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Original Research Article

Augmented reality in orthodontics: The way ahead

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Background: Augmented Reality is a favorable and definitive pedagogical approach for integrating formal learning. E-learning combined with Augmented Reality (AR) technology can surpass traditional learning methods if the system is tailored to include components of smart learning and evaluation of knowledge on devices ubiquitously in the absence of tutors. AR is predicted to transform and become the fundamental user interface of the twenty-first century. Augmented reality, instead, generates an interaction between the real environment and virtual objects. The use of augmented reality permits direct visualization bypassing the last transfer step, which means, on a large scale, to avoid data and time loss. Visualization of digital data directly on the patient means the possibility of achieving great advantages in digital procedures. This review briefly summarizes history, definitions, features and components of augmented reality technology and discusses its avenues and applications in orthodontics.

1. Introduction

E-learning is a positive and absolute pedagogical approach for assimilating formal learning. E-learning amalgamated with Augmented Reality (AR) technology can overshadow conventional learning methods if the system is ready-made to integrate components of smart education and assessment of data on devices throughout in the absence of tutors. AR is presumed to revolutionize and become the fundamental user blend of the twenty-first century.[1] The flourishing demand of AR is etching attention from educationists around the world in all the areas of apprenticeship. AR immersive surroundings provide a remarkable opportunity for studying and carrying out activities to fortify psychomotor and cognitive skills. The AR curriculum can utilize both visual and haptic clues to bolster users' experiences. The synergy in a graphical, riverting and embodied context provides striking prospects for experimental learning and for research in a relatively secure setting.[2] The definition of augmented reality refers to: "a technology that superimposes a computer-generated image on a user's view of the important world, thus providing a composite view". Augmented reality however is usually muddled up with computer game since both have many facets in common, even if the outcomes are completely different. Virtual reality, as the name suggests, is a virtual immersive environment where the users' senses are stimulated with computer-generated sensations and feedbacks generating an "interaction". Augmented reality, brings about a communication amidst the important environment and pregmatic items. For example a virtual reality system would be a head worn helmet which replicates navigation inside human body and enables the user to analyze it on the bottom of a virtual three-dimensional reconstruction. A similar example with the augmented reality would enable it to directly observe a person's body and to see virtual objects on it.[3–5]

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1.1. Historical perspective

The evolution of AR is credited to Boeing in the year 1990. Before AR automation, Boeing's workers were enforced to repeatedly discuss a laptop screen to ensure that the numerous wires were connected correctly. The process was tiresome and time consuming. Boeing's engineers refined AR headsets, which assisted the employees to see the information projected ahead of their eyes, which improved their wire construction efficiency and decreased the errors.[6,7] Gradually, the use of AR then broadened to various fields, including gaming, service, factory assembly, and medical industries. Within the field of oral medicine, AR is additionally utilized in oral maxillofacial surgeries, implant placement and providing oral education.[8]The revolutionary outlook of developing an augmented reality based system is to solve one of the biggest issue in the structure of commonly available systematics of digital dentistry; infact , the use of digital technologies just like the scanners is structured in a 3-step procedure which can be summarized as follows: the digital image is attained by a scanning device, the changes are collected digitally fromT0 to T1 and the new acquired information is shifted back to solid state. The utilization of augmented reality permits direct visualization bypassing the last transfer step, which suggests, on an outsized scale, to avoid data and time loss. Visualization of digital data directly on the patient means the likelihood of achieving great advantages in digital procedures. Thus the aim of this article is to shed the light on the value of augmented reality technology and its application within the field of Orthodontics.Cognitive apprenticeship and simulation-based training through Augmented Reality: The indentureship followed in orthodontic education nearly adheres to observational and simulation based learning, where learners grasp through closed monitoring of procedural work demonstrations (Chris, Bella, &Sally, 2017; Darnis & Lafont, 2015).[9] Cognitive apprenticeship has been previously applied across diverse faculties of drugs (Stalmeijer, Dolmans, Snellen-Balendong, van Santen-Hoeufft, Wolfhagen & Scherpbier, 2013),[10] dentistry (Kilistoff, Mackenzie, D'Eon & Trinder,2013)15 and pharmacy (Pinelli, McLaughlin,Khanova,Eckel,Vu,Weinberger & Roth, 2018)[11] under different settings (e.g., classrooms, clinical, and online). This approach, when combined with simulators for task execution, becomes simulation-based training. Simulation-based training provides an efficient modality to show both technical and nontechnical skills during a safe and non-threatening environment. The simulation recreates a real life representation of a procedural orthodontic event. This simulation has the advantage of assessing students in clinical tasks during a stress-free environment which may be a created model for the purpose of education and/or evaluation.

Buchanan[12] in 2004 showed that when the students were trained using virtual reality simulators; they practised more procedures in the given limited time, learned comparatively faster and accomplished the equal level of proficiency as traditional methods. The students also wished more assessments through the computer thus decreasing instructor — student evaluation time and which in turn improved their fine motor skills.

1.2. Learning orthodontic cephalometry through augmented reality

The Orthodontics cephalometry forms an ideal radio graphic examination which serves a useful diagnostic means for analysis and treatment planning. The individuality of AR is that registration of virtual objects happens within the real world granting the user to ascertain 3D virtual objects overlaped upon the real world. Due to these, the technology of AR is a boon for medicine and dentistry as complex internal structures of the body are virtually recreated during a 3D format forming a superb tool for learning cephalometrics. This permits the scholars to see the structures and its details from various angles. The haptic feedback can impart a tactile response as soon as a landmark has been detected on the cahalogram, allowing error-free learning.[10] The students would gain remarkably as AR system allows landmark identification and validation and thus decreasing the subjective evaluation by the tutors.[13]

1.3. Machine learning and its applications in Orthodontics

Machine learning encircles the diminution of human error with successive automation. The machine learning will involve training a group of features with their labels, such that the machine learning model can learn and optimally predict similar or near similar features which can occur in future. The machine learning techniques with its advantages, can when trained, perform human actions.

The applications of machine learning in dentistry have huge implications for image analysis and image-based diagnosis.[14] The Computer-aided detection/diagnosis (CAD) in dentistry has developed methods of using machine learning in detecting radiological signs of medical systemic disease within the panoramic screening radiograph.[11] This technique if integrated into the orthodontic cephalometric training model will correct the scholar while they learn and work on a task increasing efficiency and validating the training outcome objectively.

1.4. Bracket positioning on teeth as a part of treatment and education

The ideal bracket position is vital for efficient Orthodontic treatment. Using the AR-assisted bracket navigation system, the accuracy of bracket placement has improved and therefore the procedure time of lab stage has decreased. The utilization of AR system increases the accuracy rate in all the spatial directions and helps the novice orthodontist guide the bracket position with in a suitable clinical error of roughly 0.5 mm. A high accuracy in bracket positioning not only decreases the demand for first and second order bends but also lessens the complexity and treatment span which further reduces clinical chair time; thus giving skillful and precise outcomes.[15]

1.5. Orthodontic apps nearing augmented reality

Current systems are employing a separate interaction interface, where the patient or doctor sees the treatment from a 3rd person perspective. Imagine getting an augmented reality view where progress or proposed results are visible in real time and overlaid the particular patient. A real blend of the digital and real-world may be a natural evolution of a minimum of three of the present available technologies: Dental Monitoring App, iTero Progress Tracking and iTero Time lapse.

Time lapse technology allows practitioners to correlate a patient's old 3D scans to present ones, sanctioning clinicians to determine and evaluate orthodontic movement, gingival recession and tooth wear. This features areas of diagnostic interest to dental practitioners and help serve a proactive conversation with the patient regarding possible orthodontic solutions. The scanners are created to bring speed, intuitive operations, reliability and outstanding vistualization means to orthodontic treatment outcomes.

2. Discussion

The orthodontic education has supported the doctrines of constructivism which has benefitted extremely in the training process of orthodontic students. This education, when combined with technology-enabled learning, provides an identical experience as technology-enabled learning; is in itself supported the tenets of constructivism. The utilization of e-learning resource with the help of AR in orthodontic education is yet to become a neighborhood of curriculum and teaching. While the e-learning with AR simulation provides futuristic learning tool and benefits of ubiquitous learning, it simultaneously needs comprehension of unique technological and cognitive challenges to teaching and learning.[16]

The applications of AR in Orthodontics is just a inauguration of digitazation and Orthodontic field will gain from numerous inventions and development views from this field. The AR-assisted bracket navigation system can serve as a clinical training and educational tool for novice Orthodontists.[15]

3. Conclusion

It can thus be concluded that virtual and augmented reality systems will play an increasing role in orthodontic education, treatment planning and treatment outcomes. These technologies are likely to vary clinical training and encourage the utilization of reflective sorts of assessment, which involve students during a self-assessment process to spot individual learning needs and self-directed learning. These innovations promise not only lower costs of the tutorial process, but also a rise in quality by providing a replacement set of pedagogical tools for orthodontics.

4. Source of Funding

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5. Conflict of Interest

None.

References

1. Kroeker K. Mainstreaming augmented reality. *Commun ACM*. 2010;53(7):19–21. doi:10.1145/1785414.1785422.
2. Barab SA, Hay KE, Barnett MG, Squire K. Constructing virtual worlds: Tracing the historical development of learner practices/understandings. *Cognition Instruction*. 2001;19(1):47–94. doi:10.1207/S1532690XCI1901_2.
3. Azuma RT. A survey of augmented reality. *Presence Teleoperators Virtual Environ*. 1997;6(4):355–85. doi:10.1162/pres.1997.6.4.355.
4. Bimber O, Raskar R. Spatial augmented reality: merging real and virtual worlds; 2005. Available from: https://www.researchgate.net/publication/200086094_Spatial_Augmented_Reality_Merging_Real_and_Virtual_Worlds. doi:0.1201/b10624.
5. Satava RM, Jones SB. Current and future applications of virtual reality for medicine. *Proc IEEE*. 1998;86(3):484–93. doi:10.1109/5.662873.
6. Caudell T, Mizell D. Augmented reality: An application of heads-up display technology to manual manufacturing processes. *IEEE Explorer* . 1992;7(10):659–69.
7. Jiang J, Huang Z, Qian W, Zhang Y, Liu Y. Registration Technology of Augmented Reality in Oral Medicine: A Review. *IEEE Access*. 2019;7:53566–84.
8. Alqahtani ND, Al-Jewair T, Al-Moammar K, Albarakati SF, Alkofide EA. Live demonstration versus procedural video: a comparison of two methods for teaching an orthodontic laboratory procedure. *BMC Med Educ*. 2015;15:199. doi:10.1186/s12909-015-0479-y.
9. Eckert M, Hong J. Augmented Reality in Medicine: Systematic and Bibliographic Review. *Hanyang Med Rev*. 2016;36(4):242.
10. Alkhamisi AO, Monowar MM. Rise of Augmented Reality: Current and Future. Application Areas. *Int J Internet Distributed Syst*. 2013;1(4):25–34. doi:10.4236/ijids.2013.14005.
11. Katsumata A, Fujita H. Progress of computer aided detection/diagnosis (CAD) in dentistry. CAD in dentistry. *Jpn Dent Sci Rev*. 2014;50(3):63–8. doi:0.1016/j.jdsr.2014.03.002.
12. Buchanan JA. Experience with virtual reality- based technology in teaching restorative dental procedures. *J Dent Edu*. 2004;68(12):1258–65.
13. Rao GK. Learning Orthodontic cephalometry through Augmented reality: A conceptual machine learning validation approach. *Int Conf Electr Eng Inform*. 1920;1(7):133–8. doi:10.1109/ICELTICS.2018.8548939.
14. Yu Y. Machine Learning for Dental Image Analysis; 2016. Available from: https://arxiv.org/abs/1611.09958.
15. Lo YC. Prototype of Augmented reality technology for Orthodontic bracket positioning: An in vivo study. *Appl Sci*. 2021;11(5):2315. doi:10.3390/app11052315.

16. Dunleavy M. Affordances and Limitations of Immersive Participatory Augmented Reality Simulations for Teaching and Learning. *J Sci Educ Technol* . 2009;18:7–22.

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