

A Review on Augmented Reality, Virtual Reality, Application of Mixed Reality in Education

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Abstract: Education is a fundamental right every human possesses and it is also based upon it does one progress in their life. The process of learning has taken tremendous leap forward from recognizing primal symbols in the past to making breath-taking discoveries and inventions in the contemporary world. The present process of learning is gradually turning towards Virtuality where Mixed Reality plays a crucial role. Mixed Reality (MR) is a user environment where physical reality and digital content are mixed through which real-world and virtual items can interact with each other. This paper presents the details regarding the history and present developmental state of Augmented Reality (AR) and Virtual Reality (VR) and the application of Mixed Reality (MR) in Education where the opportunities presented by introducing Mixed Reality in education is discussed.

IndexTerms—Augmented Reality, Mixed Reality, Virtuality, Virtual Environment, Virtual Reality.

I. INTRODUCTION

Mixed reality (MR) is a user environment in which both the physical reality and digital content are combined in a way which enables interaction among real-world and virtual objects. Virtual Reality (VR) immerses the user in a completely digital world, and augmented reality (AR) overlays digital content on top of a physical environment, mixed reality blends digital and real-world settings. Mixed reality is sometimes considered a type of augmented reality (AR), but its capacity for interaction between real-world and digital objects places it further along the virtuality continuum [1], physical reality is on one end of the spectrum, while immersive virtual reality is on the other. Mixed Reality is the merging of real worlds and virtual worlds to generate new environments and visualizations in which digital and physical beings co-exist and interact in real time. Mixed Reality is a mix of augmented reality and virtual reality that does not take place solely in the actual or virtual environment. To distinguish between the two: Virtual Reality immerses you in a totally virtual environment without the interference of the physical world. Augmented reality takes place in the physical world, with information or items put virtually as an overlay.

II. AUGMENTED REALITY

Augmented reality (AR) is a technologically improved version of the real world that is created by the use of digital visual elements, audio, or other sensory stimulation. AR is a system with basic features as real time interaction in real and virtual world combination with accurate 3D registration of virtual and real objects [2].

The first achievement of Augmented Reality (AR) to some extent was achieved in 1957 by Morton Heilig through the invention of Sensorama which displayed visuals, delivered sounds, smell and vibration. Ivan Sutherland known as the “father of computer graphics” was the first to develop an AR technology in 1968 at Harvard. The phrase Augmented Reality was coined by Thomas P Caudell in 1990. Later universities, Business Companies, and National Agencies further advanced Augmented Reality with displays and wearables. In 2008 the first AR application for commercial use appeared which was developed by German agencies in Munich for advertising purposes.

Later other brands such as National Geographic in 2011, Disney in 2011, Coca-Cola in 2013 and so on., also started attracting customers with this idea. Later when technology progressed Virtual try-on was introduced by companies especially for watches and jewelry so that customer can feel the difference and choose accordingly. This was also carried out further in every commercial application where a person, environment will be augmented according to the requirements of the user. Technological innovations such as general hardware components, visual displays, different sensors, input devices and software helped in creating an Augmented Reality which was implemented in sectors such as Archaeology, Art, Architecture, Commerce, Office, Construction, Industrial Design, Education, Robotics, Translation, Disaster Management, Emergency Management, Disaster Recovery, Medical and Search and Rescue, Games, Sports, Entertainment, Tourism, Military, Navigation etc.

The introduction of Augmented Reality in Internet of Things (IoT) further enhanced the user experience. The future belongs to AR as it will gradually improve the task efficiency, quality of output for the user to experience, Thus UX designers in the AR field will need to consider AR can be used in the improvement of traditional experiences.

III. VIRTUAL REALITY

Virtual Reality (VR), the term itself defines it where virtual means near and reality is what we human beings experience in our daily life. In technical term Virtual Reality is a three-dimensional computer-generated environment which can be experienced by a person through exploration and interaction [3]. Virtual Reality is achieved through the combination of hardware, software along with sensory synchronicity. Basically, it achieves a user to experience sense of presence and feel that they are present in that particular environment.

The history of Virtual Reality (VR) dates back to the 19th Century where in 1960 where the first head-mounted display (HMD), the Telesphere Mask was patented by Heilig. Its function was to provide stereoscopic 3D images with enhanced image and stereo audio. In 1966, a military engineer named Thomas Furness created a flight simulator. In 1968, first virtual reality HMD was created

by Sutherland which was named "The Sword of Damocles". In 1986, a flight simulator known as Super Cockpit was developed by Furness where it featured a computer-generated three-dimensional map, radar imagery and infrared which helps in pilot experience training in real time environment where one could see and hear clearly. The term "Virtual Reality" was popularized by Jaron Lanier in 1987. In 1991 a system called "Computer Simulated Teleoperation" was designed by a NASA scientist named Antonio Medina which helps to drive the Mars rover from Earth in real time, even though there is a signal delay between planets. A Japanese company called Nintendo in 1995 launched a console called Virtual Boy which became the first portable device which could display 3D graphics. In 2007, Street View was launched by Google where dodecahedral camera array was placed on a moving car and four to five cities imagery was mapped and thus giving its virtual experience to user. In 2010 Oculus Rift developed a headset prototype which helps in experiencing the Virtual World and subsequently in 2013, Valve and HTC introduced HMD called HTC Vive. In 2014, a cardboard of low-cost stereoscopic viewer was released by Google for smartphones. Later many companies started to develop VR products which had dynamic binaural audio, haptics interfaces for human interaction using touch and movements like GloveLine Gloves.

The future will be based on the foundation of Virtuality and hence Virtual Reality (VR) plays a crucial role. VR has the greatest potential for growth. It is estimated that Global Market for VR will reach \$161.1 Billion by 2025 with CAGR of 48.8% (2020-2025). With further introduction of 5G, there will be a massive growth for VR.

IV. MIXED REALITY IN EDUCATION

Mixed Reality is a fusion of the physical and digital worlds, which unleashes the both natural and intuitive three-dimensional interactions between humans, computers and the environment. This new reality is based on advances in computer vision, extended graphics processing, visual display technology, advanced input systems, and cloud computing. The term "mixed reality" was introduced in the 1994 article "Mixed Reality Visual Display Classification" by Paul Milgrom and Fumio Kishino. Their dissertation explored the concept of virtual continuum and the classification of visual representations.

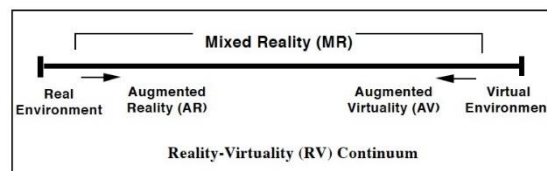


Figure 1: The Reality-Virtuality (RV) Continuum [4]

Education is a fundamental quality of a human and learning is a process where a lot of factors involve. Not every human has high IQ to grasp everything they learn but this can be overcome a little with the introduction of Mixed Reality where a person can visualize and grasp with sense of presence in that particular situation or environment. Few things are not easy to learn for normal students like Physics, Chemical Reactions, History etc. [5] But what if they can visualize and experience the force, temperature and other concepts with ease without any danger and what if one can observe and perform chemical reactions without any fear of harmful exposure and what if one can travel to the time of Independence and learn what happened, together with their mentor and without leaving the classroom? With Mixed Reality this is possible as it provides an immersive and more effective learning experience to those who wish to learn.

In classroom, Mixed Reality can be used in traditional way where students explore a virtual environment in preset desktop using input devices such as keyboard, mouse. And the advanced way of using the Mixed Reality in education is using the Head Mounted Device (HMD) and the motion controller, [6] which helps one to interact with a virtual environment produced by combination of real and virtual worlds where there is co-existence of both physical and digital objects. Hence with the help of these objects can be moved and manipulated by the students giving them the better understanding of them. Students can also interact with the complex notations, reactions, phenomenon and so on which will be more difficult to understand with just the verbal teaching by a teacher. [7] Thus, it provides a type of fun, engaging and effective learning experience.

The benefits of Mixed Reality in classroom includes Engaging, Universal, All-purpose, Faraway worlds. Engaging is the best way to give an opportunity to those students those who struggle by generating a direct experience. Mixed Reality doesn't discriminate anyone regardless of any disparities in social, economic, geographic as it brings everyone together to share and learn along with visualization. Mixed Reality serves every purpose as it can involve anything present in the world. Further many imaginative things can also be immersed and the Mixed Reality is a best key for the researchers and the scientists those who do experiments as it gives them the basic ideas and also reduces the risk. [8] Using HMD students and teachers can traverse through time and space as if one wants to learn the past one can traverse through the worlds of past and if one wants to learn about the space, then one can travel through space and observe the universe and all of this is based on the condition that these are all pre designed. Mixed Reality in Education is best focused on training. Training one expert in any field requires a lot of resources and money and hence using Mixed Reality environment as a base for training helps in lowering the costs, risk and also helps the trainee to best understand the circumstances before performing it in the real life.

As there are plenty of Virtual tools for learning through Mixed Reality, there are also plenty of challenges for these to be executed in the contemporary world. The biggest challenge to these is the lack of content. It is because mixed Reality developmental cost is expensive as it requires the content to be developed. If one wants to immerse into the virtual environment then one needs to develop that particular environment. Availability of HMD, these are the most basic requirements for one to experience the Mixed Reality worlds and the cost is expensive and not all can afford it. And the other challenge one needs to face is Cyber Sickness as one requires a strong will power, experience and healthy body and mind.

V. CONCLUSION

It is no doubt that future will be based on Virtuality and hence Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR) plays a crucial role in this tremendous change. Augmented Reality and Virtual Reality began to develop slowly from 19th century and now the stimulus has been activated in enhanced growth of Mixed Reality which is the combination of both Augmented Reality and Virtual Reality. This is all due to the growth in the Industrialization and hence Education system has also become easier and effective due to the introduction of Mixed Reality. The growth rate of Virtuality is tremendous as the Mixed Reality hardware segment is expected to grow at a CAGR of over 76.8% from 2016 to 2024.

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