ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 7, Issue – 1, February – 2024, Page No. : 116 - 120

Virtual Reality in Dentistry: Current Trends

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Citation of this Article: Dr. Vaishnavi Peddi, Dr. Harshitha Akkinepally, Dr. Rachana Kola, Dr. Avinash Vallabhaneni, Dr. Shazia Sameera, Dr. Anugu Anjali, "Virtual Reality in Dentistry: Current Trends", IJDSIR- February – 2024, Volume –7, Issue - 1, P. No. 116 – 120.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

In recent times, dentistry has witnessed remarkable technological advancements that have revolutionized the various subspecialties within the field. To further enhance and improve dental education and clinical practice, innovations have been introduced, including augmented reality (AR) and virtual reality (VR). These technologies have been researched and implemented to enhance dentistry. In computing and technology, the term 'virtual' refers to something that appears to exist without physical presence in the real world. Some authors have described virtual reality applications in healthcare as either emotion or problem-focused solutions. Emotion-focused interventions aim to divert the user's attention from underlying stressors or perceived pain during dental treatment. This review seeks to delve into the vast potential of virtual reality in dentistry.

Keywords: Virtual Reality, Dentistry, Education

Introduction

The first stereoscope was invented in the 1830s, which marked the beginning of the concept of Virtual reality (VR). This device used a set of mirrors to project an

image, creating a sensation of depth and immersion for the user.[1]

VR can be described as "a computer-generated, three-dimensional world in which the user interacts with virtual objects" or characters [2] and Augmented reality (AR) as "the addition of computer-generated output, such as images or sound, to a person's view or experience of his or her physical surroundings using any of various electronic devices".

The introduction of VR-like haptic features dates back to 1929 when the US Air Force incorporated it into their flight simulator for pilot training. This technology was designed to emulate air turbulence and plane movements, providing trainees with a more realistic experience.[1]Ivan Sutherland is credited with introducing virtual reality through the creation of the first head-mounted display during the early 1960s.[3]

Publicly available virtual reality (VR) systems have gained tremendous popularity, especially as video games. Since 2012, various VR systems, including Oculus, Project Morpheus, and HTC VIVE, have been introduced and commercially released to the public, incorporating headsets. These systems have sparked a new wave of interest in VR and augmented reality (AR), extending beyond the gaming sphere and into areas such as social networking, skills training, and education. Today, VR is utilised in many spheres, including training pilots, military simulations, and education.

Virtual reality (VR) and augmented reality (AR) systems are usually head-mounted devices that come with OLED screens, with or without haptic controllers. These systems allow users to interact with virtual models and application features.

The use of VR in dentistry is still in its early stages, but the technology has already shown great promise. From virtual reality simulations of dental procedures to VR-based pain management techniques, the possibilities are vast. This review covers the current state of VR in dentistry, including its potential benefits and limitations, and provides insights into the future direction of this exciting field.

Dental Anxiety and distraction

Dental anxiety is a widespread issue faced by patients of all ages, from young children to the elderly. Distraction techniques have been employed in dentistry for years, operating under the principle that pain perception has a significant psychological component. By directing less attention towards noxious stimuli, patients can perceive less pain. A multisensory experience like virtual reality can provide optimal distraction. While VR can detect movement of the head and hands, it is not suitable during dental procedures. Thus, an exposure-based approach may be more appropriate.

Many experts support exposure therapy (ET) as the primary treatment for specific phobias [4].ET aims to reduce the impact of feared stimuli by gradually exposing the individual to them. As anxiety decreases and avoidance becomes less necessary, a process of habituation occurs [5]. Recently, virtual reality exposure therapy (VRET) has emerged, allowing for exposure therapy to be conducted in a virtual environment. Studies suggest that VRET can elicit the same physiological and psychological responses as real-life exposure [6,7]. This is likely due to the immersive and realistic nature of virtual reality, which creates a strong sense of presence for the user.

Education

Dental schools currently employ simulators featuring realistic manikins and dental models in simulated operatories to enhance students' hand-eye coordination and dexterity. However, conveying the tactile sensation through verbal descriptions remains a challenge. To

address this, new technologies incorporating haptic and virtual lab environments are being developed to improve motor skills and student efficiency while reducing faculty time. The use of virtual reality devices in dental education holds great promise for engaging students and enhancing their knowledge. These simulators also enable self-learning and assessment by storing and replaying students' work. The flexibility of VR laboratories allows for self-teaching outside of formal training hours, resulting in increased training time and reduced overall costs.

There are different types of software available that can be of great help to dental students, such as Periosim. [8] This software offers 3D and VR graphics, as well as tactile sensations, which allow students to use a range of animated dental instruments to visualize, detect, and evaluate caries or periodontal diseases in a haptic environment without the need to prepare the surfaces of teeth. Through the internet, students can access this device, and instructors can upload various dental procedures that can be saved and replayed by the students at any time. Voxel-Man is another such simulator for surgical training and is a 3D, virtual training device for surgical procedures.[9]

Real surgical images and virtual surgical plans can be utilized by this technology to guide a treatment plan, such as a mandibular angle split osteotomy. When compared to the traditional two-dimensional navigational method, augmented reality has shown increased accuracy and applicability in the guided placement of dental implants.[10]

Limitations

High purchase and potential maintenance costs and a lack of standards for software is a limiting factor.[11-15] There are technological challenges such as lack of visual alignment with the operative field, the inability of AR to account for patient movements correctly and “ghosting”, a double image which may occur with certain types of 3D vision techniques.[14-16]The discomfort of using VR headsets for extended periods and motion sickness experienced by some users is not to be forgotten.[17]

The visual fatigue caused by a stereoscopic view in children and adults is concerning [18]. Pediatric and geriatric patients in dental care settings could be negatively affected by frequent and repeated exposures to AR/VR environments [19-23].

Conclusion

In the field of dentistry, the use of augmented reality and virtual reality has proven to be quite advantageous. These advanced technologies allow dentists to show their patients the expected outcomes of procedures even before they undergo them. Moreover, AR and VR have the potential to revolutionize dental education, particularly in the current pandemic situation, by enhancing the learning experience for students during their pre-clinical education and training. Another exciting application of AR and VR in dentistry is to help patients overcome dental phobia. By using virtual reality simulators, students and dentists can reduce materials wastage as they no longer need to practice on artificial teeth and models. However, to ensure that this technology is utilized to its fullest potential with minimal drawbacks, further research and trials are necessary.

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