

# Study of Revolutionizing Healthcare with VR and AR Technology

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## Abstract

Technology which comprises of scientific knowledge, skills, tools and techniques are incorporated in our day to day lives for achieving an optimized goal. As technology advances, computer devices have evolved into mobile gadgets and gradually transformed into wearable appliances, and Augmented Reality (AR) and Virtual Reality (VR) act as connecting platforms between the digital and physical worlds and are revolutionizing the healthcare industry. The Augmented Reality provides an interactive combination of real and virtual environment, and Virtual Reality just develops an interactive virtual environment for the viewer and are applied more widely.

AR and VR technologies are exercised in healthcare facilities for surgical training, 3D study of cancer, nurturing social skills for children with autism, neurological rehabilitation, early disease diagnostics. Related case study and research results have proven that AR and VR improve the traditional healthcare, education and skills, reducing the dereliction of duty and disruption in medical practice. The present study discusses revolutionizing of healthcare with AR, VR technology with an emphasis

on improving the quality of healthcare along with medical professionals.

## Keywords

Augmented reality; Virtual reality; Healthcare; Medical practice; Education; Review

## 1. Introduction

The evolution of AR and VR can be dated way back to 1838, when Stereoscope was invented by Charles Wheatstone that used an image for each eye to create a 3D image for the viewer [1]. In 1992, the earliest functional AR systems were developed at the U.S. Air Force Armstrong Laboratory known as Virtual Fixtures system that provided immersive alloyed reality episodes to the users. AR and VR technology are well known nowadays and have been applied in the field of healthcare, education, defence, construction establishments, gaming, entertainment, engineering sector and so on. Some people often coincide AR and VR because of their virtual/ digital environment perception but actually differ in their principle. The AR technology provides an enhanced real-time interactive and digitally-generated perceptual data by combination of real and virtual worlds whereas VR technology simulates this information by replacing the user's real-world environment, just like an illusion. The

year 2016 was reported by media as the year of popularization of Augmented Reality and Virtual Reality. VR technology has been adopted on many platforms like YouTube, Android, gaming and so on. A popular online game “Pokémon Go” which was released in 2016 in Taiwan, combined location-based service with AR technology, thus making it popular [2]. The hardware suite Oculus, which was bought by Mark Zuckerberg for two billion dollars paved a way of interest for AR and VR technology, attracting a lot of investors and public attention. However, the research in VR goes far more than 25 years with many researchers in the field and 1000s of papers, the application history of AR is more recent.

In Global forecast to 2023, the valuation of Augmented Reality and Virtual Reality in healthcare market in 2016 was USD 504.5 Million and by 2023 it is anticipated to gain USD 4,997.9 Million during the forecast period 2017 and 2023 at a CAGR of

36.6%.The base year considered for this study is 2016 [3].

## 2. Literature Review of VR and AR

The virtual environment and the real environment were considered as Continuum by Milgram and Kishino et al and taken as the two ends respectively [4]. They objectified this Continuum into four systems: Real environment, Augmented Reality, Augmented Virtuality and Virtual Environment. The Augmented Reality was formed on the left end with inward extension of real environment whereas the right end revealed a virtual domain, extended to form Augmented Virtuality. The in between abode was known as Mixed Reality, comprising of Augmented Reality, Virtual Reality, Real Environment and Virtual Environment which forms a interactive virtual image in lined with human vision. This schema can be better visualized via a diagram as shown figure 1:

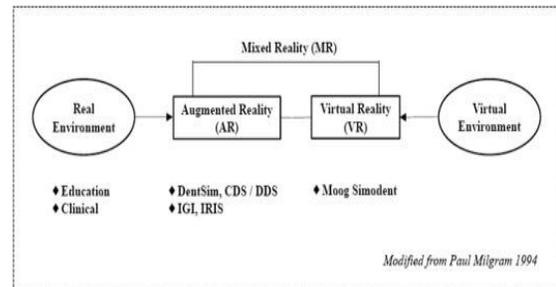


Figure 1: Schematic diagram of real and virtual performance [4].

### 2.1.The Virtual Reality (VR) characteristics and applications

VR technology has a vast area of implementation, such as defense, education, healthcare, entertainment and upskill[5]. The traditional training methods in the medical field can be improved, and the equipment along with adequate resources can be hatched with the adoption of VR technology. VR comprises of many features characteristics

that are ideal for medical therapy, surgical skill simulation, rehabilitation, like VR –User interaction, reduction in technical healthcare negligence, VR medical upskill and so on [6,7].The implementation of VR in healthcare can assist assemblage or construction of virtual tissues and organs, efficient doctor to patient communication, diagnostics enhancement, early disease detection, lower real risk to patients, non-invasive conduction and ex-post assessment.

However, there are many risks to VR technology if pursued in excess which may result in nausea, dizziness, excessive headaches and pain.

## **2.2.The Augmented Reality (AR) characteristics and applications**

AR technology mainly works via the recognition of a real-world target object, tracking it, and infliction of virtual object/image upon the target object which is then dispensed by the display device to the user. Presently AR is divided into two categories: (a) Marker-based AR and (b) Marker less AR [8]. Under the umbrella of Marker less AR, reside four more categories: (i) Location-based AR, (ii) Superimposition AR, (iii) Projection-based AR and (iv) Outlining AR.

Marker-based AR triggers an augmented experience through markers. The markers act as anchors for the technology, often made with clear-cut designs like QR codes or other unique patterns. An AR application recognizes the physical word marker and places the digital content on top of it. Often implementation of Marker-based AR can be seen for marketing and retail purposes.

The versatility of Markerless AR is commendable as it puts the placement decision of the virtual object upon the user. We can try different styles and locations completely digitally, without having to move anything in your surroundings. Markerless augmented reality relies on the device's hardware, incorporating the camera, GPS, digital compass, and accelerometer to gather the information necessary for the AR software to perform its task.

Location-based AR binds the digital content and the experience it creates, to a specific place. When the predetermined spot matches

the user's location over the mapped-out objects, it is displayed on the screen. For example, Pokémon Go, game that brought AR environment to the masses.

Superimposition AR acknowledges an object in the real world and provides an alternate perspective of it via enhancement. It can incorporate recreating a portion or entirety of the object.

Projection-based AR is slightly different than the other types of markerless AR because instead of mobile display device, it uses light to project the digital graphics onto an object or surface.

Outlining AR recognizes boundaries and lines to help in situations when the human vision goes blur. Outlining AR uses object recognition to understand a user's immediate surroundings like parking or lane outlines.

## **2.3.Applications in healthcare and medical education**

**Exposure therapy via VR technology:**In medical field, VR technology does the job of healing people's minds by bringing the real environment to them. The process cures their anxiety and fear like chromophobia, cyberphobia, ecophobia through VR exposure therapy [9].

**Autism treatment via VR technology:**The VR involvement has been proven to assist children with autism. As a result, in UK, an enticing VR technology has been developed by Newcastle University's Neuroscience Institute, known as the Blue Room, which helps the people with autism to overcome phobias via recreation of real-world scenarios through VR and has been a success [10].

**Phantom limb pain treatment via AR technology:**The patients who have lost their

limb or a part of it but can still feel its presence and pain, are diagnosed as Phantom limb pain patients [11]. AR technology lets the amputees visualize the virtual arm on the display and perform actions through the interactions to activate and achieve a therapeutic effect by letting the patients control the amputated limb via their brain [12,13].

**Virtual anatomy via VR technology:** The most advanced 3D anatomy visualization and dissection instrument, widely used for anatomical and physiological education by healthcare institutions is the Anatomage table. It's also featured in PBS, Fuji TV and various other journals. Anatomage table diversifies itself from other imaging systems in the market by its eminent radiology software, incorporated with the operating table form factor [14].

**Surgery simulation via VR technology:** VR surgical simulation training helps medical professionals refine their skills and ultimately reduces errors that could be fatal to patients [15]. The development and implementation of VR surgical system has been adopted by many companies [16]. Osso VR is a surgical training and assessment platform that allows surgeons, sales teams, and hospital staff to train and assess using advanced virtual reality [17]. A knee arthroscopy simulation to practice injection of anesthetics correctly during surgery has been developed by Fundamental VR company. VR operating environment not only helps interns learn from their mistakes but also provides a risk-free experience.

**Anatomy teaching via AR technology:** The AR technology provides a 3D stereoscopic visual environment which likely allows students to operate repeatedly on patients to enhance their skills and learning outcome [18]. This practice was not possible in the

traditional healthcare education system. It saves time and cost. Moreover, the staff does not have to provide a real and specific specimen to the students for examination and operation. AR human anatomy app, Anatomy 4D, provides a real-time examination of the human heart, respiratory system and other organs and can be used as a self-studying tool as well as a teaching material as it instantly provides a 3D model of the human heart on the card [19].

### 3. Discussion

#### The future development in healthcare

In 2021, both VR and AR are experiencing a keen interest from healthcare. For the benefit of enhanced data analysis and healthcare practices, more and more healthcare foundations are ready to strengthen their digital solutions with AR and VR technologies. During the pandemic times, these technologies paved a way to establish a remote and personalized doctor to patient connection [20]. A patient's identity and past diagnostics can be easily accessed by the healthcare workers by simply wearing an AR glass while delivering the medication. This emphasizes on mobile assessment too. Moreover, VR and AR technologies are able to provide high-quality education assistance to healthcare consumers as well as the staff.

However, VR and AR technologies are still in their experimental level on healthcare grounds but an increasing interest in these technologies simulates their faster and wider development in medical institutions. Ignoring VR and AR in the present by these institutions will have to face adverse challenges and competition in the future [20].

#### 4. Conclusion

The importance and attention towards VR and AR technologies is humongous in the healthcare system. Apart from refining the unconventional traditional healthcare education and practices, it can also enhance the effectiveness, efficiency and assessment of the medical healthcare education and services. However, the technical integration of healthcare workers and medical healthcare system, along with the durability and reliability of the hardware and cloud is a challenge to overcome. Nowadays, the development of new techniques to overcome the related technical problems are in progress through many manufacturers, academic and healthcare institutions. In nutshell, VR and AR technologies are revolutionizing the healthcare system and more expansion is highly anticipated.

#### Abbreviations and Acronyms

AR: Augmented Reality

VR: Virtual Reality

GPS: Global Positioning System

UK: United Kingdom

PBS: Public Broadcasting Service

TV: Television

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