International Journal of Current Pharmaceutical Research

ISSN- 0975-7066 Vol 15, Issue 3, 2023

Review Article

VIRTUAL REALITY AND DENTISTRY

ANAND BHATNAGAR[1], EVA BHATNAGAR[2*]

[1]Department of Periodontics, Jaipur Dental College Jaipur Rajasthan. [2]Bhatnagar Hospital Jaipur Rajasthan
*Corresponding author: Eva Bhatnagar; Email: dranandbhatnagar@gmail.com

Received: 11 Mar 2023, Revised and Accepted: 14 Apr 2023

ABSTRACT

The field of dentistry could benefit considerably from virtual reality (VR). There will be several ways like Virtual reality can be used to teach patients about oral hygiene and dental procedures in a more dynamic and engaging way. Patients can utilize virtual reality (VR) to learn about various dental procedures, view 3D representations of their teeth and gums and comprehend how poor oral hygiene affects their general health. Many people experience fear or worry when going to the dentist, which can prevent them from getting the essential dental care. VR can reduce these anxieties by fostering a more tranquil and immersive atmosphere. For instance, patients might utilize virtual reality (VR) headsets to divert their attention during treatments or imagine serene settings to lessen anxiety. Virtual reality can also be utilized to educate and teach dental practitioners in a more effective and efficient manner. Before working on actual patients, students can perform a variety of dental operations in a virtual setting, which helps them develop their confidence and competence. VR can be used by dental practitioners to learn about new methods, instruments, and technologies. In general, the use of virtual reality in dentistry has the potential to enhance dental professional training and education, patient results, and patient involvement and satisfaction.

Keywords: Virtual reality, Dentistry, Oral hygiene

© 2023 The Authors. Published by Innovare Academic Sciences Pvt Ltd. This is an open access article under the CC BY license (https://creativecommons.org/licenses/by/4.0/)
DOI: https://dx.doi.org/10.22159/ijcpr.2023v15i3.3005. Journal homepage: https://innovareacademics.in/journals/index.php/ijcpr

INTRODUCTION

A rapidly expanding area of computer science, artificial intelligence (AI) enables machines to learn from and adapt to their surroundings. Several industries, including manufacturing, healthcare, finance, and customer service, could be completely transformed by it. Predictive analytics, facial recognition, natural language processing, and autonomous cars are just a few applications of AI. The applications of AI will develop along with technology, from boosting marketing initiatives to improving operational efficiency [1, 2].

Dentistry is undergoing a transformation thanks to artificial intelligence (AI). Artificial intelligence (AI)-based technologies are being utilized to automate a number of procedures, including diagnosis and treatment planning, as well as to help with oral disease prevention and early detection. By making individualized recommendations based on data about specific patients, AI can also be utilized to enhance medical care. Moreover, AI can help dentists spend less time on administrative work and more time on patient care. AI has the potential to significantly improve dental care in the near future thanks to its promise for greater accuracy and efficiency.

What is artificial intelligence

The goal of artificial intelligence (AI), a subfield of computer science, is to comprehend and create intelligent things, frequently in the form of software [3]. It can be described as a series of actions intended to carry out a particular task. 4 Previously, artificially intelligent systems solved the specific problems they were designed to address by applying manually constructed rules. Each activity needed subject-matter specialists to manually fine-tune the system using engineering and domain-specific knowledge. For instance, a system created to find lesions in medical imaging would search for lumps with an unusual colour and a specific form. The system's ne-tunable components may be a range of colours for healthy tissue or the minimum lengths and widths for a potential lump. Machine learning, a subfield of AI, is currently used most frequently in medicine [5] and more lately.

In machine learning (ML), a subfield of artificial intelligence, systems learn to carry out intelligent tasks without the aid of predetermined information or prewritten rules. Instead, without aid from humans, the systems find patterns in cases from a vast dataset. By defining a target and maximizing the system's adjustable functions to achieve it, this is accomplished. An ML algorithm learns by exposure to random examples and incremental tuning of the "tunables" in the direction of the correct response. This process is known as training. The system discovers patterns as a result, which it may subsequently use to analyse new photos. This method is comparable to an adult showing a toddler multiple pictures of cats. The young toddler soon picks up on the patterns needed to identify and recognize a cat.

In deep learning (DL), a branch of machine learning, systems try to learn not just a single pattern but also a hierarchy of interconnected, composable patterns. A "deep" system is far more effective than a simple, "shallow" one due to the combination and layering of patterns. For example, a young toddler could not see a cat in the youngster instead first notices the margins of the object, a certain grouping of which denotes a textured outline with straightforward shapes, like eyes and ears. Larger groups such as heads and legs form among these parts, and a specific arrangement of them denotes the entire cat. The artificial neural network (ANN), [6] a structure made up of numerous small communication units known as neurons grouped in layers, is a very well-liked class of DL methods. An input layer, an output layer, and intermediate hidden layers make up a neural network [7]. A shallow neural network may have one or a few hidden layers, or it may have many hidden layers (deep neural network, DNN) because their values are neither pre-specified or externally apparent, these levels are referred to as hidden. They want to make it possible to compute the accurate value of the visible output layer by building hierarchically on the data that was obtained from the visible input layer. The architecture of a particular neural network is determined by the arrangement of connections between neurons, and the strength of those connections which is net unable is referred to as the weights of the neural network. The convolution neural network (CNN) is one of the ANN subclasses that is most frequently utilized in medicine and dentistry. Convolution is a mathematical technique used by CNNs to interpret digital data including sound, picture, and video. It also uses a specific neuron connection design. CNNs employ a sliding window to evaluate a larger image or signal by scanning a small area of inputs at a time from left to right and top to bottom. They are the most used algorithm for image recognition because they are so well suited to the task of classifying images [7].

How artificial intelligence are useful in dentistry

Due to the arrival of artificial intelligence, the field of dentistry is undergoing rapid change (AI). The way that AI is used to diagnose and treat patients by dentists has the potential to change completely. AI can analyze patient data, automate administrative processes, and even produce 3D models for dental operations in addition to spotting trends in medical photos.

Artificial intelligence (AI) technology can be used to identify periodontal disease and other dental disorders early on. As a result, less time must be spent on preventive measures while a more precise diagnosis and more successful treatment strategies are possible. By automating repetitive operations like appointment scheduling or alerting patients of impending appointments, AI-powered systems can also assist in reducing workloads and enhancing patient satisfaction. AI has the potential to change the dental industry and make dental procedures more effective, precise, and patient-centered thanks to its many uses.

In Radiology use of AI are

The ability of CNNs to recognize and detect anatomical features has showed promise. As an illustration, some people have received training to recognize and classify teeth from periapical radiographs. In the detection and identification of teeth, CNNs have shown a precision rate of 95.8-99.45%, closely matching the performance of clinical specialists, whose precision rate was 99.98% [8, 9].

CNNs have additionally been employed in the identification and treatment of dental cavities [10]. A deep CNN algorithm was able to identify carious lesions in 3000 periapical radiographs of posterior teeth with an accuracy of 75.5-93.3% and a sensitivity of 74.5-97.1%. Clinical diagnosis using radiographs alone, with sensitivity ranging from 19% to 94%, is significantly improved by this [11]. Deep CNNs are among the most effective methods employed in this field because of their high potential for improving the sensitivity of dental caries diagnosis and their speed.

In orthodontics treatment

ANNs offer a great deal of promise to support clinical decision-making. To provide patients with consistent results throughout orthodontic treatments, it is crucial to meticulously schedule treatments. The inclusion of tooth extractions in the orthodontic treatment plan is typical, nevertheless. Before beginning any irreversible operations, it is crucial to make the best clinical decision possible. In individuals with malocclusion, an ANN was utilized to help identify whether tooth extraction was necessary before to orthodontic treatment [12, 13]. The four built ANNs demonstrated an accuracy of 80-93% in detecting whether extractions were required to treat patients' malocclusions while taking into account a number of clinical indices [12, 13].

In periodontics

The aggressive (AgP) and chronic (CP) forms of periodontitis are recognized by the 1999 American Academy of Periodontology classification of periodontal disease [14]. No single clinical, microbiological, histological, or genetic test, or a combination of them, can distinguish AgP from CP patients due to the disease's complicated pathophysiology [15]. Leukocytes, interleukins, and IgG antibody titers were employed by Papantanopoulos and colleagues [16] to train an ANN to differentiate between AgP and CP in patients. Patient classification as AgP or CP was 90–98% accurate using the single ANN. An ANN including monocyte, eosinophi, and other cells produced the best overall prediction inputs include neutrophil levels and the CD4+/CD8+T-cell ratio. According to the study's findings, ANNs can be used to accurately diagnose AgP or CP using relatively easy-to-obtain information, including leukocyte counts in peripheral blood. Treatment options for periodontally compromised teeth (PCT) and supporting structures include both surgical and non-surgical procedures [17]. Despite improvements in therapeutic options, the process for detecting PCT and determining its prognosis has not much improved. The accuracy of clinical diagnostic and prognostic assessments is strongly dependent on empirical data [18]. Deep CNN algorithms' potential usefulness and precision for identifying and forecasting PCT were assessed by Lee and colleagues [19]. The accuracy of PCT diagnosis using the CNN algorithm was found to be 76.7-81.0%, while the accuracy of predicting the requirement for extraction was 73.4-82.8%. Premolars were more accurately identified as PCTs than molars (accuracies were 82.8% and 73.4%, respectively), which was the apparent difference in accuracy between tooth types. Premolars typically have a single root, however molars typically have two or three roots, making the anatomy of molars more complex for a Child to understand.

In the endodontic

Although mandibular molars tend to have comparable root canal configurations, some unusual variants may occur [20]. Cone-beam computed tomography (CBCT) has emerged as the gold standard for reducing treatment failures caused by morphological variations and improving the therapeutic results of endodontic therapy. However, CBCT is not routinely employed due to its increased radiation exposure when compared to conventional radiographs [21]. To tackle these difficulties, artificial intelligence (AI) has been developed to categorize the provided data using a CNN22 to ascertain whether the distal root of the first mandibular molar has one or more additional canals. Dental CBCT radiographs of 760 mandibular first molars were examined. After determining whether the atypia was present or absent, image patches of the roots were processed using corresponding panoramic radiographs [22]. Although having a reasonably high accuracy of 86.9%, the CNN's clinical integration has a number of drawbacks. Manual segmentation of the photos is required, which takes a lot of time. In order for the system to concentrate on the object being investigated, the obtained images must also be of an appropriate size and should focus on a small region while still covering enough ground to incorporate relevant information [23].

In oral pathology

Detection and diagnosis of oral lesions is of crucial importance in dental practices because early detection significantly improves prognosis. It is crucial to obtain an accurate diagnosis and give the patient the proper therapy because some oral lesions might be malignant or precancerous in nature. In the process of diagnosing head and neck cancer lesions, CNN has proven to be a helpful tool. CNN demonstrates remarkable potential for identifying unmoral tissues in tissue samples or on radiographs with specialty and accuracy at 78-81.8% and 80-83.3%, respectively (compared to those of specialists, which were 83.2% and 82.9%, respectively) [24].

Challenges in AI

Major obstacles to the application of AI systems in the healthcare industry include the administration and sharing of clinical data. The initial training of AI algorithms as well as ongoing training, validation, and enhancement require personal data from patients. Additionally, the advancement of AI will encourage data exchange across various institutions and, in certain situations, across international borders. Systems that safeguard patient confidentiality and privacy must be modified in order to integrate AI into healthcare operations. Hence, anonym zing personal data is required before considering a wider release. There is scepticism regarding secure data sharing in the medical sector despite the capacity to take these steps.

Also, there are safety concerns with AI systems. It is necessary to develop mechanisms to regulate the effectiveness of the AI algorithms. Government should established a new medicine category called "Software as Medical Device" via which it will control patient safety and safe innovation. Another issue is ambiguous accountability when using AI systems. Who will be held accountable for a patient who suffers unintended effects as a result of a mistake or unfavorable event brought on by AI technology? Which party is at fault the expert or the programmer who created the algorithm? Given that the underlying tenet of our legal system is that wrongdoing and crime are ultimately accountable to individuals [24].

Clinic labeled datasets could have variable quality, which would restrict the effectiveness of the resulting AI systems. Health care practitioners should also be able to defend the judgments and projections produced by an AI system in addition to having a thorough comprehension of them. Major advancements are needed before certain kinds of algorithms, like neural networks, can offer clinical diagnosis or treatment suggestions with complete transparency. Interpretability of AI technology is a known issue.

CONCLUSION

The majority of institutions are currently unprepared for the challenge of successfully integrating AI into dentistry, which will require training in both dental and continuing education. AI is also essential to augmented reality (AR) and virtual reality (VR) (AR). In order to improve learning and surgical planning, a novel concept known as mixed reality combines elements of generative AI, VR, and AR into computer-superimposed information overlays. A future for AI in the health care system cannot be discounted given that numerous AI systems for various dentistry specialties are being researched and have so far yielded good preliminary results. AI systems have the potential to be a valuable resource for oral health professionals.

FUNDING

Nil

AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICT OF INTERESTS

Declared none

REFERENCES

1. Yu KH, Beam AL, Kohane IS. Artificial intelligence in healthcare. Nat Biomed Eng. 2018;2(10):719-31. doi: 10.1038/s41551-018-0305-z, PMID 31015651.
2. Topol EJ. Deep medicine: How. Artificial intelligence can make healthcare human again. 1st ed. New York: Basic Books; 2019.
3. Russell SJ, Norvig P. Artificial intelligence: a modern approach. 3rd ed. Englewood Cliffs: Prentice Hall; 2010.
4. Muller J, Massaron L. Artificial intelligence for dummies. Hoboken, NJ: John Wiley & Sons; 2018.
5. James G, Witten D, Hastie T, Tibshirani R. An introduction to statistical learning with applications in R. New York: Springer; 2013.
6. Goodfellow I, Bengio Y, Courville A. Deep learning. 1st ed. Cambridge, MA: MIT Press; 2016.
7. Nielsen MA. Neural networks and deep learning. Determination press; 2015. Available: http://neuralnetworksanddeeplearning.com [Last accessed on 16 Apr 2021].
8. Zhang K, Wu J, Chen H, Lyu P. An effective teeth recognition method using label tree with cascade network structure. Comput Med Imaging Graph. 2018;68:61-70. doi: 10.1016/j.compmedimag.2018.07.001, PMID 30056291.
9. Tuzoff DV, Tuzova LN, Bornstein MM, Krasnov AS, Kharchenko MA, Nikolenko SI. Tooth detection and numbering in panoramic radiographs using convolutional neural networks. Dentomaxillofac Radiol. 2019;48(4):20180051. doi: 10.1259/dmfr.20180051, PMID 30835551.
10. Lee JH, Kim DH, Jeong SN, Choi SH. Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. J Dent. 2018;77:106-11. doi: 10.1016/ j.jdent.2018.07.015, PMID 30056118.
11. Bader JD, Shugars DA, Bonito AJ. Systematic reviews of selected dental caries diagnostic and management methods. J Dent Educ. 2001;65(10):960-8. doi: 10.1002/j.0022-0337.2001.65.10.tb03470.x, PMID 11699997.
12. Xie X, Wang L, Wang A. Artificial neural network modeling for deciding if extractions are necessary prior to orthodontic treatment. Angle Orthod. 2010;80(2):262-6. doi: 10.2319/111608-588.1, PMID 19905850.
13. Jung SK, Kim TW. New approach for the diagnosis of extractions with neural network machine learning. Am J Orthod Dentofacial Orthop. 2016;149(1):127-33. doi: 10.1016/j.ajodo.2015.07.030, PMID 26718386.
14. Armitage GC. Development of a classification system for periodontal diseases and conditions. Ann Periodontol. 1999;4(1):1-6. doi: 10.1902/annals.1999.4.1.1, PMID 10863370.
15. Armitage GC. Learned and unlearned concepts in periodontal diagnostics: a 50 y perspective. Periodontol 2000. 2013;62(1):20-36. doi: 10.1111/prd.12006, PMID 23574462.
16. Papantonopoulos G, Takahashi K, Bountis T, Loos BG. Artificial neural networks for the diagnosis of aggressive periodontitis trained by immunologic parameters. PLOS ONE. 2014;9(3):e89757. doi: 10.1371/journal.pone.0089757, PMID 24603408.
17. Papantonopoulos G, Takahashi K, Bountis T, Loos BG. Using cellular automata experiments to model periodontitis: a first step towards understanding the nonlinear dynamics of the disease. Int J Bifürcation Chaos. 2013;23(3):1350056. doi: 10.1142/S0218127413500569.
18. Papantonopoulos G, Takahashi K, Bountis T, Loos BG. Mathematical modeling suggests that periodontitis behaves as a non-linear chaotic dynamical process. J Periodontol. 2013;84(10):e29-39. doi: 10.1902/jop.2013.120637, PMID 23537122.
19. Lee JH, Kim DH, Jeong SN, Choi SH. Diagnosis and prediction of periodontally compromised teeth using a deep learning-based convolutional neural network algorithm. J Periodontal Implant Sci. 2018;48(2):114-23. doi: 10.5051/jpis.2018.48.2.114. PMID 29770240.
20. Hiraiwa T, Ariji Y, Fukuda M, Kise Y, Nakata K, Katsumata A. A deep-learning artificial intelligence system for assessment of root morphology of the mandibular first molar on panoramic radiography. Dentomaxillofac Radiol. 2019;48(3):20180218. doi: 10.1259/dmfr.20180218, PMID 30379570.
21. Zhang X, Xiong S, Ma Y, Han T, Chen X, Wan F. A cone-beam computed tomographic study on mandibular first molars in a Chinese subpopulation. PLOS ONE. 2015;10(8):e0134919. doi: 10.1371/journal.pone.0134919, PMID 26241480.
22. Xue Y, Zhang R, Deng Y, Chen K, Jiang T. A preliminary examination of the diagnostic value of deep learning in hip osteoarthritis. PLOS ONE. 2017;12(6):e0178992. doi: 10.1371/journal.pone.0178992, PMID 28575070.
23. Wang X, Yang W, Weinreb J, Han J, Li Q, Kong X. Searching for prostate cancer by fully automated magnetic resonance imaging classification: deep learning versus non-deep learning. Sci Rep. 2017;7(1):15415. doi: 10.1038/s41598-017-15720-y, PMID 29133818.
24. Trebeschi S, van Griethuysen JJM, Lambregts DMJ, Lahaye MJ, Parmar C, Bakers FCH. Deep learning for fully-automated localization and segmentation of rectal cancer on multiparametric MR. Sci Rep. 2017;7(1):5301. doi: 10.1038/s41598-017-05728-9, PMID 28706185.