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Artificial Intelligence in Oral Medicine and Radiology

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Abstract

Artificial intelligence particularly the deep learning, is the cognitive function that mimics the activity of the human brain, and working of the human being. Dentistry has always accepted the new transformations in the field, with various technological advancements. The application of AI in oral and maxillofacial radiology includes the diagnosis, analysis of radiographs, and treatment of the various diseases.it could also be helpful in treating dental emergencies. While by no means AI can replace the human brain. It is an attempt to integrate the technology in human world. which could make work easy for clinician in an orderly manner. The outcome of the treatment can be improved. AI aims to provide an insight into various techniques, software's and their vast applications in the medical and dental field.

Keywords

Oral medicine; Radiology; Artificial intelligence

Introduction

Artificial intelligence which is sometimes called as machine intelligence, is the intelligence which is demonstrated by the machine or it is the stimulation of human intelligence in machines that are made and programmed accordingly to think and work like humans with utmost efficiency. It is used to reduce the working load on the humans with its precise working capabilities.

Artificial intelligence is composed of

1. Reasoning
2. Learning
3. Problems solving
4. Perception
5. Linguistic intelligence

Main focus of AI is towards understanding human behavior and performance.

Techniques of AI used in Oral Medicine and Radiology

1. ANN (ARTIFICIAL NEURAL NETWORK)
2. CNN (CONVOLUTIONAL NEURAL NETWORK)
3. PCA (PRINCIPAL COMPONENT ANALYSIS)
4. DATA MINING TECHNIQUE

ANN (Artificial Neural Network)

An artificial neural network (ANN)is an information processing paradigm that is inspired by the way biological nervous system such as brain processes information. ANN consists of multiple layers of simple processing elements called as neurons (perceptron). Neurons (perceptron) perform two functions namely, collection of input and generation of an output. These systems are now extensively used in assessing the degree of aggressive activity of cancer and has impressively supported to contrive unique approaches to predict the course of the disease and prognosis and thus providing the perspective suggestion to treatment modalities.

Two types of ANN are there

1. Most commonly used ANN formed is multilayer perceptron (MLP). This represents a feed forward network where in a layer of input perceptron connects to a number of hidden perceptron's followed by an output layer.
2. MLP has been shown to be a well-grounded vehicle for exploring the predictive potential of biomarkers for oral cancer [1].

CNN Convolutional Neural Network

Convolutional neural network (CNN) are analogous to traditional ANN in that they comprise of neurons

that self-optimize through learning. Each neuron will still receive an input and perform an operation (such as a scalar product followed by a non-linear function) and is the basis of countless ANN from the input raw image vector to the final output of the class score.

The only notable difference between ANN and CNN i.e.; CNN are primarily used in the field of pattern recognition within images. This allows us to encode image specific features making the network more suited for image focused task. It is being used extensively in the radiology sector. Cephalometric analysis, MRI, CBCT technique where CNN provide a healthy information by reading it in a simpler manner thus providing the essential information to the clinician regarding the anomalies and other clinical challenges [2].

Principle Component analysis (PCA)

(PCA) is a statistical technique that linearly transforms an original set of variables that represents most of the information in the original set of variables. In dentistry it is used in finding out the clinical features of the particular disease by ruling out the non-important clinical features. Laser induced fluorescence (LIF) spectroscopy and fluorescence is a non-invasive diagnostic tool mainly used to differentiate between thne normal and neoplastic oral lesions that involve illumination of tissue with non-chromatic light and recording the fluorescence spectrum [3].

Advantages

1. Fast results
2. Instruments are less costly
3. Can be acquired in small cities also
4. Helpful in early detection and diagnosis of malignancy

Data Mining Technique

1. It is the process of filtering, sorting and classifying data from larger datasets to reveal subtle pattern and relationships.
2. It is the technique which helps the clinician to identify and solve the complex diseases through data analysis.
3. It extracts information from data sets and converts into a decipherable structure for further use
4. Genetic based id3 algorithm is the simplest algorithm for diagnosis and prognosis of cancer [4].

Application of Artificial Intelligence in Dentistry

1. It can be used in diagnosis and prevention of oral cancer.
2. Use of artificial intelligence in oral and maxillofacial radiology(omfr).
3. AI in detection of dental caries.
4. Maintenance of records

Use in Diagnosis and Prevention of Oral Cancer

The global occurrence of oral cancer has increased in years. Oral cancer that is diagnosed in its advanced stages resulting in high rate of morbidity and mortality. Use of AI would be beneficial for early detection of cancer in its initial stages and thus would help the clinician to diagnose and plan the treatment accordingly. Global occurrence of oral cancer has increased with, high rate of oral squamous cell carcinoma counting for more than 90% of the oral cancers. WHO reported 529,000 new cases of oral cancer. And 300,000 deaths due to oral cancer each year. AI has potential to improve oral cancer screening.

Methods that are used in screening of oral cancers are traditional machine learning uses algorithm and computer processes to calculate information and recognize input data patterns to offer a quantified diagnostic result. Ml methods are divided into supervised and unsupervised. Deep learning or neural network are technique comprising of non-linear processing units with multiple layers to learn and understand input and associate output with the relevant input. Presently this technique is being assessed for more effective methods for diagnosis, especially for screening of diseases. AI can analyze a vast dataset of various imaging modalities, such as fluorescent, hyperspectral, endoscopic, cytological, histological, radiological clinical and infrared thermal modalities [6].

Use of Artificial Intelligence in Oral and Maxillofacial Radiology (OMFR)

OMFR is a specialty of dentistry which is mainly concerned with performance and interception of diagnostic imaging used for examination of the craniofacial, dental and adjacent structures. Digital radiographs have greatly enhanced the development of AI in dental and medical field. Radiograph produced by X-ray radiation are digitally coded and can be readily translated into computer language. Dental radiograph i.e. IOPA, Cephalogram, Panoramic Radiograph, are collected during routine dental practice for diagnosis, treatment planning and treatment evaluation.

In common radiology practice; radiologist visually examine and access and intercept the findings according to features of image. Sometimes it can be time consuming and subjective but in contrast A.I enables automatic recognition of complex patterns in imaging data and provide quantitative analysis. Studies have been done to enhance the radiographic studies. identification of anatomical land marks in children. A study was done to investigate the success and reliability of detection of maxillary and mandibular anatomic structures on Panoramic Radiographs using AI.

This study was carried out using 2-D can architectures in which total of 981 mixed images of pediatric patients for 9 different pediatric anatomical landmarks were studied:
Landmarks: Maxillary Sinus, Orbit, Mandibular Canal, Mental Foramen, Foramen Mandible, Incisor Mandible, Articular Eminence, Condylar and Coronoid Process.

Result of this study was regular and standardized labelling in which relatively larger areas were easily detected and labelled and smaller landmarks detection was not accurate. Cephalometric analysis has been performed using several AI models, in recent years' researchers have actively explained 3-D cephalometric landmark analysis using CBCT images. R/g imaging is very useful in dental field both for diagnostic and treatment purpose. OMF radiologists are professional who understand the basic principles and characteristics of radiographic images and have ability to read the radiograph and interpret in terms of diseases which continues to play an important role in AI related researches [5].

Dental Caries

Dental caries is one of the most prevalent disease across the world, early diagnosis is the key to prevent the caries. Early detection rules out the chances of caries. Diagnosis is exceedingly based on visual cons and radiographs. Visual input be a form of input dataset FOR MACHINE LEARNING (ML). DeVito, et al. evaluated the efficiency of a multilayer perceptron neural network in diagnosing proximal caries in bitewing radiographs and concluded the diagnostic improvement was 39.4% [7]. Lee, et al. used 3000 periapical radiographs to evaluate the efficacy of deep convolutional neural network to identify dental caries [8]. High accuracy of 89%, 88% and 82% was observed in the premolar, molar and both the premolar-molar region. Hung, et al. conducted a study with test and training set comprised of data obtained from the national health and nutrition examination survey [9]. Clinical imaging data from various sources have been used in AI models for diagnosing dental caries. A study done in 2019 with the use of CNN (convolutional neural network) to identify dental caries in near– infrared trans-illumination images. CNN increases the speed and accuracy of caries detection.

In (2020) Contu. et.al used the bitewing radiograph to assess the performance of deep learning (dl) network in carious lesions [8]. 3686 radiographs were used out of which 3293 were used for training and 252 were used as a test data 10c. Recent study of (2021) Park, et al. tested ML prediction models for the detection of ECC [11]. Data of 4195 children (1-5) were obtained from the Korea national health and nutrition examination survey (2007-2018) and analyzed. ML based models were able to detect ECC, predict high risk group and suggest treatment [11].

Maintenance of records

Maintaining each and every record of the patients in an orderly manner is a vigorous task. AI uses the technology of automation which is being used in many big organization including hospitals and research labs. Two main categories of automation are given below:

1. Fingerprinting technology
2. Linguistic analysis

Fingerprinting Technology

Documents are provided to an application that represents the types of content in an organization
These documents are analyzed by the application to find common characteristics. These common

characteristics are referred to as the document's "fingerprints".

Linguistic Analysis

When provided with sample document the application extracts data from the samples. It then uses linguistic analysis to determine what record series should be applied to what content. Record of various anomalies, diseases, lesions are easy to maintain in a useful manner using this technology.

Conclusion

The use of AI is increasing day by day in our day-to-day life, use of latest technology has always been in trend in Dentistry. However, AI can only mimic the role of human beings but cannot work or think like humans. Dentist has always been keen in using the latest technology, the AI can always make the work easier for the dentist but the perfection is still questionable, life would be easier for the clinician with the AI.Apart this new challenges would also arise as it would come into practice.

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