging experience thanks to current developments in haptics, display technologies, and motion tracking, making VR perfect for training in practical processes. As a result, VR is mostly used in surgical and other interventional treatments. With AR, you may overlay virtual information and structures on real-world items to improve or change the surrounding environment. It seems advantageous to incorporate AR applications into our understanding of physiological and anatomical systems. Studies have tried to demonstrate the validity and educational effect of many VR and AR applications, in many different areas, employed via various hardware platforms. Some of them even propose a curriculum that integrates these methods[2].

II. LITERATURE SURVEY

For at least 20 years, individuals with diseases like post-traumatic stress disorder (PTSD), acute pain in burn victims, and phobias or fears have been treated with VR simulators. Since at least 1997, VR has been utilised to help troops with PTSD. Virtually Better's Bravemind programme for virtual reality exposure therapy enables therapists to gradually expose their patients to stimuli that set off their traumatic stress reactions, enabling them to aid the patients in recovering[4].

Prototypes are being developed and research is being done by the University of Southern California Institute for Creative Technologies in a variety of medical virtual reality fields. An early VR environment called SnowWorld was created by Hunter Hoffman at HITLab and Firsthand Technology about 15 years ago to help burn patients escape the discomfort of their treatments. Although throwing virtual snowballs at polygonal penguins is beneficial, there is undoubtedly more that can be done in the field of pain management[4].

VeinViewer, a device from Luminetx, was unveiled in 2006, and Accuvein unveiled Accuvein in 2008. They map the veins using near-infrared light reflection. Following that, the returned projection of the received imagery onto the patient's skin or display on a screen is used. The aim of near-infrared vein finders is to improve the visibility of veins for medical professionals. With the use of a vein finder, nurses and other medical professionals may quickly administer IV cannulas and other parenteral medications[4].

In September 2018 Leica Microsystems received FDA 510(k) gave clearance to market its AR based "GLOW800 surgical fluorescence for vascular neurosurgery". In combination with ICG (Indocyanine Green) and GLOW800, surgeons can view cerebral anatomy in natural color, augmented with superimposed co-registered real-time vascular flow allowing full depth perception. This AR application provides the surgeon with a never before possible immersive view of anatomy and physiology aiding in additional understanding during vascular neurosurgery[8].

OpenSight AR System received 510(k) approval from the FDA in October 2018. This is the first AR medical application for Microsoft HoloLens that the FDA has authorised, and it is now authorised for use in pre-operative surgical planning. Using pre-operative MRI, CT, or PET imaging data, this technology interactively superimposes 2D, 3D, and 4D images of the patient's pertinent anatomy onto the patient's body. Aligning photographs with the real patient is done continuously by "Persistent RegistrationTM technology." It is proposed that medical surgical procedures could be carried out with shorter operating times, more accuracy, and increased safety. If numerous operators wear the HMDs, a multi-user experience is feasible. The system also enables AR-based intra-procedural guidance, which has been shown when used with 3D freehand biopsy guidance for percutaneous biopsies that uses needle sensors in conjunction with scan-head localization sensors[8].

In order to train orthopaedic surgeons, Osso VR employs VR and HMD to track motions in a simulator environment. SentiAR has created an AR visualisation system for use during interventional procedures[8].

III. METHODOLOGIES

A. FRAMEWORK / BASIC ARCHITECTURE:

Few of the various software frameworks used in the development of AR and VR devices and their applications are listed below :

- Vuforia
- ARcore
- Wikitude
- Unity AR
- Amazon Sumerian
- Blender 3D Computer Graphics Software Toolset
- OpenVR SDK
- Unity Virtual Reality Engine
- Autodesk 3ds Max® Modeling and Rendering Software
- Eyeware Beam Head and Eye Tracking Software Development Kit
- Google Cardboard – Cardboard VR Developer Tool

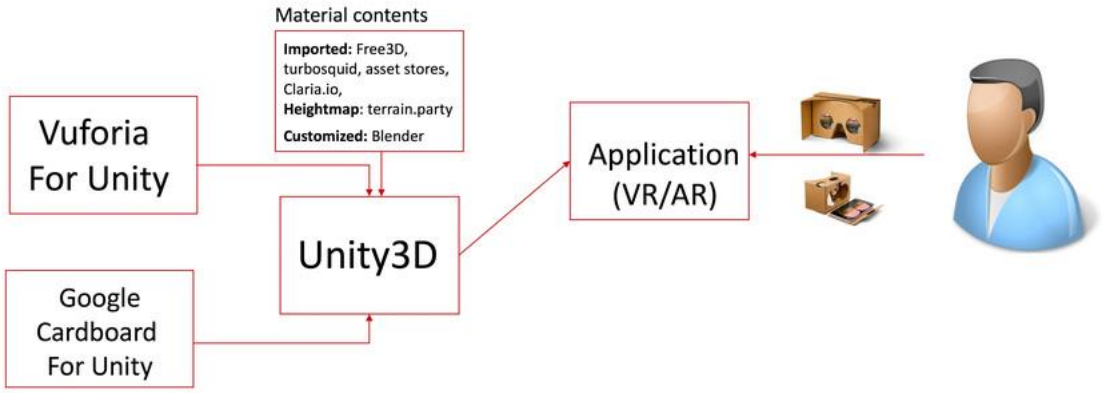

Fig. 1 : AR/VR application frameworks[10]

B. APPLICATIONS OF AR & VR IN HEALTHCARE:

1. **Advanced Diagnostics / Risk Assessment :** With AR - a doctor can look through the layers of the patient - check veins, organs, lesions, and other things without actually penetrating. All this can increase the precision of diagnosis. And that is always a good thing. Microsoft's HoloLens is one of the premier examples of this. With its help, doctors can do all sorts of checks and simulations with live stats and extract more valuable data for further research[5].
2. **Improved Patient Experience :** Patient experience is one of those elusive things that barely gets mentioned when it comes to talking about how VR & AR can make the Healthcare system better. However, in reality, patient experience is the one field that gets the most out of the implementation of VR AR to the operation. Immersion and engagement matter a lot for successful treatment, and it is often the one thing that gets limited attention due to its relatively inconsequential influence in the

grand scheme of things. I mean - when it comes to matters of life and death, customer experience is not the thing that comes to mind first[5].

3. **Psychological Relief and Treatment :** Specific environments can be used to treat mental conditions, such as anxiety, various kinds of phobias, and addictions. VR Healthcare Simulation of events can help better understand the patterns of disorders and develop more effective treatment strategies[5].
4. **Surgery Run-Throughs :** AR and VR Surgery can provide models for planning an operation and playing out various scenarios to optimize the sequence and prepare a course of action for any circumstances. While there are doubts that the VR environment will be able to play out every detail of the proposed scenario any time soon, the prospect of the technology improving the process of preparation is exciting[5].
5. **Medical Education/Training Simulation :** The implementation of VR and AR solutions can seriously simplify the whole process of medical education and subsequent training. For starters, VR Healthcare Training is a good way of studying human anatomy layer by layer and the mechanics of the human body. On the other hand, AR and VR provide interactivity which provides much more profound insight into nuances of the body functions. Cutting edge technology is especially critical when it comes to the training stage as it is near-impossible to imitate near-real life conditions to prepare professionals, which is less of an issue with the implementation of VR.

IV. LIMITATIONS & CONSTRAINTS

Potential limitations to the use of AR and VR in healthcare need to be considered. For example, the amount of information a surgeon has presented to them through AR during a surgery is increasing and may become distracting or imprecise due to latency issues or misalignment of imaging data or annotations. Therefore, it is necessary to display only important data or provide a method to switch between different sets of information on demand. Hansen et al. proposed a method for the reduction of cognitive demands, where they developed a series of algorithms for silhouettes and texture gradients beneficial for distance assessment in liver surgery, with the goal to increase acceptance of AR in the operating room. However, participants in the study reported that too much information was presented to them, and the authors highlight that the usability of the visual cues correlates with the user's familiarity with the illustrative techniques, proposing their integration in surgical training. 4 Another key factor is assuring clinical staff with regard the anatomic fidelity of any images, particularly when there may be remote interventional guidance in an AR environment.

Clinicians would want to know discriminatory resolution between vital structures and have confidence they would not miss any injury or other pathology. Main challenges remaining for future research include improving the experience in immersive VR/AR simulators of organ movement and deformation, human factor issues, and the undertaking of large clinical studies. Basic human perception and interaction factors need to be further developed to improve the experience. Rendering of content is commonly required to be commensurate with photo realism, particularly in training environments. Another unresolved issue is the influence of audio–visual quality in aiding human cognition, and defining clearly this quality concept in

this surgical context, for example, a vascular surgeon in an operating theatre and a paramedic on a car accident site might require different levels of visual detail and audio quality.

V. APPLICATIONS IN OTHER INDUSTRIES

1. **Hospitality :** The hospitality and tourism sectors can gain from using virtual reality training in a number of ways. However, as soft skills are crucial for this industry, soft skill training is the most important advantage. The fast-casual restaurant business Honeygrow is an excellent example of a company embracing virtual reality training in the hospitality sector. While staff members listened to the company's founder and CEO discuss the company's ideals, VR gave trainees a 360-degree tour of a Honeygrow location[9].
2. **Tourism :** Nothing makes you miss having the ability to travel to different places, see famous monuments, and get a taste of another culture like a global pandemic and lockdowns. Imagine being able to take a tour of Barcelona or Budapest from the comfort of your home in Singapore or California. You can accomplish exactly that using VR. From anywhere in the world, you can even take a Harry Potter tour of Edinburgh. The advancements in VR tourism in the post-Covid age allow you to test a vacation before you buy it. In order to sample a vacation in virtual reality before making a reservation, Thomas Cook developed its "Try Before You Fly" VR experience back in 2015. As a result, there was a 190 percent uplift in New York excursions bookings after people tried the 5-minute version of the holiday in VR[9].
3. **Education :** The influence of e-learning apps in the midst of the coronavirus, where educators have started utilising AR and VR in the classroom as technology improves. To make learning more interesting for pupils, teachers use augmented reality applications in the classroom to animate scientific literature and study flashcards. By adding interactive quizzes and riddles, some teachers use augmented reality to enhance their students' tasks. Social activities and training programmes are now starting to be included in how augmented reality might aid in education using virtual reality classrooms. Learners can perform 'impossible' tasks like travelling back in time or peering inside a brain cell. Students are more interested in learning about a subject when interactive 3D models are used in VR/AR[9].
4. **Entertainment :** In the live events industry, people in Delhi could view a concert taking place in Hyderabad. Perhaps. It doesn't have to be a concert, it could be a play, an opera or even a comedy show. The technology is currently being applied to allow users to immerse themselves in various games and sporting events. Beyond this, VR is also being implemented in museums and art galleries to make the tour interactive to provide a rich user experience[9].

VI. CONCLUSION

Healthcare procedures are surely changing as a result of advances in VR and AR, which have been made possible through partnerships between doctors, scientists, patients, software developers, and hardware makers. Industry-specific solutions for more pro-active and individualised health services are becoming more innovative as a result of technical, cognitive, scalability, and adoption issues. Enhancing medical teaching, redesigning the patient experience, dispersing centralised expertise, and streamlining medical procedures are just a few of the unique advantages that AR and VR provide to efforts globally to digitalize hospitals.

Patients experience a sense of relief when undergoing medical procedures as a result of the benefits of AR and VR on the healthcare industry having proven to be much and much better than the approaches employed in the past. Due to its numerous uses and improving outcomes over time, AR and VR in healthcare will continue to grow rapidly in the future. This is fantastic news for the entire human species.

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