Mobile Based Augmented Reality Dental Caries Application: A Review

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ABSTRACT

Technology that adds virtual information and objects to the actual world is known as augmented reality (AR). AR can be utilized in dentistry to enhance a number of patient care processes, include diagnosis, treatment, and surgical techniques. Real-time, interactive visualizations of a patient's anatomy are one of the key benefits of using AR in dentistry. This is especially helpful for diagnosing problems since it makes it simpler for dentists to find and evaluate potential problems with a patient's mouth and oral structures. Dental professionals can more properly diagnose and arrange treatment for illnesses like tooth decay, periodontitis, and other dental issues by using AR, for instance, to present accurate, three-dimensional representations of a patient's teeth, gum, and other structures. AR's diagnostic skills are complemented by its ability to increase the precision and accuracy of surgical treatments in the dental field. For instance, virtual overlays that direct doctors through difficult treatments like root canals, tooth extractions, and dental work can be made using AR technology. In addition to improving patient outcomes, this can help lower the chance of surgical errors. Additionally, the usage of AR in dentistry can enhance patient education and communication. To help teach complicated dentistry ideas and treatments in a way that patients can comprehend, AR can be used to construct virtual, interactive representations of a patient's teeth and mouth. Better patient outcomes may result as a result of increased patient engagement and adherence to treatment recommendations.

Keyword: - *Augmented Reality, Dentistry*

1. INTRODUCTION

To begin with the application of Augmented Reality, we must know what it is. So what is Augmented Reality actually? Through the use of technology, people can interact with virtual items in the actual world. It is often accomplished with the aid of specialist equipment, like smartphones or augmented reality (AR) glasses, which have sensors and software that allow them to recognize and track the user's motions and location in the real world. User experience, interaction design, and usability are few of the important topics of research in augmented reality. Researchers have also looked into how augmented reality can be used in a variety of industries, including education, entertainment, and business. The technology has the ability to improve the user experience by offering more captivating and interactive experiences, according to research in the field of augmented reality.

For instance, using Augmented Reality (AR) to develop virtual exhibits in museums will make it easier for visitors to explore and learn about items. Another important discovery is that AR can enhance the effectiveness and efficiency of specific jobs, including training and maintenance in commercial settings. AR can assist workers in completing jobs more quickly and accurately by offering real-time information and coaching. Overall, augmented reality research indicates that the technology has considerable potential to change a variety of businesses and enhance how individuals interact with their environment. To fully grasp the potential of AR and create useful applications for the technology, more study in necessary.

On the other hand we have VR which stands for Virtual Reality. VR is a quickly developing technology that has the power to completely transform a variety of sectors, including gaming, entertainment, healthcare, and education. The creation of increasingly complex and immersive VR experiences is a major focus of VR research. This entails developing the technology and software necessary to build VR experiences and exploring novel methods of interacting with them. For instance, scientists are creating increasingly sophisticated haptic feedback systems that will enable VR users to feel sensations like touch and temperature. The investigation of VR's possible applications and usage is another crucial field of research. Gaming, healthcare, and education are just a few of the areas that have already adopted virtual reality. Virtual reality (VR) technology has improved the realism and fun of the gaming experience by allowing gamers to fully immerse themselves in virtual worlds. VR has been used in the medical field to treat a variety of ailments, such as PTSD, phobias, and chronic pain. Virtual reality has been utilized in education to build immersive learning environments that let students go on virtual field trips and engage in other educational activities. A substantial quantity of study has also been done on how VR affects users physically and psychologically. According to some research, VR can benefit consumers by lowering anxiety and boosting empathy, among other things. However, some studies have raised questions about the possible drawbacks of VR, including the possibility of causing motion sickness and other types of discomfort.

VIRTUAL REALITY	AUGMENTED REALITY
An immersive virtual environment is created through VR	A real-world scene is improved through AR.
75 percent of VR is virtual	Whereas AR is only 25 percent virtual
Users in VR travel through an entirely made-up world.	while AR users interacts with the actual world
VR requires a connection speed of at least 50 Mbps..	AR needs a minimum of 100 Mbps of bandwidth.
A VR headset is required.	You don't need an AR headset
A computer-generated simulation of an alternative reality or environment is known as virtual reality (VR). It is utilized in video games and 3D movies.	To create an artificial environment, augmented reality (AR) seamlessly combines the digital and physical worlds.
Virtual reality (VR) replaces the real world with a made-up reality that is primarily used to improve video games.	AR aims to improve both the actual world and the virtual one.
Virtual reality is primarily concerned with simulating vision. A VR headset screen must be placed in front of the user's eyes	In augmented reality, contextually applicable digital content is added to the user's immediate physical environment.
Uses : In many sports, virtual reality (VR) is used as a digital training tool to measure performance and assess technique.	Uses: The Unity 3D Engine tool is being used to create real-time 3D games using AR.

Table-1: Differences between Virtual Reality and Augmented Reality

Both virtual reality (VR) and augmented reality (AR) technologies are utilized to produce immersive experiences. However, there are a few significant distinctions between the two that, in some circumstances, make AR a more appealing choice. The ability to interact with the real world rather than being entirely submerged in a virtual environment is one of the key advantages of AR versus VR. This makes AR a preferable option for applications like training simulations or interactive teaching tools that call for users to be aware of their surroundings. Another benefit of AR over VR is that it is typically less expensive and simpler to implement. AR doesn’t require the same level of hardware and software as VR because it bases its experience on the actual world. This makes AR more accessible to a larger audience because it can be utilized on a wider variety device, such as smartphones and tablets. Furthermore, AR has the capability to be more user-friendly and intuitive than VR. Users may find it simpler to comprehend and navigate because it is grounded in reality. For apps like instructional tools or entertainment options that are meant for a broad audience, this is especially crucial. The fundamental benefit of AR versus VR is that it enables more intuitive and natural interactions between users and the real environment. This makes it a superior option for a variety of applications, such as instruction, entertainment, and training.

2. EVOLUTION OF AR IN DENTISTRY

From the topics discussed above we know that the ultimate goal of Augmented Reality is to create a system such that the user cannot tell the difference between the real world and the virtual augmentation of it. To put it in a more succinct way, its purpose is to enhance a person's perception and performance of the world. The first use of Augmented reality dates to the 1960's. Where a computer scientist by the name Ivan Sutherland had invented the first augmented reality head mounted display system.

Fig -1: The first ever use of AR

One such example is oral and maxillofacial surgery. Tumor's, functional issues, and cosmetic issues are all addressed in oral and maxillofacial surgery. To achieve a functional and appealing outcome in all these circumstances, noble structures (such as the teeth, nerves, and bones) must be safeguarded. Surgery quality and efficiency can be improved with the help of virtual reality (VR) and planification based on 3D virtual models. However, in actuality, it falls short. The patient could benefit greatly from real-time projections of anatomical features and tumors. Therefore, augmented reality (AR) is a potential strategy. The technology for medical education, surgical training, and surgical treatments has developed during the previous ten years.

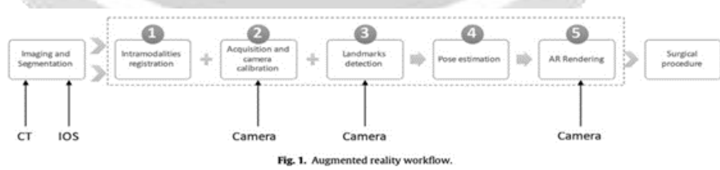

Fig -2: Augmented Reality Workflow

Slowly AR made its way through various domains, disrupting the traditional working systems by making them more immersive and interactive. It made its first appearance in the field of dentistry with the creation of a novel anatomical imaging system using software based on virtual reality. From there it was further discovered that its usage could be applied to various applications such as performing reconstructive surgery, maxillofacial surgery, esthetic dentistry as well as helping to educate and train dental students. Performing dental implant surgery has become much simpler.

A basic outline as to how orthognathic surgeries are done is described. It starts with building a virtual 3D representation of the patient's oral anatomy before surgery. A CT scan or cone beam is transformed into a 3D model by minimizing the quadratic distance between pairs of points on the plane. Step two would be camera calibration and acquisition of intraoperative video. In this step the basic idea is to take photos of the calibration patterns, from here it will try to establish a relationship between the real 3D world and the images captured. The third would be the extraction of landmarks. As these surgeries aim at aligning the patient's teeth, keeping checkpoints as to where the molars and premolars must be planted helps to assist with the surgery. The second last step of this process is pose assessment. Finding a rigid transformation mapping points from the preoperative 3D model to the camera constitutes pose estimation. The desired alignment is represented by this transformation. The final step is the augmented reality rendering. By overlaying the preoperative 3D model over the actual intraoperative 2D camera view, we create the augmented reality.

Fig -3: Proposed Graphical user interface showing the setting, the preoperative calibration, the pre-optive planification with marker localization and the intraoperative view before augmented reality alignment.

In fact, the use of digital technologies like scanners is structured in a 3-step procedure that can be summed up as follows. The revolutionary scope of developing an augmented reality-based system is to solve one of the biggest issues in the structure of most digital dentistry commonly available systematics. A scanning device captures the digital image, adjustments are made digitally from T0 to T1, and then the updated data is sent back to solid state. Through the use of augmented reality, direct visualization is possible without going through the final transfer process, which, on a large scale, prevents data loss and time wastage. The ability to see digital data immediately on the patient opens the door to obtaining significant benefits in digital procedures.

Introduction Another major breakthrough done by augmented reality was that it had revolutionized the way students were able to take tests. The OSCE tests are the examinations that dental students have to appear for. The augmented reality simulator is the best method of evaluation for OSCE. With its ergonomic postures, quick feedback, exam simulation, direct data transfer to the programmer, and campus use, DentSim is a full system that combines VR and AR. The system combining VR and AR, according to experts, not only integrates systems for teaching and learning from an organizational standpoint, but also trains skills and enhances hand-eye coordination. The system's outcomes can help users modify their posture and skills. And some evidence indicated that a variety of information technology related to VR and AR can instruct users and familiarize them with the programme, skill, and lesson. When compared to conventional preclinical teaching methods, a system incorporating VR and AR might cut down on faculty time by five times, making it an instructional tool for students to learn on their own.

3. CURRENT METHODOLOGIES USED IN AR

Introduction With the use of augmented reality (AR) technology, people may view and interact with virtual items in the real world. There are numerous ways to integrate augmented reality, but some of the more popular ones include employing markers, GPS, and computer vision techniques. With marker-based AR, virtual material is displayed by using a real-world object, like a QR code, as a point of reference.

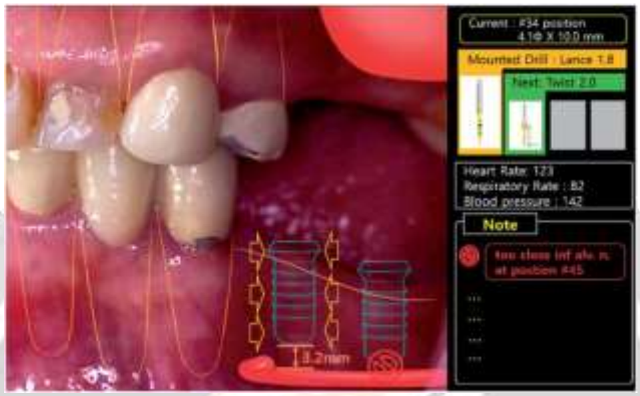

Fig -4: Proposed Contents of AR display through head mounted display during implant distillation

Various approaches are now being employed in AR, each with unique advantages and disadvantages. These consist of:

1. AR based on markers In this method, the display of virtual content is initiated by a certain visual pattern called a marker. The marker is picked up by the AR device, which utilizes it to identify where and how to arrange the virtual content in relation to the surrounding environment. Although this method is straightforward and simple to use, it has the drawback of only displaying virtual material when the marker is present.

2. Location-based AR: This method is used to determine the user's orientation and location using the device's integrated GPS and other sensors, then displays virtual material based on that data. This approach makes it possible to display a greater variety of virtual content, but it is less accurate than marker-based Augmented reality and may not function well inside or in locations with weak GPS service.

3. Projector-based augmented reality: This technique projects virtual content onto actual surfaces. The projector may be a standalone device positioned in the environment or it may be incorporated into a headphone or other device. Larger and more intricate virtual information can be displayed using this technique, but it necessitates that the projector is positioned and angled specifically in relation to the user.

4. Superimposition-based AR: This method presents virtual material that is aligned with real-world items after using computer vision algorithms to recognize and track them in the real world. This approach enables seamless integration of virtual material with the actual world, although it can be technologically demanding and may not be effective in complicated contexts.

5. 3D reconstruction, which involves combining sensors and vision - based algorithms to produce a 3D model of the world, is another important AR technique. This enables virtual information to interact with the environment and the AR system to comprehend its structure and layout. For instance, a digital chair positioned in a recreated setting may give the impression that a real table is hidden behind it.

6. Aside from these technical procedures, there are several strategies for developing and putting into practice AR experiences. For instance, some augmented reality (AR) systems employ a "magic window" strategy in which digital content is only seen through a smartphone's camera view. In other systems, virtual material is smoothly incorporated into the target environment, even though watched without a device, using a "mixed reality" method.

Although there are numerous existing augmented reality (AR) approaches, most AR systems generally use a combination of sensor and computer vision technology to comprehend the surroundings and impose online content on top of it. As a result, people can interact and perceive virtual items as genuine. Overall, the most successful AR experiences frequently blend different approaches to maximize the benefits of each. To show virtual content, for instance, a position AR app can employ markers.

Fig -5: Using a straightforward augmented reality technique, the inferior alveolar nerve block treatment is carried out . The mandibular foramen is in an intraoral view

4. USING AR TO TECH DENTAL STUDENTS

Conclusion For the best execution of any treatment plan for patients, dentists must have coordinated motor skills in addition to learned information. Over time, learning opportunities for both students and healthcare professionals have changed. Traditionally, cadavers were used in pre-clinical teaching, however these days, there are significant limitations due to cost, morality, and administrative issues. Pre-clinical training now includes simulation thanks to the way that technology has been adapted in dentistry.

Prior to managing patients, it gives students the chance to practice pre-clinical, standardized learning competencies, which will help them strengthen their psychomotor abilities for operations. Virtual reality, augmented reality, and computer-aided learning are all components of simulation, which is increasingly replacing pre-clinical instruction. Maxillofacial, restorative, and tooth morphology learning and mastering techniques for providing local anesthesia in dentistry frequently use augmented reality.

AR and VR both hold significant promise for medical education among them is dentistry. By combining digital components with a genuine learning setting, AR offers fresh educational possibilities. Laparoscopic surgery, echocardiography, and neurosurgery are the three areas where AR is most often used. Dentistry and medicine both have an interest in anatomy. Typically, anatomical models that are used in traditional anatomy lessons are a cadaver and an atlas, which takes a lot of time and effort to procure. When there are few cadavers, AR's benefits become more apparent. Additionally, AR offers a unique benefit when instructing on live anatomy due to the possibility of visualization.

Using augmented reality, the user may see the inside body structures and mirrored pictures. Additionally, AR can be applied by combining automated ultrasound in real time. The 'VirDenT' project uses augmented video and audio rendering to teach dental students how to fabricate abutments for all-ceramic restorations.

While in Brazil, the learners were prepared for gold only design by producing learning objects through augmented reality. In a study done, where traditional teaching was put against AR teaching. It was found out that class I and class II students particularly in the concept of cavity preparation had a more profound depth of knowledge.

Fig -6: Demonstration of haptic technology for infection of the inferior dental nerve.

Below are a few applications that can be developed which use Augmented Reality. The goal is to assist students in learning concepts with more clarity:

1)AR Manual The Manual for Dental Hygienists begins with very fundamental lessons that serve as the fundamental building blocks for more complicated learning about the complexity of understanding periodontal disease and its oral manifestations. The chapters also go into great length about raising awareness, inspiring prevention, and treating oral disease with both surgical and medicinal treatments. The part of the dental hygienist has grown to be crucial to the overall course of care. The appendix at the end of the book contains the Dental Council of India's regulations for dental hygienists. The manual includes a code of ethics for dental hygienists as well as recent developments in oral health care. All 56 chapters, which are divided into 7 sections, have been written in a very clear, concise manner so that dental practice trainees and instructors can easily understand the contents.

2)Augmented Reality Training An augmented reality training can focus on input data processing, XYZ plane detection, image object recognition, meta data and 3D models. Coming to the first one, the programme collects and processes real-world data via sensors, a tablet or smartphone, the camera lens of AR glasses . These devices range from a wide variety. Such as GPS, gyroscope, and accelerometer. For the second component In order to appropriately overlay AR information on it, the camera lens automatically scans the scene and interprets the result as an image on XYZ coordinate plane. Thirdly, recognition of particular QR codes/pictograms or specific objects (such as an equipment part or a tool model) that cause the database to get corresponding AR data. And lastly a request to the server and on-demand loading of pertinent explanations, 3D models, vocal instructions, or instructional films in the app.

5. CONCLUSION

The review article covered the following topics: how augmented reality has impacted the world, what is the difference between AR and VR, the evolution of augmented reality , the current methodologies used in AR and lastly how Augmented Reality has transformed the way dental students learn and study. Images and other visual stimuli help the brain process information more quickly. Since the human brain operates on the principles of images and associations, the notion of human interpretation of reality is limited to the three dimensions of space, which in turn supports the concept of AR and offers the possibility of future adjustments. Although the viability of using AR in dentistry has been demonstrated, it has not yet been determined whether AR is more effective than current practices. In the near future, it's anticipated that AR applications in dentistry will spread rapidly thanks to other cutting-edge technology like robotics and haptics.

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