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Review Article

Artificial intelligence in dental practice: a review

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ABSTRACT

The human brain is a distinctly complex structure with several interlinked neurons that transmit signals all over the body. The search for an excellent model mimicking the human mind has led to a sophisticated breakthrough in what's referred to as artificial intelligence (AI). AI methodologies have determined programs in numerous disciplines ranging from telecommunication, aerospace, robotics, medical analysis, alternate marketplace, law, science, or entertainment to name some. Medical clinical decision support system (CDSS), a factor of AI is being carried out in dentistry which includes Artificial neural networks (ANN), genetic algorithms (GA) and Fuzzy logic. Various fields of drugs such as diagnostic systems, biomedical analysis, image analysis, and drug development have utilized this complicated and tremendously advanced detail of AI. The AI systems along with virtual reality have been used now not handiest to lessen dental anxiety but also to appear as an effective tool for the non-pharmacological manipulation of pain. Ordinary, AI offers us a glimpse of the destiny tool to be able to assist dentists in an inconceivable manner.

Keywords: Artificial intelligence, Dentistry, Diagnosis, Oral diseases

INTRODUCTION

In today's world, technology is developing very rapidly, and we are getting in contact with unique new technologies day by day. Right here, one of the booming technologies of computer science is Artificial Intelligence which is prepared to create a brand new revolution within the global with the aid of making wise machines.

A machine can now carry out duties that can only be completed by humans thanks to artificial intelligence (AI), a rapidly evolving technology. It is thriving in healthcare, where conventional dentistry is transforming into digital dentistry over time.

AI has the ability to dramatically increase diagnosis accuracy and completely transform the healthcare industry. Computer-based diagnosis is gaining popularity because it can find and identify lesions that are invisible to the human eye, opening the door to a holistic practice.

AI research started in 1943, but John McCarthy first used the word 'artificial intelligence' in 1956 at a conference in Dartmout. John McCarthy, who is credited as being the father of artificial intelligence, defines it as 'the science and engineering of creating intelligent machines, especially intelligent computer programs. It makes it possible for people to combine human intelligence with computer technology to increase the healthcare sector's potential for improved patient care.[1]

Since AI offers significant advantages to both dental clinics and patients, we can anticipate seeing it have a growing effect on dentistry in the future as the technology develops quickly.

Personalized medicine, personalized therapeutic protocols, patient monitoring, and the prediction and tracking of epidemiological disease transmission are just a few of the choices that physicians are using AI solutions to assist them. Analytics for patient outcomes is just one of the main uses of AI in the field of health care.

Therefore, the goal of this review article is to concentrate on AI working principle, application of AI in dental practice with recent advances, societal impact arising from these developments.

WORKING PRINCIPLE

Techniques of AI applied in dentistry Artificial neural network (ANN), Clinical decision support system (CDSS)**,** Fuzzy logic**,** Deep learning (DL), and Machine learning (ML).

Artificial neural network

Artificial neural networks (ANNs) are data processing systems that draw inspiration from the analytical functions of the human brain. A lot of complex real-world problems are solved with ANN.

AI in the form of ANN has been widely used to evaluate the level of cancerous activity and has impressively supported the development of novel approaches to predict the course of the disease and prognosis, thereby offering prospective recommendations for treatment modalities.

Clinical decision support systems (CDSS) are one example of how AI application technology is developing rapidly in the field of dentistry. A health professional receives skilled assistance via CDSS. Moreover, these systems are capable of resolving issues that are beyond complicated for traditional approaches. Moreover, CDSS offers dental professionals useful data that enables them to deliver better and quicker oral health outcomes.

A dynamic knowledge base and an inferencing mechanism are the fundamental elements of a CDSS, and they are implemented using medical logic modules built on a language like Arden syntax.

These systems assess patient data using embedded clinical knowledge to make recommendations about the diagnosis, avoidance, and treatment of orofacial diseases.

Fuzzy logic

A fuzzy logic system (FLS) is the nonlinear mapping of an input data set to an output data set that is represented as a scalar value.

Fuzzy logic's capacity to introduce linguistic words into the decision-making process that is simpler for human users to grasp and interact with is a significant benefit that can be used to justify its usage in medicine.

The fuzzifier, rules inference engine, defuzzifier, and the FLS itself are its four key components. It is used to determine the accuracy of diagnostic tests, forecast mouth cancer risk, and diagnose oral cancer.[7]

Deep learning

Deep learning (DL) is a branch of representation learning that learns representations of data with numerous layers of abstraction by using multiple processing layers (thus, deep). With a hierarchical framework, this algorithm employs numerous layers to recognize everything from straightforward elements like line, edge, and texture to complicated forms, lesions, or entire organs.[6]

DLS will significantly help reduce the tremendous strain on radiologists and doctors in areas like molecular imaging for cancer early diagnosis. Can assess oral cancer metastases to the cervical lymph nodes.

Machine learning

Machine learning (ML) is the scientific study of statistical models and algorithms that can process a wide range of data without the need for human rule-making or prior knowledge. ML algorithms can be classified as either supervised or unsupervised learners.

The process of data analysis is laborious due to the enormous amount of data that healthcare service providers collect. ML aids in efficiently processing the data and producing insights that can be put to use. Also, several dental applications, such as automating clinical workflow and using ML for disease detection, prognosis, and therapy, can profit from them.[7]

APPLICATION OF AI IN DENTAL PRACTICE

AI has made widespread development inside the numerous disciplines of medical and dental specialities. With the latest improvement of AI technologies designed for dental practitioners, dental clinicians make particular diagnoses and provide accurate guidelines. Figure 1 indicates the areas inside the dentistry where AI can be used followed by a detailed description of AI applications in dental practice.

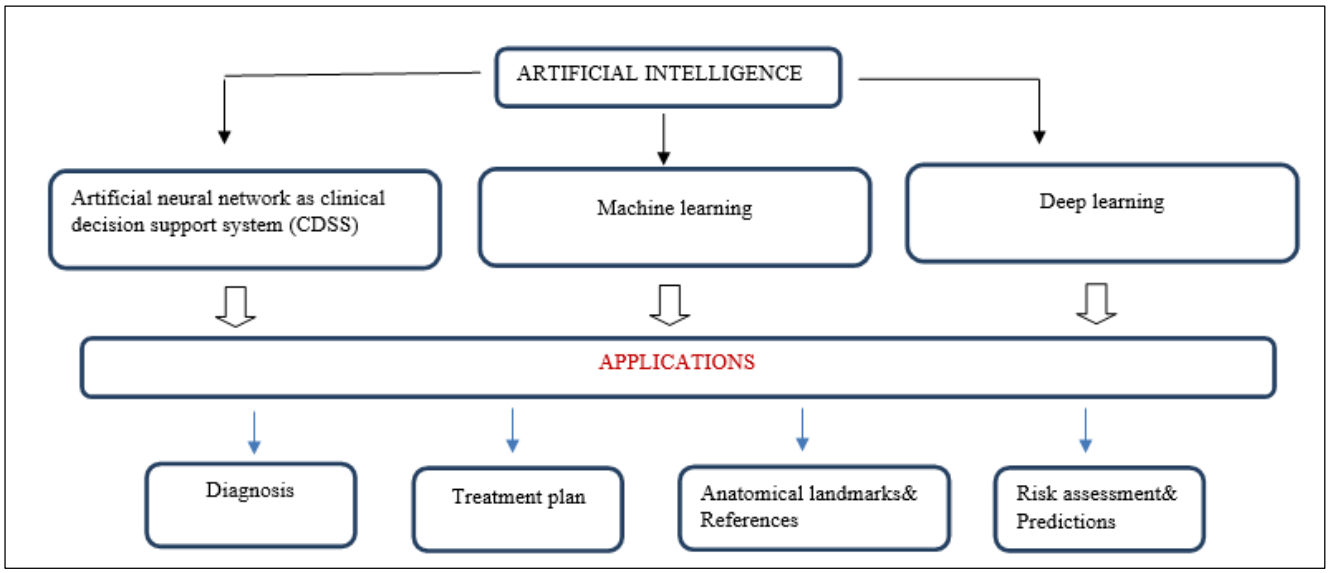

Figure 1: Flowchart representing application of AI in various branches of dentistry.

ROLE OF AI IN DIAGNOSIS

Early diagnosis and detection of oral diseases are crucial in dental practice since it considerably improves prognosis. Early diagnosis often improves prognosis, and oral lesion identification and diagnosis are vital in dental practices. It is crucial to obtain an accurate diagnosis and give the patient the proper therapy because some oral lesions might be precancerous or cancerous in nature.[2]

When diagnosing and treating oral diseases and malignancies, artificial intelligence can be a very helpful tool. This cutting-edge technology also allows for the screening and classification of altered mucosa undergoing premalignant and malignant alterations. It can be combined with other imaging techniques like CBCT and MRI to spot minute deviations from the normal that the human eye might miss.[1]

Making an accurate diagnosis and providing the patient with the proper care is essential due to the possibility that some oral lesions could be precancerous or cancerous.

The use of CNN in the diagnosis of head and neck cancer lesions has proven to be quite beneficial. It offers a great deal of potential for finding tumors on radiographs or in tissue samples.

The ANN may also help in creating a treatment regimen by identifying and classifying individuals who are at high risk of developing oral cancer or pre-cancer.[3]

Diagnosis of dental caries

The Logicon caries detector helps find proximal caries (Figure 2), and an AI system helps find tiny apical foramina, improving the accuracy of measuring working length.[8] With CBCT pictures of endodontically treated and intact teeth, it can even identify vertical root fractures.

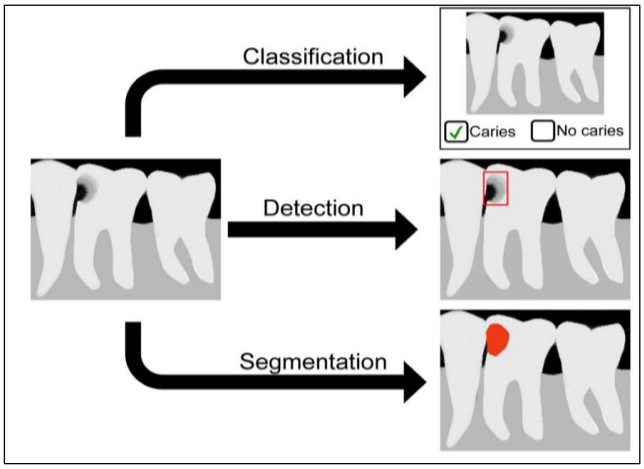

Figure 2: Representing AI-based caries detection.[17]

ROLE OF AI IN TREATMENT

One of the most important uses of AI in oral and maxillofacial surgery is the introduction of robotic surgery. Robotic surgery simulates human body motion and intelligence, which helps the surgeon design surgeries with shorter operation times and higher intra operative precision while also protecting the key structures nearby to the tiniest detail before the real surgery. AI is crucial in determining the type of bone and cortical thickness to create accurate surgical guides for pacemaker implants. A further development in this area is the use of CADCAM technology, which replaces the time-consuming and tedious process of conventional casting and produces 2D and 3D models, thereby eliminating human error.AI-based systems are also used to create crowns, bridges, onlays, inlays, and onlays.[1] RaPiD combines databases, knowledge-based systems, and computer-aided design by using a logic-based representation as a unifying framework. Cone-beam computed tomography (CBCT) has emerged as the gold standard for reducing treatment

failures caused by morphological variation and optimizing the therapeutic results of endodontic therapy. The new advancement of pain control with AI devices is that injection-free pediatric practice is more useful. The AI-assisted aligners promise to shorten treatment times and simplify appointment schedules in addition to providing precise treatment execution and aiding in progress monitoring.[4]

ROLE OF AI IN ANATOMICAL LANDMARKS DETECTION

The degree of maxillary arch constriction, which can be impacted by a number of variables including timing and surgical procedure, is one important 'core' outcome measure of primary surgery of the palate and is used to assess facial and maxillary development. By analyzing the relationships between the dental arches, several scoring systems have been created to determine the degree of maxillary arch constriction.[9]

Accurate landmark identification is essential for the creation of automatic scoring software, and dental tissues are presently landmarked manually. Therefore, despite the possible advantages of 3D information capture, this new technology also brings about new challenges in terms of data capture, data manipulation, and labor and time efficiency. This is especially true when it is necessary to analyze numerous cases; despite its reliability, manual handling becomes impractical and challenging to complete .manual identification has been difficult to cross-compare and analyze due to errors like landmark inaccuracies and varying degrees of subjectivity from different experts. This emphasizes the significance of automatic land marking and automatic scoring software based on it and gives the creation of automated software tools based on automated landmark identification significant value.[10]

ROLE OF AI IN RISK ASSESSMENT

The risk of dental disease was discussed, and it was discovered that computerized risk assessment was superior to even the opinions of senior dental experts with extensive experience. Risk assessment entails identifying variables that increase risk in a particular situation and making judgments about how much of a contribution they make to the development of the disease. There is evidence from two independent studies by Persson et al. that risk assessments based on expert dentists' and periodontists' expert opinions differ too widely to be helpful in clinical periodontal decision-making.[11] The Periodontal risk calculator (PRC), an electronic instrument created by Dental Medicine International Inc. of Mount Vernon, Washington, in the United States, measures risk and forecasts periodontal deterioration. Based on algorithms that give relative weights to the various known risks that increase susceptibility to periodontitis, the system assesses some factors as possible risk factors for the disease. It assesses risk on a scale of 1 to 5 and produces recommended treatment options to direct the clinician and patient toward a risk-reduction-based healthcare strategy. The calculation of risk involves mathematical algorithms that use nine factors including the patient's age, smoking history, diagnosis of diabetes, history of periodontal surgery, pocket depths, furcation involvements, restorations or calculus below the gingival margin, bone height, and vertical bone loss. Its predictive algorithm was verified using a database of individuals with periodontitis. These factors combine to give each person a risk score for periodontal deterioration on a range of one to five.[12]

SUMMARY OFRELATED STUDIES FOR VARIOUS ARTIFICIAL INTELLIGENCE TECHNIQUES IN DENTAL PRACTICE (TABLE 1)

Societal impact of AI

It saves the time of both the practitioner as well as the patient. Logical and feasible choices without any involvement of human feelings which results in an accurate Analysis. It has a highly standardized system.

Limitation of AI

The control and sharing of clinical records are the most important demanding situations within the implementation of AI structures in health care. Personal records from patients are important for preliminary education of AI algorithms, in addition to ongoing education, validation, and improvement. Furthermore, the development of AI will aid in data sharing among different institutions and various countries. To integrate AI into scientific operations, systems should be adapted to protect affected person confidentiality and privacy.

Accordingly, before considering broader distribution, personal records will be anonymized. Regardless of the capability to take those precautions, there is doubtfulness in the healthcare network about data sharing. AI structures also are associated with safety problems. The quality of final results predictions carried out through AI systems is predicated closely on the accuracy of annotations and labeling of the dataset utilized in education. Poorly labeled information can result in bad outcomes. Thus limits the efficacy of the resultant AI systems. Moreover, healthcare experts should possess a high understanding of the decisions and predictions made by means of an AI tool, as well as the functionality to defend them.

Table 1: summary of related studies for various AI techniques in dental practice.

Target problem	AI technique	Author
Dental caries diagnosis	ANN as CDSS	Geetha et al[13]
Teeth extraction	Machine learning	Suhail et al[14]

Continued.

Target problem	AI technique	Author
Cephalometric Landmarks	Deep learning	Song et al[15]
Periodontitis risk assessment	ANN as CDSS	Shankarapillai et al[16]
Temporomandibular disorders	Machine learning	Orhan et al[18]
Distal root assessment	Deep learning	Hiraiwa et al[19]
Vertical root fracture	ANN as CDSS	Kositbowornchai et al[20]
Maxillary structure assessment	Machine learning	Chenet al[21]
Bone recession and inter radicular radiolucency	Deep learning	Khan et al[22]
Differential orthodontic diagnosis	Deep learning	Lee et al[23]

CONCLUSION

The mortality of patients suffering from various diseases has increased in the majority of countries due to a lack of medical and dental experts. Artificial intelligence applications in healthcare and dentistry could cut down on costs, wait times, human error, and human knowledge. The use of this technological innovation in dental practice is expanding quickly and should help to lower the morbidity and mortality of oral and maxillofacial diseases, which will ultimately lead to better patient care. To sum up, AI is not hype; rather, it is dentistry's future. It has improved clinical evaluation and decision-making abilities in a number of dental tasks.

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