TPM Vol. 32, No. S5, 2025
ISSN: 1972-6325
https://www.tpmap.org/

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THE ROLE OF ARTIFICIAL INTELLIGENCE IN DENTOMAXILLOFACIAL RADIOLOGY – A NARRATIVE REVIEW

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ABSTRACT:
Artificial intelligence (AI) is the ability of a machine to mimic human behaviour and intelligence in order to carry out particular tasks.[1] Intelligence is the explicit capacity to find solutions to particular issues as well as the intrinsic capacity to discover answers to novel challenges and hence AI is defined as an artificial set-up that is able to learn new problem-solving techniques and solve existing ones. This implies that the object must be able to sense its surroundings , search for patterns and recognize them, plan and carry out an appropriate course of action, and use reasoning skills to derive general principles.[2]This review is focused on the use of artificial intelligence in the field of dentomaxillofacial radiology.
KEY WORDS: Artificial intelligence, maxillofacial, radiology

INTRODUCTION:

Numerous artificial intelligence (AI) technologies, like virtual assistants, picture recognition, and online search engines, have made people's lives easier and enhanced their quality of life. AI development and application have also surfaced in the medical domain. In order to help clinicians with disease diagnosis and detection, picture analysis, and treatment outcome analysis, a number of AI tasks have been developed.[3] By reducing errors in routine practice and providing better diagnostic tools, AI technology may enhance patient care.
Although it was formerly thought of as a sci-fi fantasy for the far future, artificial intelligence is now slowly becoming a reality in a variety of fields, including the dental and medical fields. Recently, artificial intelligence has been specifically used to radiographic pictures in the dental industry, particularly in dentomaxillofacial radiology.
Artificial intelligence is slowly but surely encroaching on every part of our life through a variety of convenient devices, like content recommendation systems and speakers powered by AI. The development of deep learning also presents intriguing opportunities for automating the examination of medical and dental images. Significant progress has been made in every field of artificial intelligence, including data mining, robotic systems, natural language processing, and medical picture analysis.

HISTORICAL BACKGROUND OF AI IN IMAGING:

The notion of applying artificial intelligence to imaging dates back to the 1960s. After computers proved successful in other areas of science and business, researchers in radiology tried to take advantage of their “unique and crucial power to preserve large sets of facts and comprehensive set of guidelines explaining how to use these facts to produce a statistically weighted

response".[4] That being said, the possibility of computerized picture interpretation was recognized long before the vision matched the technology.

During a summer workshop, held at Dartmouth in 1956, artificial intelligence emerged and it led to the discovery of various important study topics, including as theory, neural networks, and natural language processing, computational issues, as well as other interesting subjects.[5] Yet, artificial intelligence faced several difficulties in spite of the hope had by those who founded this science.

A period of decreased funding and interest in artificial intelligence known as the "artificial intelligence winter" occurred between 1974 and 1980 and 1987 and 1993. This downturn was partly caused by the conflict between the unreasonably high expectations placed on artificial intelligence systems and the constraints of the time regarding the availability of data and the processing power needed to solve complicated problems.[6]The various aspects of artificial intelligence include deep learning, neural network and machine learning.

NEED FOR DEEP LEARNING IN TODAY'S REASEARCH AND APPLICATIONS:

Due to their superior capacity for learning from past data, deep learning techniques can be extremely useful in the development of intelligent data-driven systems that meet current needs. As a result, DL's automation capabilities and capacity for experience-based learning have the potential to transform both the world and the daily lives of humans. Thus, DL technology is pertinent to well-known fields in computer science, especially modern intelligent computing, such as artificial intelligence [7] , machine learning , and data science with advanced analytics. [8]

ASPECTS OF ARTIFICIAL INTELLIGENCE:

Real-world problems, data are dynamic and vary, developing a suitable deep learning model is a difficult undertaking. Furthermore, the absence of fundamental knowledge renders deep learning techniques, impeding standard development.

Due to the development of numerous effective learning techniques and network architectures, neural networks gained popularity in the fields of artificial intelligence (AI) and machine learning (ML) in the late 1980s [9]. Such novel techniques included self-organizing maps, radial basis function networks, and multilayer perceptron networks trained by "Backpropagation" type algorithms [10,11,12].

ROLE OF AI IN MEDICAL IMAGING:

AI has made its way into the field of medical radiography, bringing with it novel approaches to picture interpretation, analysis, and diagnosis. A remarkable capacity for analysis, as evidenced by the growing number of imaging studies and the requirement for prompt, precise interpretations in emergency situations.[13]

AI has a significant impact on medical radiography, particularly in the areas of illness detection and characterization. For example, artificial intelligence models have been created to identify pulmonary abnormalities in chest X-rays, which are among the most frequently performed radiographic exams. These AI algorithms are frequently able to recognize characteristics that are suggestive of diseases like lung cancer, pneumonia, and tuberculosis with an accuracy that is on par with or better than that of skilled radiologists. Prognosis and treatment planning are additional functions of AI in addition to diagnosis. AI systems are used in oncology, for example, to evaluate radiographic pictures and identify the size, volume, and form of tumours—information that is essential for cancer staging and treatment planning. By anticipating the way, a tumour will react to therapy, AI-driven technologies also support personalized medicine. This use of AI in medical radiography heralds a move in the direction of more patient-centred approaches to healthcare, where choices are guided by in-depth, data-driven insights.[14]A number of issues are brought up by integrating AI into medical radiography, including the need for reliable datasets for AI model training.

ROLE OF AI IN DENTAL IMAGING:

Artificial intelligence plays a major role in dental diagnosis and it has various applications such as detection of dental caries, in cephalometric analysis, periodontal bone loss , diagnosis of oral lesions. Since it is an emerging field, it can be applied in other dental diagnosis.

Research have demonstrated that digital tooth charting can be finished using AI in conjunction with dental radiographs. While tooth charting is based on the extraction of parameters like the width/height ratio of teeth or the size of the crown, tooth detection can be accomplished by pixel-level segmentation techniques.(15)

IN DETECTION OF DENTAL CARIES:

Dental caries is the most common cause of pain in the patients when it involves the pulpal portion. AI in the detection of dental caries has three major divisions such as classification, detection and segmentation.AI can offer extra capacity to identify some pathologies that are occasionally missed by human eyes on radiographs because of picture noise and/or low contrast, such as proximal caries and periapical pathologies.[16]

IN CEPHALOMETRIC ANALYSIS:

Skeletal relation categorization and automated cephalometric anatomical landmarks are two areas where AI technology has been used. Cephalometric imaging analysis is commonly used in dental clinics for examining the skeletal anatomy of the human skull for treatment planning and evaluating treatment outcome. [17]

Artificial intelligence (AI) algorithms have been created to measure or analyze anatomical landmarks on cephalograms in addition to identifying them. Using knowledge-based algorithms, Gupta et al. (2015) created an AI model that can do automatic cephalometric measurement. The results indicated that there was no discernible difference between the automatic and manual measurements.[18,19]

IN DENTAL IMPLANT PROCEDURES:

Dental implants have developed into a common procedure used to restore lost teeth. Mechanical and biological difficulties can arise even though dental implant treatment has been shown to be successful in the long run, with over 90% of cases having a survival rate of more than 10 years. Finding the appropriate implant system is crucial for repairing the current implant when an implant fails and information on the implant system is unavailable.Based on dental radiographic images, CNN is shown a high degree of effectiveness in categorizing various implant system types with comparable forms.

IN ROOT FRACTURES:

CBCT and artificial intelligence (AI) tools like ML, CNN, and PNN have the potential to increase diagnostic precision. Johari et al.'s first model for VRF detection was created using removed teeth [20]. The limitations of this study included the use of sound removed teeth without any models of the related structures. Hu et al[21]conducted more in-vivo research using CBCT pictures. The model attained an accuracy, sensitivity, and specificity of greater than 90% and demonstrated good diagnostic accuracy. But the training database contained only teeth that had not received endodontic treatment.

IN ORAL LESIONS:

AI plays a major role in the diagnosis of various oral lesions including radicular cysts , dentigerous cysts and amelobalstoma. Various dental softwares have been programmed to diagnose the condition. Recent studies are ongoing in the diagnosis of oral cancer .

CONCLUSION:

AI has developed quickly in a number of medical domains and has recently drawn interest, especially from the radiology community. Thus far, artificial intelligence (AI) in dental radiography has demonstrated significant promise for a range of uses and could be crucial in supporting clinicians during the decision-making process. However, before being used in clinical routine, AI in dental imaging needs to be significantly improved upon as it is currently not developed to a sufficient level of maturity. To better coordinate the study design and increase the influence of AI development worldwide, future AI research in dental radiography should engage interdisciplinary researchers and adhere to reporting format criteria.

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