

## Augmented reality in prosthodontics



The availability of clinical education is decreasing over the days.<sup>[1]</sup> The need and demand for the same is required for better specialized services.<sup>[2,3]</sup> The development of clinical skills requires extensive knowledge and ability. Recently, the requirement is substituted by simulated training obtained through artificial intelligence (AI) – virtual reality (VR) and augmented reality (AR). The VR is creating a simulated environment, whereas AR is a division of the same, but it augments sensory perception and replicates real environment in virtual world.<sup>[4-6]</sup>

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. AR superimposes a computer-generated image on an operator's view of the real world, thus providing a composite view. The invention of augmented reality has simplified many of the prosthetic treatment processes and meets the patient's expectations easily.<sup>[6]</sup>

AR has diverse applications. It is used as a guide to enhance the understanding. AR technology is used for smart learning, interactive tutoring, diagnosis, and treatment planning. AR is widely used in digital radiographs, dental scans, computer-aided design–computer-aided manufacturing (CAD-CAM) restorations, orthodontic aligners, oral surgery, and implantology. The information obtained from wider sources are stored and computed, and the algorithm is created by AR to support the dental or prosthodontic needs. The significant advantage of these machines with AR is the extended working time, and it completes the tasks without human fatigue.<sup>[4]</sup>

Preclinical and clinical training has witnessed a significant transformation with the use of AR technology for training and evaluation. The use of AR draws more attention and imparts quality training, and on the longer run, it decreases cost. The technology enables and simplifies the training for advanced clinical situations. The technology has been used successfully in many dental schools, and in few, integrations of these systems and technology into the dental curriculum have been done to enhance the training quality.<sup>[4-6]</sup>

The significant application of AR in prosthodontics is used in CAD-CAM restorations, implantology, and esthetic planning. It aids in designing the restoration and mills a restoration with great precision that offers superior function and esthetics. In addition, the concepts are employed in obtaining other craniofacial prosthesis which shall be a reality in the near future.<sup>[5,6]</sup>

The communication and visualization of esthetic planning and smile designing is always challenging. The developed software such as digital smile design, digital smile system, Trios smile design, and Smile pro aids in better conception and interaction. In addition to the present software technologies, these systems integrate the programs of facial recognition technology and automatic picture-based strategy (APBS) and enhanced mirror strategy (EMS) of AI technology. Facial recognition identifies the person with digital images using extraoral facial reference line and by mathematical algorithms. APBS and EMS use the intelligence technology to aid in designing, planning, communication, and education. Although these systems are widely used, still more advancements are required in quality of image construction, flexibility of the software, and easy integration in daily dental office. Most of the present-generation technologies are of two dimensional, partially immersive, or partly computer assisted. More evolution required for three-dimensional conception, video analysis, functional movement evaluation, and designing are required. These features are complex that requires extensive research and development for future.<sup>[7]</sup>

The use of dental robots, especially in prosthodontics, can be realistic future. The robotic trials are done in fabrication of removable partial denture, complete denture, and implant prosthesis. The data input of experienced personnel is coded to robots which can aid in productive prosthodontic actions. Extensive studies have been done in Canada on CRS robots for complete denture tooth arrangement. MOTOMAN UP6 robot, 50DOF multimanipulator tooth-arrangement robot system, 84DOF multimanipulator tooth-arrangement robot, and miniature Cartesian robot are some of robotic prosthodontic systems that are in

various stages of experimentation. Various universities such as Coimbra, Ecole des Mines de Paris, Ume<sup>o</sup>a Universitet, Dusseldorf, Chosun University, Mahidol University and National Science and Technology Development agency are studying on robotic prototypes that use AI for the use in implant prosthodontics. Recently, in China, robots were used to execute a guided implant surgery. The robotics in prosthodontics is under constant development, and in future with the use of human-computer interaction technology and with sensor control technique, extensive prosthodontic procedure can be made with robots.<sup>[8]</sup>

AR aids in realistic predictions of treatment. The navigations systems aid in obtaining superior results in implantology and maxillofacial surgery. The simulators aids in high-quality training to students. AR aids in precise diagnosis and calibration of procedures and it saves time. The use of technology also has limitations. The cost of the system is still expensive. In future with extensive use and economic alternatives, the cost can be reduced. Limitations exist in technology where few aspects of understanding and conversions to clinical requirements are difficult. With more researches and developments, these limitations shall be reduced. The experiments are done to use the photo emission tomography, infrared spectroscopy, indocyanine green dyes to determine tissue vascularity and sentinel nodes. The use of haptic force feedback and robotics enhances the use of AR technology.

The review of studies by Joda *et al.*<sup>[9]</sup> indicated that the number of studies on AR in dentistry is low, and more established designs and long-term studies are required for definitive protocols. The studies found that it is effective in use for interactive learning and objective evaluation. Encouraging results were found in maxillofacial surgery, CAD-CAM, and implantology. The literature, however, stressed on the importance of establishing technological standards with high data quality and developing approved applications for dental/prosthodontic AR devices for effortless clinical use.

The applications and interest of AR have increased recently with the availability of free source development programs. The open platforms have stimulated more participants, and it has led to increased applications in prosthetic dentistry. AR technology basically involves computation devices, software, exhibit devices and sensors. An effective AR system can be generated with the database of real and virtual information, recording techniques, image processing, display forms, perception settings, and response mechanisms.

AR is a novel technology in prosthodontics. Although effectively used in learning and CAD-CAM applications, in future it shall have wider applications for effective clinical procedures. It becomes mandatory to understand these concepts and techniques to utilize its advantages.

N. Gopi Chander

Editor, The Journal of Indian Prosthodontic Society, Chennai,  
Tamil Nadu, India

**Address for correspondence:**

Dr. N. Gopi Chander,  
Professor, Department of Prosthodontics, SRM Dental College,  
SRM University, Chennai - 600 089, Tamil Nadu, India.  
E-mail: drgopichander@gmail.com

**Received:** 02<sup>nd</sup> September, 2019, **Revision:** 08<sup>th</sup> September, 2019,

**Accepted:** 11<sup>th</sup> September, 2019, **Publication:** 10<sup>th</sup> October, 2019

**REFERENCES**

1. Nair KC. Marching ahead to the future. J Indian Prosthodont Soc 2007;7:162-5.
2. Bhambhani R, Bhattacharya J, Sen SK. Digitization and its futuristic approach in prosthodontics. J Indian Prosthodont Soc 2013;13:165-74.
3. Prithviraj DR, Bhalla HK, Vashisht R, Sounderraj K, Prithvi S. Revolutionizing restorative dentistry: An overview. J Indian Prosthodont Soc 2014;14:333-43.
4. Huang TK, Yang CH, Hsieh YH, Wang JC, Hung CC. Augmented reality (AR) and virtual reality (VR) applied in dentistry. Kaohsiung J Med Sci 2018;34:243-8.
5. Albuha Al-Mussawi RM, Farid F. Computer-based technologies in dentistry: Types and applications. J Dent (Tehran) 2016;13:215-22.
6. Kwon HB, Park YS, Han JS. Augmented reality in dentistry: A current perspective. Acta Odontol Scand 2018;76:497-503.
7. Touati R, Richert R, Millet C, Farges JC, Sailer I, Ducret M. Comparison of two innovative strategies using augmented reality for communication in aesthetic dentistry: A Pilot study. J Healthc Eng 2019;2019:7019046.
8. Jiang JG, Zhang YD, Wei CG, He TH, Liu Y. A review on robot in prosthodontics and orthodontics. Adv Mech Eng 2014;7:1-11. [doi: 10.1155/2014/198748].
9. Joda T, Gallucci GO, Wismeijer D, Zitzmann NU. Augmented and virtual reality in dental medicine: A systematic review. Comput Biol Med 2019;108:93-100.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

| Access this article online   |   |
|--|---|
| <b>Quick Response Code:</b>  | <b>Website:</b><br>www.j-ips.org        |
|  | <b>DOI:</b><br>10.4103/jips.jips_324_19 |

**How to cite this article:** Chander NG. Augmented reality in prosthodontics. J Indian Prosthodont Soc 2019;19:281-2.