Review Article

Artificial Intelligence in Dentistry: A Review

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ABSTRACT

Artificial Intelligence (AI) is a fast-growing technology that allows machines to do tasks that usually need human intelligence, like making decisions and predictions. Although AI was first introduced in the 1950s, its real-world use has become more common in the last 20 years, making many tasks easier. In healthcare and dentistry, AI is now helping improve the accuracy of medical images, detect diseases, and predict treatment results, leading to better patient care and simpler procedures. This abstract highlights how AI is being used in dentistry and how it can help dental professionals work more efficiently while improving patient outcomes.

Keywords: Artificial intelligence, Dentistry, patient care

INTRODUCTION

Artificial Intelligence (AI), a swiftly advancing technology empowers machines to execute tasks traditionally requiring human intelligence. By mimicking human intelligence, AI can undertake complex prediction and decision-making processes in various sectors, including healthcare. Although the concept of AI dates to 1950s, its practical application only emerged in the past two decades. [1,2] Owing to the rapid advancement in technology, AI has significantly enhanced more convenience in people's lives and has been widely incorporated into various sectors. In the field of medicine and Dentistry, AI plays a major role in accurate medical and diagnostic imaging thereby improving the patient care. Currently, its application in dentistry aids in identifying both normal and abnormal structures, detecting diseases, and predicting treatment results, all of which contribute to better patient care thereby making the physician's work easier. Also, it offers healthcare benefits by decreasing the post-operative complications thereby decreasing the number of complex procedures which in turn improves the quality of life. [2,3] Hereby, this gives an overview about the applications of AI in dentistry and also aims to make the dental professionals understand that use of AI seems to be a valuable tool in assisting their routine work with improved efficiency.

HISTORICAL BACKGROUND:

History of AI traces back to Alan Turing's concept in 1950's, where he considered much on machine thinking, suggesting that machines could make decisions using available information and inference. In 1955, John McCarthy and Marvin Minsky proposed the idea, although it remained theoretical. Between 1957 and 1974, AI flourished experiencing rapid growth due to advances in computers and accessibility,

along with the development of AI algorithms such as ELIZA, which is capable of interpreting spoken language and solve problems. However, in mid 1970s and 1980s there were setbacks known as "AI winters." Despite this by 1980, AI had progressed along two paths: machine learning and expert systems. [3,4,8] Machine learning involves learning from experience, while expert systems simulate human decision-making processes. In 2012, deep learning networks like GPV with eight layers were developed, followed by SCNET and Google AlphaGo in 2017.Finally, in 2022, ChatGPT emerged as a text-generation model capable of generating human-like responses based on input text.
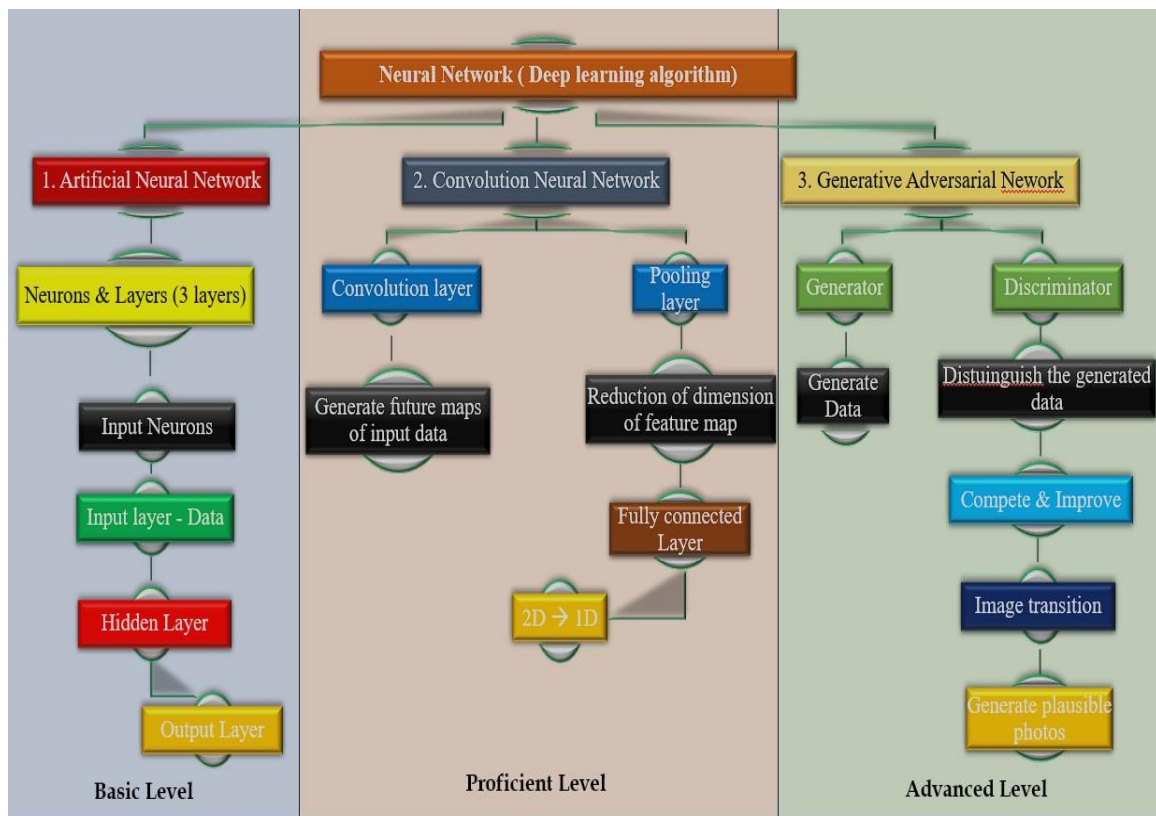
WHAT IS ARTIFICIAL INTELLIGENCE?

Artificial intelligence, a rapidly evolving technology that imitates human thinking abilities and has caught the attention of scientists worldwide. Strongly interconnected neurons which makeup the neural network in AI mirrors the intelligence and thoughts of humans thereby acting as a data processing hub to address an issue effectively simulating human cognitive abilities [7,8]

KEY ELEMENTS OF AI

Machine Learning: Machines acquires the available data and resolves the problem by itself without human intervention.

Deep Learning: Analyses huge amount of data and has numerous computational layers which create the neural network thereby identifies the pattern on its own and gives the final output. [7,8]

AND SO HOW DOES THE AI WORK IN DENTISTRY?

Artificial intelligence, also referred to as machine intelligence, operates similarly to machines with human-like intelligence. It

has three layers with the input, hidden and an output layer. In dentistry, the input layer is fed with data which may be in the form of voice (Sound of handpiece)/text (Medical or dental treatment records)/an image.
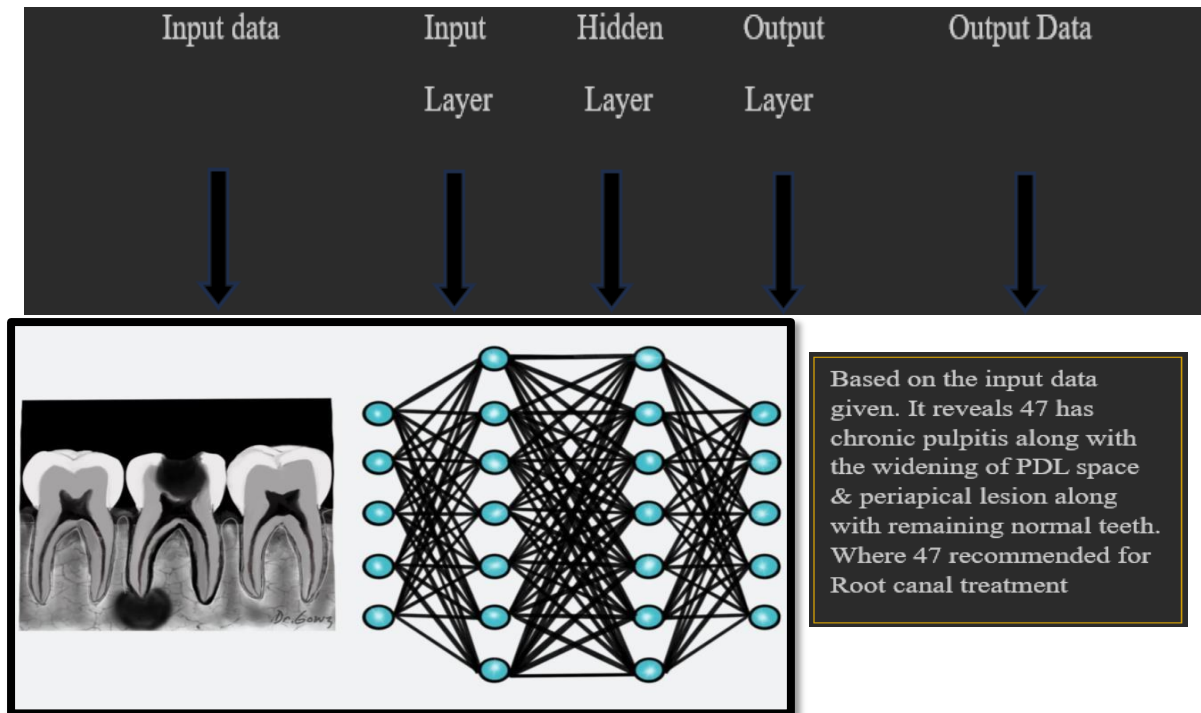
ARTICIAL INTELLIGENCE IN DENTISTRY:

As in other fields, application of Artificial intelligence in dentistry started to bloom over the recent years. A game changer in every aspect of oral health care from providing an accurate diagnosis to personalized treatment plans and empowering the dental professionals to offer a better care for the patients than ever before. From analysing the dental images to streamlining the administrative tasks, it is reshaping the way dentistry was practiced. As AI continues to develop, its integration in this field promises to benefit both the clinicians and the patients with superior care and tries to simplifies the complicated procedures thereby providing a predictable outcome. Well trained AI systems have the ability to detect the normal and abnormal structures, identify pathologies and anomalies including dental caries, periapical lesions and maxillofacial abnormalities in less time with more accuracy and efficiency than the specialized dentist. This not only guarantees an accurate diagnosis but also provides a better treatment outcome. [8,9]

IN PERIODONTICS

Periodontitis is one of the most prevalent oral health issues which when not treated earlier can lead to tooth mobility eventually leading to tooth loss. In order to prevent the spread of periodontitis and tooth loss, it is necessary to detect the disease as soon as possible and an effective earlier intervention is needed. In clinical practices, this diagnosis is usually based on evaluating the recession and probing depth. However, this evaluation has low reliability and is still based on the dentist experience and sometimes may miss to detect the disease at the earliest stage. Some innovative methods which have revolutionized the field of dentistry: digital imaging, intraoral cameras, artificial intelligence Algorithms have been developed recently to aid in early detection of the disease and prevents the spread of the disease further. Artificial intelligence algorithms can recognize the patterns and indicators of the disease with large datasets available by analysing the radiographs and identifying the minor changes in bone and periodontal tissue. AI algorithms can help identify subtle changes that might be missed by human observation alone, aiding in early diagnosis and treatment planning.

Henceforth, incorporating these technologies into practice, dentists can improve their ability to detect the disease early and intervene promptly thereby preserving the patient's oral health by reducing the mobility and tooth loss. [10]

IN PROSTHODONTICS:

Integrating AI with CAD CAM Systems and 3D printing, it has indeed streamlined the fabrication process, leading to a higher efficiency and better outcomes for the patients. the use of AI, such as RaPid, in Prosthodontics offers numerous benefits. By considering anthropological dimensions, patient preferences and facial dimensions, AI can assist in creating prosthesis that not only fit well but also enhance the patient's aesthetics. Matching the exact shade for the patient's restoration is crucial for achieving optimal esthetics, AI can play a significant role in this aspect as well. The integration of AI not only improves the workflow but also ensures that the final restorations meet the highest standards of esthetics, function and fit. With AI -guided design assistance, prosthodontists can deliver tailored solutions that cater to each patient's unique needs and preferences. [7,8,9,10]

IN IMPLANTOLOGY

By integrating AI algorithms with the intraoral scan and Cone beam Computed tomography, Clinicians can the number of complications and increasing the success rate of implants. Overall, the synergy between AI and dental implant procedure holds a great promise in improving the patient care and advancing the field of dentistry.

IN OPERATIVE DENTISTRY AND ENDODONTICS:
Morphology and Canals:

To minimize the failures related to the morphology and have a favourable clinical outcome of the root canal therapy, CBCT remains the gold standard option. But, because of its higher dose of radiation than the Conventional Periapical radiographs, it is not been used routinely. With the advent of AI and using CNN network, it analyses the fed data and determines the exact morphology and the number of canals in a tooth thereby assisting the endodontist in a better way to have a desirable outcome. [7,8,9,10]

Periapical lesions:

With the Use of AI and CNN model, early detection of the periapical lesion is possible which can prevent the spread of it to the supporting structures thereby providing and increases the efficacy of the treatment.

Determination of Working length:

Determining the accurate working length is crucially important for a successful root canal treatment. Conventionally, IOPA is been used routinely to assess the approximate working length but with the newer methods -Electronic apex locator, digital tactile sense and CBCT imaging, accuracy have improved. And with the Use of AI and the ANN, accuracy of working length determination can still be improved further and it can be considered as a second opinion to locate the apical foramen.

Root canal fractures:

Using AI, the data from the various periapical radiographs and CBCT images were used to create a deep learning network to identify the root fractures. With the early diagnosis of the root fracture in both root canal treated and an intact tooth case, an effective treatment can be made leading to a better prognosis. Henceforth, with the use of AI in Operative dentistry and Endodontics, dentist can provide an efficient treatment with a much better outcomes.

IN ORTHODONTICS:

With the use of Artificial intelligence systems, simulating the pre and post operative changes in the appearance of patient with the skeletal patterns, anatomical landmarks of cephalograms clearly seen allowing a great communication between the patient and dentists providing an

effective patient care. Whether extraction / surgery is needed or not for any particular case can also be predicted with ANN model. Virtual models and 3D scans allow orthodontists to create accurate representations of the patient's teeth, which can be used to design and fabricate custom aligners using 3D printing technology. This process is often faster and more convenient for both patients and orthodontists compared to traditional braces. AI algorithms can analyse the vast amount of data generated by these scans to determine the optimal treatment plan for each patient. By calculating the precise amount of pressure needed to move the teeth and predicting how they will respond to treatment, AI can significantly shorten treatment times and streamline appointment schedules. This not only improves the overall efficiency of orthodontic treatment but also enhances the precision and effectiveness of the results. [7,8,9,10]

IN ORAL AND MAXILLOFACIAL SURGERY:

It's fascinating to see how AI and robotic technologies have revolutionized the field of surgery. Thanks to AI. With the AI-guided procedures, surgeons can achieve greater precision and accuracy, especially in delicate operations like implant placement, tumour removal and biopsies. The ability to use AI for image guidance enhances surgical outcomes by providing real-time insights and improves the accuracy rate compared to traditional freehand procedures. Moreover, AI-powered systems can reduce operational time, making surgeries more efficient while minimizing risks to patients. This combination of advanced technology and medical expertise is truly transforming the way surgeries are performed, ultimately leading to better patient outcomes.

IN FORENSIC ODONTOLOGY:

Artificial intelligence in forensic medicine is used for determining gender and biological age, as well as analysing bite marks and mandible morphology. AI algorithms analyse the large datasets of skeletal features and bite mark patterns available to assist forensic experts in making more accurate assessments thereby help automate and streamline the process, potentially improving the efficiency and accuracy of forensic analyses. [7,8,9,10]

IN ORAL AND MAXILLOFACIAL PATHOLOGY:

AI integrated with the CNN networks is found to be one of the most valuable tools in detecting the lesion based on the radiographic, ultrasound and microscopic images as early as possible and also detects whether it is benign or malignant in a short span of time thereby providing a better predictable outcome. [7,8,9,10]

CONCLUSION

AI indeed has the potential to revolutionize dentistry, offering tools for diagnostics, treatment planning, and even patient management. However, the human touch remains irreplaceable in the field of medicine and dentistry. Dentists bring not only technical expertise but also empathy, understanding, and the ability to personalize care to each patient's needs. AI can enhance their capabilities, but it cannot replace the human connection and intuition that dentists provide. Therefore, rather than viewing AI as a substitute for dentists, it should be seen as a valuable tool to support and enhance their capabilities, ultimately leading to better patient care and experiences. [7,8,9,10]

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