AUGMENTED REALITY -A FUTURE DIRECTION IN DENTISTRY

[1] *Pavithra.V.R* [2] *Aarthi.S.L.M,* [3] *Narchonai.R.A,* [4] *Lambodharan.R*

[1,2,3] Post graduate students (Final year),
[4] Professor and Head, Department of Prosthodontics & Crown & Bridge, CSI College of Dental Sciences & Research, Madurai, Tamilnadu

ABSTRACT

Augmented reality technology creates new opportunities in a variety of industries by providing virtual information in addition to that of the actual world. The use of augmented reality technology in medical education and training is widespread. Its use is enhanced in Prosthodontics and Oral maxillofacial surgeries for Dental implant placements and Orthognathic surgeries. Newer applications of Augmented reality in endodontics, orthodontics, and restorative dentistry are now possible thanks to recent technical developments.This article addresses the uses of augmented reality technology in dentistry as well as its future prospects by providing a quick overview of its definitions, features, and components.

INTRODUCTION

Virtual Reality utilizes virtual environments where all perceived information is computer-generated , while AR applications inserts virtual content centered within the real world through smart glasses or a camera and screen.

The addition of artificial information to one or more senses through augmented reality enables users to complete activities more quickly.

The AR system combines virtual and real objects in single realistic environment. It can register both virtual and real objects reciprocally. It runs interactively in real time [4].

A "head's up" visualisation method has been used for augmented reality, where the visualisation data is on a screen, as is frequently seen in smartphone-based broadcasting and video games.

Access this article online

Quick Response Code:

Website:
www.jiadsr.org

Address for correspondence:
Dr. Pavithra.V.R
No. 129,CMH compound,
CSI College of dental sceiences & research,
East veli street, madurai-625001

The haptic device is integrated with the 3D graphics in this augmented reality (AR) environment, providing users with a more natural approach to practise dental surgery, where hand-eye coordination is essential.[11]

The development of augmented reality has made it easier to match patients' expectations and deliver aesthetic prosthetics. The patient can try a virtual prosthesis with the aid of AI systems and augmented reality, which will be adjusted until the patient is pleased and the final prosthesis is built precisely in accordance with these requirements.

HISTORY OF AUGMENTED REALITY

1968- The first Virtual Reality (VR) augmented reality system was Ivan Sutherland's Sword of Damocles. It was one of the first head-mounted displays with an optical see-through 6DOF tracker.

1975- Artist Myron Krueger created Video place, an Augmented Reality system which allowed users to interact with virtual things for the first time.

1992- "Augmented Reality" term was credited to Tom Caudell and David Mizell of Boeing's Computer Services' Adaptive Neural Systems Research and Development project..

1996- Prototype NaviCam AR, created by Jun Rekimoto. Markers are actual or virtual artefacts or locations. A marker is what the computer recognises as the display position for digital data. This was one of the earliest marker systems to provide six-degree tracking.

1997- Ronald Azuma, defined augmented reality as having these three properties: It merges the real and virtual worlds, it's interactive in real-time and is registered in 3D.

1999- Hirokazu Kato released the ARToolKit. This package of tools allows to merge real world video with virtual objects and 3D graphics on any operating system

2000- Bruce Thomas and his colleagues created an augmented reality Quake with a six-degrees of freedom (6DOF) tracking system.

2001- Reitmayr and Schmalstieg developed a mobile augmented reality system..

2004- Mathias Möhring demonstrated the first mobile 3D marker tracking system.

2008- Mobilizy offers the Wikitude World Browser with AR. This programme combines GPS and compass data with Wikipedia pages over a smartphone's real-time camera view. [13]

WORKING MECHANISM OF AUGMENTED REALITY

The programme uses computer vision technology to examine the video stream and recognise objects when a user points the device at them..

Similar to how a web browser loads a page using a URL, the device then gets data about the object from the cloud. The AR information is displayed as a 3-D "experience" superimposed on the object as opposed to a 2-D page on a screen, which is a key distinction. So, what the user sees is a combination of the real and the digital.

Users may be able to interact with items via a touchscreen, speech, or gestures, as well as view the data that is being sent from them in real-time. For instance, to instruct a product via the cloud, a user could say "stop" or click a stop button on a digital graphic overlay during an augmented reality experience.

The size and angle of the AR display automatically change to fit the changing context as the user moves. While older information fades out of view, new graphic or textual information appears. Users in various jobs, such as a machine operator and a maintenance technician, can look at the same object in industrial settings and receive various augmented reality experiences that are catered to their needs.

A 3-D digital model that resides in the cloud—the object's "digital twin"—serves as the bridge between the smart object and the AR. This model is created either by using computer-aided design, usually during product development, or by using technology that digitizes physical objects.

COMPONENTS OF AUGMENTED REALITY SYSTEM:

Components of a working Augmented Reality (AR) system include a

- See-through HMD,
- A position and orientation sensing system
- Support electronics and software

HEAD MOUNTED DISPLAYS:

A head-mounted display (HDM) is a gadget with one or two small displays in front of the user that is worn on the head or as a component of a helmet. Although some HDMs use see-through lenses or screens, the majority use opaque screens. While a virtual image is shown, the user can be aware of his surroundings thanks to see-through screens. In augmented reality or mixed reality, the real

environment and the computer-generated image are combined. By superimposing the virtual visuals on the patient's anatomy, augmented reality (AR) gives a surgeon a direct spatial experience of the actual world.

GOOGLE GLASSES:

After the release of Google Glasses, interest in accessible AR increased. This technology benefited from having wireless connectivity, a cloud-accessible viewing screen, a high-resolution video camera, and other characteristics found in smartphones. The device's open source platform enabled for inventive medical and surgical applications, and as a result, several other similar devices specifically intended for surgical enhancement have been created. Trials of GG in other surgical disciplines have shown positive results for patient integration and high levels of clinician satisfaction.

TOOLS FOR AUGMENTED REALITY APPLICATIONS

Depending on the type of augmented reality being planned for and the devices available for students to utilize the AR, many tools are now available for educators wishing to create augmented reality applications in education.

Some tools, such as **Daqri,, MixAR,** and **ZooBrust,** are quite simple and require no programming knowledge or skill. Others tools include SDK kits such as **ARToolKit, Unifeye Mobile SDK**, and **Wikitude**, which have been developed for serious AR developers. These kits are very powerful and allow developers design various AR applications for variety of devices.

.

APPLICATIONS OF AUGMENTED REALITY IN DENTISTRY:

The augmented reality technology can be applied in various fields of dentistry. Some are mentioned below:

1.AR IN DENTISTRY TEACHING AND LEARNING:

The advantages of augmented reality technology in dentistry education are obvious. AR simulators can give students better options as teaching resources. Learning activities can be completed anywhere, at any time, without supervision,which can facilitate adaptability in the learning process The use of augmented reality technology can be very advantageous for students making the transition from preclinical to clinical practise or gaining proficiency in increasingly difficult dental procedures.

2.LEARNING ANATOMY WITH AR:

These mobile augmented reality (AR) "apps" enable students to engage with the environment directly and combine virtual learning items into the actual world [7]. In comparison to students who studied using textbooks alone, medical students who studied anatomy using a smartphone app with augmented reality were able to understand more material in the allocated time frame[2]**.** In addition to boosting productivity, augmented reality technology improves students' comprehension of spatial relationships, grabs their attention more effectively, and decreases failure rates once a student is actually applying what they learned.

3.AR IN LOCAL ANESTHESIA TRAINING:

In dentistry, the ability to administer local anaesthesia is crucial. The student should comprehend the principles of the process and acquire fine motor skills to carry it out. As high as 29–39% of IANBs have been found to fail [10]. Mandibular foramen location is the most frequent cause of failing IANB. Therefore, even with thorough anatomical information, it is impossible to correctly establish the shape of the mandible or the precise location of the mandibular foramen.

Regardless of the operator's skill level, anatomical structures in the oral cavity and anatomic reference points are easier to localise and identify using the augmented reality technique, and mistakes in the positioning of the mandibular foramen are greatly diminished.

4.APPLICATION OF AR IN DENTAL IMPLANTOLOGY

An AR navigation system for dental implant surgery was proposed by Ma et al. (2018). Their navigation method shows the overlay scene at various depths and the viewing field of the surgical site. Their experimental study's findings demonstrate that the created AR navigation system has respectable accuracy. In situ image guidance is a capability of the suggested system, which solves the hand-eye coordination issue. The AR guided implant placement technique has been shown to have promise for the future of dental implant surgery.

5.AR IN MAXILLOFACIAL PROSTHESIS:

Maxillofacial prosthetics are a challenging field to work in because of patients who have severe mouth injuries and high societal expectations. It is necessary to have a thorough understanding of oral physiology, anatomy, and prosthetic designs and functions. Due to the multidisciplinary nature of maxillofacial prosthesis therapy, digital data presentation is essential for

treatment planning and patient education. They were created using software like Vuforia and Unity 3D.

6.AR IN ORTHOGNATHIC SURGERIES:

Orthognathic surgery is one of the most widely used fields of AR applications among the other dental fields. In 1997, Wagner et al. reported augmentation in facial skeleton osteotomy via partial visual immersion using a head-mounted display (HMD). The technology enriched visual access to the invisible anatomy offered by continuous observation and was very helpful to doctor's fluent surgery.[12]

7.APPLICATION OF AR IN LEARNING DENTAL MORPHOLOGY

In order to understand the function, external shape, position, size, structure, and development of teeth, dental morphology studies their anatomical components. It is regarded as crucial to have a thorough understanding of dental morphology in all dentistry disciplines. An AR system was created by Juan et al.[6] to teach dental morphology. Students that used the AR system were very impressed with how simple it was to use and would be happy to include it as another tool to their regular practise.

8.APPLICATION OF AR IN AESTHETIC DENTISTRY

The achievement of a patient-specific ideal appearance for the intended restorations may be regarded as a key goal in aesthetic dentistry. Pre-visualization can be accomplished using an intraoral mock-up and standard laboratory-made wax-ups in the form of a two-dimensional smile design that is created by superimposing idealised tooth forms onto a portrait image of the patient. This method is now only applicable to the planning and creation of teeth in the anterior maxilla.

9.APPLICATION OF AR IN MAXILLOFACIAL SURGERIES

The augmented reality system established for maxillofacial surgery has the advantages of easy manipulation and high accuracy, which can improve surgical outcomes.This system exhibits significant potential in clinical applications.

10.APPLICATION OF AR IN RESTORATIVE DENTISTRY

In a study published by Llena et al., the application of AR technology has been used in teaching cavity preparation [8]. The experimental group further educated with the AR method showed a significant improvement in skills related to Class I and Class II

cavity preparation. It should be emphasized that cavity preparation and the understanding of different parts of cavities is strongly conditioned by spatial vision, and it is in these areas that the experimental group has shown greater success.

11.OTHER CLINICAL APPLICATIONS IN DENTISTRY

Few studies have looked into the clinical uses of AR in dentistry other from its use in surgery. However, as associated technology advancements have progressed, so has interest in this sector. A lightweight AR system was used in orthodontics for guided bracket placement, and it was demonstrated that this system was workable and practicable [1]. Automated real-time detection of root canal orifices is a fascinating endodontic application of AR technology.

LIMITATIONS OF AUGMENTED REALITY

It is likely that AR will have an important role in image based augmentation of the surgical environment. This will require increasingly powerful microcomputers to drive AR, which is currently limited but will improve with time. For the device to be a natural extension of the surgeon's senses, it has to be

- Light
- Mobile
- Comfortable
- Functional for potentially long periods of time

Therein lies the limitations of the technology at present, where the battery life is limited, devices are large and the cables can be cumbersome. Such technology has to progress at present and eventually after several generations of development these tools will become as common as surgical loupes. As with electronic patient records, confidentiality and data management will be a major hurdle in the integration of recordable HMDs into medical practice.

FUTURE OF AUGMENTED REALITY AND EDUCATION

It has long been understood that the continually changing nature of modern digital technology is dramatically altering the situations of both teachers and pupils. According to Dede, educators always develop new approaches to teaching and learning as information technologies advance. But when these things alter, so do learner characteristics, skill sets, academic fields, and knowledge domains that society values [5]

Augmented reality is widely used today. Due to the low cost of mobile devices and other technology capable of processing and displaying information at fast speeds, the widespread application of AR has been made possible. Additionally, specialists in the field predicted that handheld devices that can give augmented reality experiences will advance..

CONCLUSION

After reviewing the augmented reality systems, it was discovered that these systems are still in the testing phase because there are still some issues preventing the widespread use of this technology in the dental industry [3].Systems appropriate for clinical use have been developed through numerous investigations, but no reported routine clinical use has been made. The entire potential of AR technology will soon undergo a revolution thanks to ongoing advancements in the field.

REFERENCES:

1. Aichert A, Wein W, Ladikos A, Reichl T, Navab N. Image-based tracking of the teeth for orthodontic augmented reality. InMedical Image Computing and Computer-Assisted Intervention–MICCAI 2012: 15th International Conference, Nice, France, October 1-5, 2012, Proceedings, Part II 15 2012 (pp. 601-608). Springer Berlin Heidelberg.
2. Albrecht UV, Folta-Schoofs K, Behrends M, von Jan U. Effects of mobile augmented reality learning compared to textbook learning on medical students: randomized controlled pilot study. J Med Internet Res. 2013 Aug 20;15(8):e182. doi: 10.2196/jmir.2497. PMID: 23963306; PMCID: PMC3758026.
3. Al-Khaled A, Al-Khaled I, Abutayyem H. A Review of Augmented Reality Systems and an Update on The Most Recent Technological Developments and Applications in Dentistry. European Journal of Dental and Oral Health. 2021 May 10;2(3):1-8.
4. Chander NG. Augmented reality in prosthodontics. The Journal of the Indian Prosthodontic Society. 2019 Oct;19(4):281.
5. Dede C. Immersive interfaces for engagement and learning. science. 2009 Jan 2;323(5910):66-9.
6. Juan M-C, Alexandrescu L, Folguera F et al (2016) A Mobile Augmented Reality system for the learning of dental morphology. Digital Education Review 30:234–247
7. Kucuk, Sevda & KAPAKİN, Samet & Goktas, Yuksel. (2016). Learning Anatomy via Mobile Augmented Reality: Effects on Achievement and Cognitive Load. Anatomical sciences education. 9. 10.1002/ase.1603.
8. Llena C, Folguera S, Forner L, Rodríguez-Lozano FJ. Implementation of augmented reality in operative dentistry learning. European Journal of Dental Education. 2018 Feb;22(1):e122-30.
9. Ma L, Jiang W, Zhang B et al (2018) Augmented reality surgical navigation with accurate CBCTpatient registration for dental implant placement. Med Biol Eng Compu 57(1):47–57
10. Madan GA, Madan SG, Madan AD (2002) Failure of inferior alveolar nerve block: exploring the alternatives. J Am Dent Assoc 133:843–846

11. Rhienmora P, Gajananan K, Haddawy P, Dailey MN, Suebnukarn S. Augmented reality haptics system for dental surgical skills training. InProceedings of the 17th ACM Symposium on Virtual Reality Software and Technology 2010 Nov 22 (pp. 97-98).
12. Wagner A, Rasse M, Millesi W, Ewers R. Virtual reality for orthognathic surgery: the augmented reality environment concept. Journal of oral and maxillofacial surgery. 1997 May 1;55(5):456-62.
13. Zaidi SA, Kumar CR, Sujesh M, Rajanikanth AV, Sunitha K. Augmented reality application in prosthodontics. IP Ann Prosthodont Restor Dent 2022;8(2):98-103.