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Electric Brain Extending its Help in Periodontics

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Abstract: ***Artificial intelligence is intelligence perceiving, synthesizing, and inferring information demonstrated by machines, as opposed to intelligence displayed by non - human animals and humans. At its simplest form, artificial intelligence is a field, which combines computer science and robust datasets, to enable problem - solving. It also encompasses sub - fields of machine learning and deep learning, which are frequently mentioned in conjunction with artificial intelligence. AI is the ability of a machine to display human - like capabilities such as reasoning, learning, planning and creativity. AI enables technical systems to perceive their environment, deal with what they perceive, solve problems and act to achieve a specific goal. Dental practitioners can identify AI as a supplemental tool to reduce their workload and improve precision and accuracy in diagnosis, decision - making, treatment planning, prediction of treatment outcomes, and disease prognosis.***

Keywords: Artificial Intelligence, Periodontitis, Bone loss, Neural Network

1. Introduction

Artificial intelligence is intelligence perceiving, synthesizing, and inferring information demonstrated by machines, as opposed to intelligence displayed by non - human animals and humans. At its simplest form, artificial intelligence is a field, which combines computer science and robust datasets, to enable problem - solving.1It also encompasses sub - fields of machine learning and deep learning, which are frequently mentioned in conjunction with artificial intelligence. AI is the ability of a machine to display human - like capabilities such as reasoning, learning, planning and creativity. AI enables technical systems to perceive their environment, deal with what they perceive, solve problems and act to achieve a specific goal. AI facilitates the creation of a next - generation workplace that thrives on seamless collaboration between enterprise system and individuals. Therefore, human resources are not made obsolete, but rather, their efforts are bolstered by emerging tech. In fact, AI provides organisations with the luxury of freeing up resources for higher - level tasks.2

The following are the primary advantages of AI:

- AI drives down the time taken to perform a task. It enables multi - tasking and eases the workload for existing resources.
- AI enables the execution of hitherto complex tasks without significant cost outlays.
- AI operates 24x7 without interruption or breaks and has no downtime
- AI augments the capabilities of differently abled individuals
- AI has mass market potential, it can be deployed across industries.
- AI facilitates decision - making by making the process faster and smarter.[3]

4 main types of artificial intelligence

- Reactive machines. Reactive machines are AI systems that have no memory and are task specific, meaning that an input always delivers the same output.
- Limited memory. The next type of AI in its evolution is limited memory.
- Theory of mind.
- Self - awareness.[4]

2. Background

The British mathematician Alan Turing (1950) was one of the founders of modern computer science and AI. He defined intelligent behaviour in a computer as the ability to achieve human - level performance in cognitive tasks, this later became popular as the 'Turing test'. Since the middle of the last century, researchers have explored the potential applications of intelligent techniques in every field of medicine.5The application of AI technology in the field of surgery was first successively investigated by Gunn in 1976, when he explored the possibility of diagnosing acute abdominal pain with computer analysis. AI can automate administrative tasks, like pre - authorizing insurance, following - up on unpaid bills, and maintaining records, to ease the workload of healthcare professionals and ultimately save them money. Artificial neural networks (ANNs) are inspired by the functionality of the electro - chemical neural networks found in human (and animal) brains.6 The working of the brain remains somewhat mysterious, although it has long been known that signals from stimuli are transmitted and altered as they pass through complex networks of neurons. In an ANN, inputs are passed through a network, generating outputs that are interpreted as responses. If we compare the actual output of an ANN to the desired output as reported in the labelled data, the difference between the two is described as the error. Back propagation and gradient descent improve the ANN's performance by using calculus to gradually minimise this error. Back propagation deals with adjusting the neurons in the ANN. The process starts with an input signal passing through the ANN and generating an output signal.7This is compared to what it should have been – according to the labelled data – to calculate the error. Now, calculus is used to generate an error signal which passes backwards through the ANN, making changes to neurons so that it gives an output with a lower error. It starts with the output layer, which has a stronger impact on the result, and then moves back through the hidden layer (s) to make deeper changes. In this sense, back propagation takes the error and propagates it backwards through the ANN. In future, new approaches to AI could emerge that differ substantially from the symbolic

and data - driven waves described so far. Three key concepts regularly emerge in discussions of future AI. First, artificial general intelligence (AGI), which refers to AI that is not limited to specific domains, but performs intelligently in a wide range of contexts and problem spaces. The second is artificial super intelligence (ASI), which refers to AI with higher levels of general intelligence than typical humans. The third is singularity which, in this context, refers to the moment where AI becomes intelligent and autonomous enough to generate even more intelligent and autonomous AI. The following sections explore some possible future development paths for AI technology that remain beyond today's capabilities but might lead to better AI, if not towards AGI, ASI or even singularity. Artificially intelligent computer systems are used extensively in medical sciences. Common applications include diagnosing patients, end - to - end drug discovery and development, improving communication between physician and patient, transcribing medical documents, such as prescriptions, and remotely treating patients.[8]

Application in Periodontics

A subset of ANNs, a convolutional neural network (CNN), is specifically designed for handling imaging data. The CNN concept was developed to replicate the visual cortex and differentiate patterns in an image. Classic neural networks typically need to consider each pixel individually to process an image and therefore are heavily constrained in the size of the images that can be analysed. CNNs, on the other hand, are capable of working with the image data in their spatial layout; their output is a new set of data replicating the original layout of the image while increasing or condensing the information stored at each location. This process is similar to applying several digital filters to an image to 'highlight' key features that will collectively help perform the task at hand, e. g., select distinct aspects of an object to identify its presence inside the image.[9]

CNN - based architectures will often have multiple layers, or multiple levels at which these transformations are applied. Early layers will focus on picking up gross content such as edges, gradient orientation, and colour, with later layers focusing on higher - level (more task specific) features. This kind of approach is usually called an encoder because the iconic information inside the image is transformed into a more abstract, symbolic representation, and this is achieved by juxtaposing CNN - based blocks that progressively reduce the size of the image being processed while, concurrently, increasing the number of the channels, i. e., the number of values associated with each image pixel. The complementary approach to an encoder is a decoder where the abstract information is transformed into an iconic representation by successively increasing the image size while reducing the channel number.1[0] A common pattern in ANN architectures based on CNN layers is to have an encoder section, a decoder section, or both; for instance, the U - Net architecture, which is one of the most used approaches when segmenting imaging data, is structured as an encoder section followed by a decoder section to achieve a transformation of the image information from iconic to abstract and then back to iconic while performing the task at hand. Previous systematic and scoping reviews in dentistry have highlighted the underuse of this tool and a lag for dental research in this area. However, with the total number of periodontal imaging papers alone now equalling the number of dental imaging papers in 2018, this lag is likely to have been overcome. This is unequivocally to the betterment of dental patient care when considering the benefits patients have enjoyed through similar endeavours in medicine.[11]

The advantage of a broad search is the volume of literature that is assessed. However, it must be noted that a significant portion of the literature was derived from technical standards, conference proceedings, and related materials on computer - science - oriented repositories rather than journal articles. This is advantageous for the authors because the time to publication can be significantly reduced by removing the requirement for peer or public review. This may suit the rapidly evolving world of computer science, where breakthroughs can occur at breakneck speed, but it is unclear if the intrinsic validity of these publications is reduced due to a lack of public/peer scrutiny. This literature is published by technical scientists and therefore reported differently to how clinicians might expect it. Periodontitis (PD), a multifactorial and complex inflammatory disease in tooth - supporting tissues, is categorized by the loss of periodontal tissue support. It is considered the second most prevalent oral disease globally (20–50%) and is the primary cause of tooth loss in adults. Though the microbial plaque biofilm initiates the process, progression is largely due to an exaggerated host immune - inflammatory response. It is a major public health problem with a significant impact on an individual's quality of life.[12]

Despite the latest advances in treatment modalities, there has not been a significant improvement in the methodology for detecting alveolar bone loss and assessing the severity of the bone loss in the compromised teeth. Radiographs, such as panoramic/periapical and bitewing radiographs as well as periodontal probing, are widely used as objective diagnostic tools for diagnosing and predicting periodontally compromised teeth (PCT). Clinical diagnostic and prognostic judgment depends greatly on empirical evidence.[13]

Artificial intelligence (AI) has primarily been used in dentistry to improve the accuracy and efficiency of diagnosis, which is critical to achieving the best outcomes for procedures, and provide superior patient care. AI approaches may be beneficial because they provide a more effective diagnostic process when combined with clinical assessment. Using image recognition, classification, and segmentation, AI may enhance dental efficiency. Convolutional neural networks (CNNs), the latest core model of artificial neural networks, and deep learning in computer vision include image recognition and segmentation, which can be used as a supplement to radiographs to detect periodontal disease. CNNs can detect edges and capture patterns in PCT images. Through their multiple convolutional and hidden layers, deep CNN algorithms can learn hierarchical feature representations and capture regional patterns from the PCT images. Deep learning analysis using radiographs can help in diagnosing and treatment planning of periodontal diseases by the early detection of periodontal changes bone loss, and changes in bone density and detection of peri - implantitis. This helps in

early intervention in implantology. Artificial neural network can also effectively be used in classifying patients into aggressive periodontitis and chronic periodontitis group based on their immune response profile.[14]

Apart from all of these AI applications, the most common and straightforward is our dental chair, which a dentist utilizes all day for his patients. The dental chair has undergone a significant transformation from a traditional hydraulic chair to an electrical and fully autonomous dental chair controlled by sensors. The most recent and extra improvement is a voice command operated dental chair that does not require the dentist to do any physical effort. When a dental chair can calculate a patient's weight, vital signs, and anxiety as the patient sits in the chair for treatment, that future is not far away.1[5]

3. Discussion

This is the world of the 21st century and we are dealing with so many ups and downs in this era. It is the generation, where people are filled with new innovative ideas. If they are suffering from something, at the same time they are also planning out new things to deal with such situations. Today, we are innovating so many new technologies to provide mental, physical as well as financial support to not only our nation but also worldwide.

With a glimmer of hope, scientists have come up with a very new technology, known as "artificial intelligence" to overcome the problems of doctors, dentists, and patients as well. Artificial intelligence is defined as "a field of science and engineering concerned with the computational comprehension which is commonly known as intelligent behavior, and with the creation of artifacts that show such behavior. " In the field of dentistry, AI is slowly nudging its head in radiology, orthodontic treatments, restorative and prosthetic dentistry, endodontics, implantology, and the recent addition being voice command dental chair without any physical input from doctor in the least.

The use of AI in clinical, medical, and dental practice is at an early stage of development and still in the investigation phase. Currently, AI based virtual dental assistants are available in the market, which can perform a number of simple tasks in the dental clinic with greater precision, less manpower, and fewer errors than human counterparts.

4. Conclusion

AI technologies can help professionals provide their patients with high - quality dental treatment. Dentists may employ AI systems as a supplemental tool to improve the precision of diagnosis, treatment planning, and treatment result prediction. New technologies are developed and adopted rapidly in the dental field. AI is among the most promising ones, with features such as high accuracy and efficiency if unbiased training data is used and an algorithm is properly trained. Dental practitioners can identify AI as a supplemental tool to reduce their workload and improve precision and accuracy in diagnosis, decision - making, treatment planning, prediction of treatment outcomes, and disease prognosis.

Conflicts of interests

Author has no conflicts of interest to report.

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