PEARSON JOURNAL OF SOCIAL SCIENCES & HUMANITIES

ISSN: 2717-7386

DOI Number: http://dx.doi.org/10.46872/pj.282

VIRTUAL REALITY TECHNOLOGY IN HEALTHCARE*

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Abstract

The healthcare industry has become a big adopter of Virtual Reality (VR) technology. This paper demonstrates how healthcare and medical professionals can use VR technology for surgery and personal development, and also how physically and mentally disabled people can benefit from the innovative VR techniques. The purpose of this research is to examine the innovative healthcare applications that can be provided with VR technology in the health sector and to provide conceptual information about whether these applications are good alternatives. For this purpose, the relationship of VR technology with the health sector has been examined through a literature review, and the results have been revealed in a comparative manner. The projects of VR healthcare companies around the world and the experiences of hospitals implementing VR Health projects were scanned and the reasons for choosing the technology in question were examined. When using VR technology, the concept of telepresence makes the user feel "inside" and this technology has turned out to be an experience tool. The research findings indicate that the results of health applications made with VR technology are successful in making people feel that experience. In particular, VR health applications enable disabled individuals to reach everywhere without any restrictions or difficulties. The findings reveal that VR health applications can be a strong alternative to classical therapy activities in the field of the healthcare sector during PTSD processes. This descriptive study has been comprised of visualization of complex forms of surgery or treatment and their implementations of virtual environments to the different types of VR usage of treatments. Finally, the use of VR in healthcare has shown that VR is a useful tool for diagnosis, treatment, therapy, education, and training.

Keywords: virtual reality, VR, telesurgery, PTSD, post-traumatic stress disorder, pain treatment

Introduction

Virtual Reality is a technology by simulating interactive 360-degree imaginary digital environments for users, replaces the real world with VR headsets. As defined by Curcio et al. (2016) VR is the simulation of a digital environment achieved by the creation of immersive experiences. Along with this, Brey (1999) specified, "Virtual reality systems are defined as

* This article was presented as an oral presentation at the Annual International Scientific Conference on Economic Development and Legacy of Simon Kuznets, held in the Simon Kuznets Kharkiv National University of Economics, Ukraine on May 31 - June 1, 2018

ISSN: 2717-7386
DOI Number: http://dx.doi.org/10.46872/pj.282

being employed head-mounted displays (HMDs), data gloves and data suits to simulate an immersive, interactive computer-generated environment" (p. 5). Gaming is a most recognized virtual reality domain however there are an entire host of makes use of virtual reality, a few of which will be more familiar than others, such as military, education, simulation, entertainment, advertising, and marketing, fashion, engineering, sport, media, scientific visualization, construction, and healthcare. Virtual reality produces a set of knowledge that is then used to develop new models, methods, communication, and interplay (VRS, 2017).

There's a vital potential for VR-based healthcare applications is being more and more developed worldwide. Utilization of data and communication technologies in healthcare similar to telegraphy, telephony, radio, and tv have been known as and used for distance medication for the reason that mid-19th century (Wootton, 1999). With the Internet, email, and video teleconferencing becoming familiar methods for diagnosis, therapy, education and training, the potential impact of virtual reality (VR) on healthcare has become even higher than that offered by new communication technologies (Riva G. , 2003; Riva G. , 2000). Therefore, the healthcare industry has become a major practitioner of VR technology.

Ann, Le, & Bailenson (2013) indicates that the VR experience is perceived as a souvenir by the human brain and acquires a more forceful learning ability which gives more effective behavior changeability than conventional media sources.

Virtual Reality in health usage can be classified as virtualization of applications, visualization of surgery/treatment, training materials for health professionals, VR therapy and rehabilitation of patients, VR treatment equipment, VR training materials of relatives/nurses for care, and other educational VR stuffs for health issues.

Healthcare Usage of VR

According to the former studies, the first healthcare applications of VR started in the early '90s to visualize complex medical data especially during surgery and for surgery planning (Chinnock, 1994). According to Riva (2003), virtual reality applications related to surgery are divided into three classes: surgery training, surgery planning, and endoscopy radiosurgery. Virtual reality provides many new applications that have recently come to allow doctors to work as if looking inside the patient. Westwood et al (1999) noticed that there are many different educational VR applications for visualization. The first of these is Anatomic VisualizeR, a VR-based multimedia application used in medical school anatomy and high school biology lessons. VisualizeR provides a virtual analysis room as a virtual environment where students can interact directly with computer-generated models as well as access supporting curriculum materials (Hoffman & Murray, 1999).

Surgery with VR

Virtual reality will help surgeons gain all surgical skills and better study each organ of the human body through simulation of all surgeries. This is useful not only for students but also for experienced professionals who are implementing new or high-risk procedures to avoid critical consequences.

Manchester Visualization Center is a VR-based telemedicine system project development center for surgical simulations that use VRML and JAVA technologies to create

ISSN: 2717-7386
DOI Number: http://dx.doi.org/10.46872/pj.282

3D models. The authors can create ventricular catheterization simulations and how to cannulate emergency access via the network for neurosurgery trainees (John & Phillips, 2000). In the virtual medium, a student or a surgeon comes to a virtual room, starts operating on a virtual patient, and can move the virtual cannula to the entry point on the 3D patient to examine the surgery simulation in the same way as Deep Matrix software (Reitmayr, Carroll, & Reitemeyer, 1999) which is another VR-based surgery simulation project. In all these simulations, trainees can be guided and trained through remote viewing.

Techniques such as telesurgery allow surgeons to operate on people who are physically located elsewhere (Gorman, ve diğerleri, 1999). Medical students can use interactive 3D holographic images and collaboratively perform a surgical operation without risking patients' lives or costing a cadaver (Lee, 2013). The Virtual Reality Operating Room (VR OR) simulator is a fully functional, immersive surgical simulator that can create an interactive VR environment that replicates the surgical environment itself (Olasky, ve diğerleri, 2015).

In surgical training, surgeons have always had to gain practical experience through "supervised trial and error" on a real patient, making surgical training purely related to real case studies and jeopardizing patients' safety (Bishoy, 2018). Now, surgeries can be watched from anywhere in the world in 360 degrees and in real-time with VR applications (Thinkmobiles, 2018).

Post-Traumatic Stress Disorder (PTSD) with VR

VR is defined as an advanced form of human-computer interface that allows the user to interact and immerse in a computer-generated environment and achieve the feeling of "being there", which is called telepresence, using special devices such as head-mounted displays, special headphones, sensory gloves, and sometimes haptic feedback devices.

Clinical psychologists and rehabilitation professionals are using VR to provide a new human-computer interaction paradigm in which users are active participants in a computer-generated 3D virtual world (Giuseppe, ve diğerleri, 2009; Rizzo, Wiederhold, Riva, & Van Der, 1998). In virtual environments, the patient has the opportunity to learn to manage to remember certain details of the problematic situation related to his/her disturbance. The high level of control of interaction without restrictions and the experience provided to the patient are important characteristics of virtual environments for this domain (Schultheis & Rizzo, 2001), and feedback from patients with disabilities can be translated into alternative and/or multiple senses (Luis, Raya, Baños, & Beltrame, 2015).

VR for Disabled People

Lawther (2016) an assistant technologist at Scope, states that virtual reality can not only allow people with disabilities to practice things that can help them with life skills, but also give them the opportunity to experience something they wouldn't normally do. The virtual reality system developed at the Department of Occupational Therapy at the University of Haifa in Israel included many scenarios designed to teach autistic children to safely cross a road (21c Staff, 2008). Children significantly develop their abilities and confidence to cross the road safely, and after this VR experience, they also participate in basic daily activities.

ISSN: 2717-7386
DOI Number: http://dx.doi.org/10.46872/pj.282

Another example is an empowering first-person game using the Oculus Rift, a student in a wheelchair can take a VR orientation lesson for Aalto University in Finland (Lawther, 2016). According to New York Times article (nytimes.com, 1994), while the cost of these technologies in the ’90s was around 30,000 USD, nowadays it costs several thousand USD.

Georgia University helps disabled students with its VR-mentoring platform (georgiabreakthru.org, 2015) designed with orientation scenarios in a virtual environment similar to the Simcity application. With this platform, students can learn what they can do and how to use anything on campus.

Mark Bartlet (2016), a founder of the AbleGamers Foundation, announced that hype is a good thing. Bartlet said that “One of the main philosophies of the AbleGamers charity is that games allow people with disabilities to do things they wouldn't do in real life. And that includes people with strong bodies ... you can climb Everest in virtual reality, you can be an NFL player ... most of us can't do that. "

VR headset manufacturer Fove served an interesting project that is pitched as a “universal piano” where children can play using eye movements while wearing the headset called Eye Play the Piano project designed for children with disabilities in Japanese schools (Dredge, 2015). Danny Kurtzman, who has muscular dystrophy, says he can surf virtually with the VR headset experience surfing like standing up (Hoshav, 2015).

Vincelli (1999) find outs that virtual reality plays an important role in clinical psychology studies. Empowerment is considered a versatile structure in the psychological literature; Its meaning refers to the harmony between one's work role and one's own beliefs, values, and standards that reflect different dimensions of being psychologically active. According to Riva (2003), perceived control, perceived competence, and target internalization are the 3 main dimensions of empowerment. The virtual experience is an “empowering environment” that therapy provides to patients. Botella (1999) noted that patients are not really afraid of VR. With these guarantees and under control, they can freely explore, experiment, feel, live and experience emotions and/or thoughts such as fear.

Anxiety disorders are treated with VR technology at the University of Louisville. VR technology is used for fear of flying, fear of heights, social speech-socialization fear, post-traumatic stress disorders, and other types of fear. Patients are not exposed to dangers, realistic VR simulations are used during the sessions to create the environment that the patient is exposed to and reach it in a controlled manner (Physicians, 2013).

Many veterans, returning from military service have to cope with Post Traumatic Stress Disorder (PTSD). Rizzo (2006) et al., found that at least 1 in 6 Iraqi war veterans showed symptoms of depression, anxiety, and PTSD. The STRIVE project and Virtual Exposure therapy systems use virtual reality to help veterans overcome PTSD symptoms by exposing them to virtual situations that resemble or represent trauma (Buckwalter, ve diğerleri, 2012; Haar, 2005). The first experiments were done on Vietnam veterans from 1998, and more were done with Virtual Iraq.

Pain Treatment with VR

Video games have been shown to suppress pain perception in pediatric patients and during routine painful burn treatments (Das, Grimmer, Sparnon, Mcrae, & Thomas, 2005;

ISSN: 2717-7386
DOI Number: http://dx.doi.org/10.46872/pj.282

Gold, Kim, Kant, Joseph, & Rizzo, 2006). VR is used to relieve the patient from pain. According to Dr. Sam Sharar (2015) who is an anesthesiologist at the University of Washington, ient's attention can be consumed in an immersive virtual world, they will suffer less". Virtual Meditative Walk (Gromala, Tong, Choo, Karamnejad, & Shaw, 2015) incorporates a unique virtual environment with biofeedback and meditation in the form of a walking meditation, it is a VR system designed for chronic pain patients. SnowWorld, developed by DeepStream VR, is one of the VR games for pain relief and rehabilitation used for burn victims with children undergoing painful medical procedures (Williams, 2015).

Experiential Treatment with VR

Expedia virtually takes trips for cancer-stricken kids at St. Jude's Children's Research Hospital with a 360-degree camera, interactive live-streaming, and a specially built screening room to the jungle to play with monkeys, to the ocean to swim with fish, or to the desert to dig for fossils without any risk of infectious disease. (Beltrone, 2016). Honor Everywhere is a Virtual Reality project for veterans who cannot physically travel to see their monuments. With 360-degree and 3D videos recorded, veterans can experience different views from their bedside, wheelchairs, or assisted living centers (honoreverywhere.com, 2015).

Experience is the main working term for Virtual Reality technology and human behavior. There are many experiential studies developed by VR to understand people with disabilities or sicknesses. In order to experience the world (life) from another person's point of view in an easy and effective way, virtual environment technology is used by individuals (Ahn, Le, & Bailenson, 2013). In the Virtual Human Interaction Lab founded by Stanford University, VR technology simulates what a disabled person's life can be like for healthy people (for a healthy person to experience color blindness) (Ann, Le, & Bailenson, 2013).

Another study is to examine through VR environments how humans can adapt to a situation where more than normal limbs are created such as 3 arms or 4 legs (Hoshav, 2015). Thus, serious progress can be made for those who suffer from limb loss.

Viscira digital agency has developed a VR project by Oculus Rift that simulates walking in a schizophrenic mind. The project simulates the schizophrenic brain in a 3D environment that provides a complete visual and auditory experience of what it might be like to be a schizophrenic patient for the healthcare professional (Ashekian, 2016). Reviews of doctors and caregivers with experience with the project are not only about seeing and hearing, but also feeling (Bloom, 2014). VR migraine simulation supported by Excedrin is an application that visually describes the migraine experience with VR with changes in light sensitivity, vision loss, and coordination in order to provide an experience for healthy people other than migraines (Couch, 2016).

"Notes on Blindness" is an experiential virtual reality project created with 3D audio and video, offering the opportunity to experience how people live in a world surrounded by sounds, as well as a documentary film about a visually impaired man who keeps a voice diary. The film also won the British Independent Film Award for best documentary. Thus, VR technology started to create an empathy bridge by experiencing the disabled world while experiencing the disabled world without experiencing any obstacles (NotesOnBlindness, 2016).

ISSN: 2717-7386
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Many projects with VR technology have been developed to help dementia patients in their daily lives. Dementia patients have a memory problem that affects their survival. Short-term memory loss is common to many dementias. It can be particularly frustrating, but VR projects help make life easier by enhancing memories (Chadwick, 2016; A Walk Through Dementia, 2018).

The practice of empathy with VR is increasing to eliminate prejudices against different cultures. The 360-degree YouTube video about Syrian refugees is one of the virtual reality empathy projects that offer significant opportunities to experience what life is like in Syria and what immigration is. It also shows to the other people around the world with VR (YouVisit, 2017).

Experiential Personal Development with VR

While being patient is defined as a temporary obstacle, the research conducted by Torbay Hospital is an important opportunity for institutional and individual development. The relationship between the doctors and their patients in the emergency room at Torbay Hospital was recorded with a 360-degree video. Later, these virtual reality videos were shown to the doctors through the eyes of the patient. Doctors have seen and experienced attitudes and body language that they have never noticed before, and an improved study has been initiated in this regard (itv.com, 2015).

Simulation-Based Training (SBT) with VR technology in nursing applications is a new teaching strategy recently. Instead of using real human models for training, VR-based simulations are cheaper, flexible, and can be developed. Developed for one-on-one consultations with a Virtual Patient project, such as chatting with a patient suffering from dementia, PatientVR is used for social skills training in nursing education in UK hospitals (Elliman, Loizou, & Loizides, 2016).

Conclusion

The use of VR in current applications has shown many promises as a potential alternative and could be a well-thought-out useful tool for diagnosis, treatment, therapy, education, and training. One of the biggest advantages of virtual reality is the safe environment. Patients often accept technology and evidence that humans react in virtual environments as if they were in the real world. Potential future applications of virtual reality healthcare projects will be developed through the multidisciplinary understanding of world engineers, designers, and therapist teams, limited only by the imaginations of skilled individuals working to treat specific clinical problems.

However, some questions are still waiting for answers; When will VR healthcare be used without clinician assistance? How will VR health projects interact with other services such as telehealth?

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