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Review Article

The Scope of Artificial Intelligence in Oral Radiology- A review

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ABSTRACT

Artificial Intelligence (AI) is a revolution in the area of technology that is seeing fast progress. AI has been at the center of discus sion among radiologists.Common fiction has always depicted the farfetched risks of AI but the element of truth is that AI has the potential to revolutionize the way we work in the twenty first century. Since its formation, dentistry has seen some of its impressive accomplishments.

Dentists will be comfortable with this technology because the future of dentistry must certainly require the introduction of its multiple technologies and the computer generated expertise of specialists in automated dental radiographic analysis. Automation may help to save time and enhance the procedures.

Although AI cannot substitute the position of dentist or oral-radiologist, the precise and efficient analysing of radiographic images by artificial neural networks provides interesting diagnostic possibilities for the future and would definitely be an important part of oral radiology.

KEY WORDS: Artificial Intelligence, Deep Learning, Machine Learning, Radiology.

INTRODUCTION

Artificial intelligence (AI) is defined as "a field of science and engineering concerned with the computational understanding of what is commonly called intelligent behaviour, and with the creation of artefacts that exhibit such behaviour."[1] In terms for better understanding, Artificial Intelligence (AI) has been characterized as computer frameworks ready to perform assignments typically requiring human insight for eg. mathematical calculations, weather forecasting, speech recognition, decision making, medical diagnosis etc.[2]

AI is basically divided into Machine learning (ML) and Deep Learning associated with convoluted neural networks.(CNN). Machine learning concerns 'the question of how to construct computer programs that automatically improve with experience'. [3]Deep learning is a class of machine learning 'concerned with algorithms inspired by the structure and function of the brain. Innovation has grown by leaps and bounds in the field of medicine and dentistry in the most recent decade. AI patterns, especially those utilized in deep learning, have discovered a striking purpose in image recognition. Specifically, AI algorithms exceed expectations at consequently recognizing complex imaging data, furthermore giving a quantitative assessment of the imaging features.[1,2,3]

Machine Learning

Machine learning is a component of artificial intelligence (AI) that teaches computers to think in the same way as humans do: to learn and develop from past experiences.

This operates through data discovery, pattern recognition and requires minimal human involvement.

The machine learning can automate almost any task that can be completed with a data-defined pattern or collection of rules.

Machine learning uses two primary techniques: [4]
1)Supervised learning 2) **Unsupervised learning**

Supervised learning enables data collection or data production from an earlier ML implementation. Supervised learning is exciting because it operates in the same way that people actively learn. The computer in supervised learning is loaded with a series of labelled data points called a training set.

Unsupervised machine learning helps to discover all kinds of unexplained trends in the results. Thr-ough unsupervised learning, using only unlabeled samples, the algorithm tries to learn some intrinsic structure to the results. Clust ering and the reduction of dimension are two common unsupervised learning activities. Clustering is done to organize data points into relevant cluster such that elements within a given cluster are found.

DEEP LEARNING

Deep learning was motivated by the hugely equal design found in brain and its sources can be followed to Frank Rosenblatt's perceptron.[5]
Deep learning algorithms create a layered, separate levels system of learning and data representation, where more important level highlights are labelled in terms of lower (less conceptual)highlights.[6] The advanced learning architecture of the deep learning algorithm is inspired by artificial intelligence imitating the complex, layered learning process in the human brain of the primary sensorial areas of the neo-cortex(Figure1), there by extricating highlights and thoughts from the rudimentary understanding.[7,8,9]

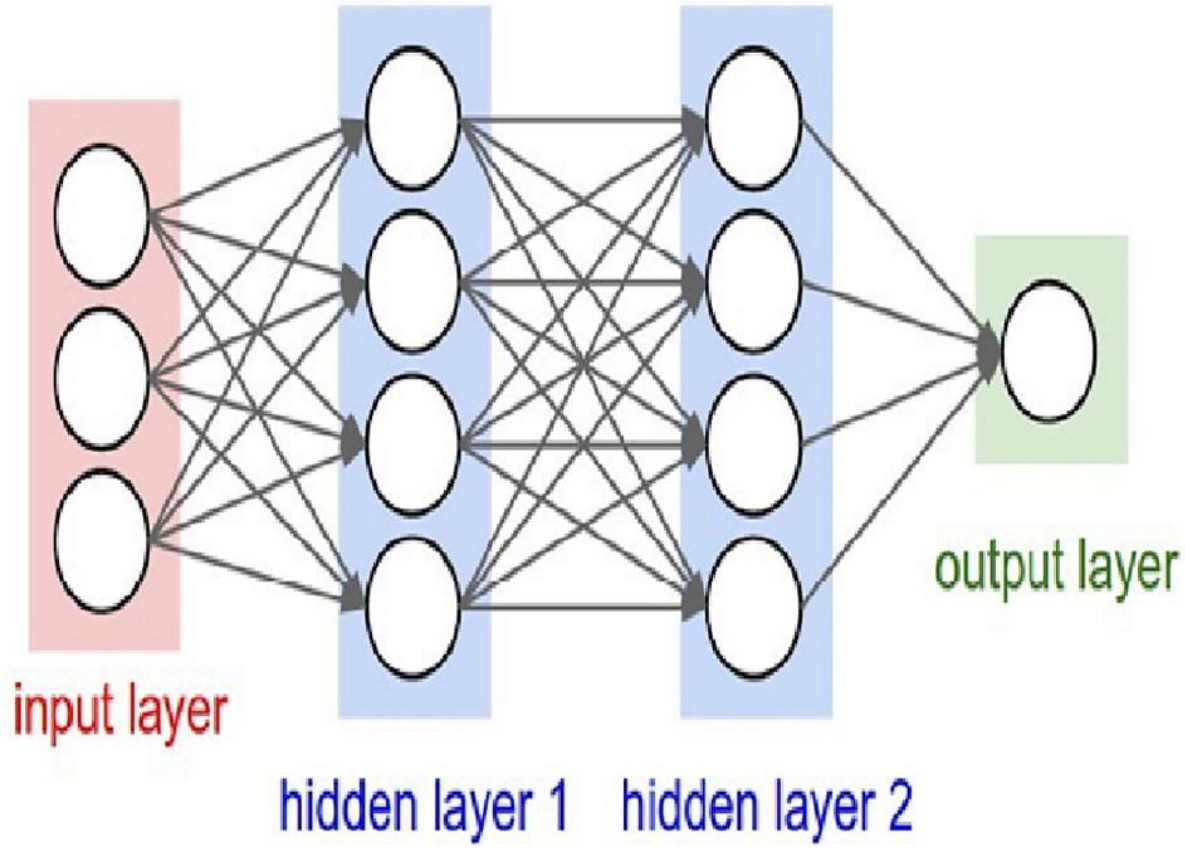

Figure-1-The Concept of Deep Learning. (Source –Google)

In deep learning algorithms, the principle idea is to mechanize the retrieval of representations from information.[8,10,11] Deep learning algorithms utilize an immense measure measure of unaided information to consequently extricate complex patterns.Such algorithms are largely convinced by the field of artificial intelligence which aims generally to imitate the human brain's capacity to watch, break down, learn, and decide, particularly for amazingly complex issues.[6]

AI In ORAL RADIOLOGY

Advances in both radiology and AI have set a more noteworthy investigation on the capacity of the radiologist as a diagnostician, which basically involves two procedures: radiographic assessment followed by interpretation.[12] Both include the capacity to physically recognize an image and the perceptual skill to apply object detection to differentiate nor mal from abnormal.[13] It is challenging, as human perception of stimuli will sometimes miss observations as cause errors.Radiol ogist negligence contributes to missing and prolonged detection, which may lead to poor health outcomes.

With the new era of automated imaging repositories and electronic health record systems, the usage of AI with radiology is asserted to enable not only more accurate, but also easier and cheaper image processing.The artificial neural network (ANN) is by far the most common and efficient method utilized by most existing AI applications in radiology.ANNs have ascended to turn into the most famous AI system in present day medicine.[14,15] These Computer frameworks mimics the role of a human brain.These include networks of tightly integrated computational systems that take on the position of neurons, conduct concurrent data processing functions, and combines complex weighted links.

The information base of the device encodes the weighting of each relation, and each ' neuron ' uses this weighting, guided by statistical logic, to determine whether to activate other ' neurons ' along with the line. [14,16,17]
ANNs provide many of the advantages that have contributed to their being the dominant type of AI in radiology. ANNs may be ' used ' through supervised learning, which involves comparisons of the predicted outcomes.
It can also learn through unsupervised learning, whereby the weighting of their interactions is modified through interpretations of and correlation with the input data.[15,16]Through unsupervised learning ANN will step ahead and progress on a case-by -case basis providing even more accurate diagnoses over time regardless of expert feedback.
This also allows the ANN to infer the experience of easy cases in order to solve more complex ones.[15]
For Oral radiology, a particular algorithm may be built, that further helps to identify and recommend appropriate treatment choices. AI gradually nudges its position in the area of dental radiology, concentrating on patient information of digital scans and radiographs. More knowledge can be obtained and processed to include AI for accelerated diagnosis and better healthcare management.[18]
Effective evaluation is the secret to good clinical practice. In this regard, properly trained neural networks can be helpful for diagnosis, particularly in conditions with multifactorial etiology. (Figure 2)

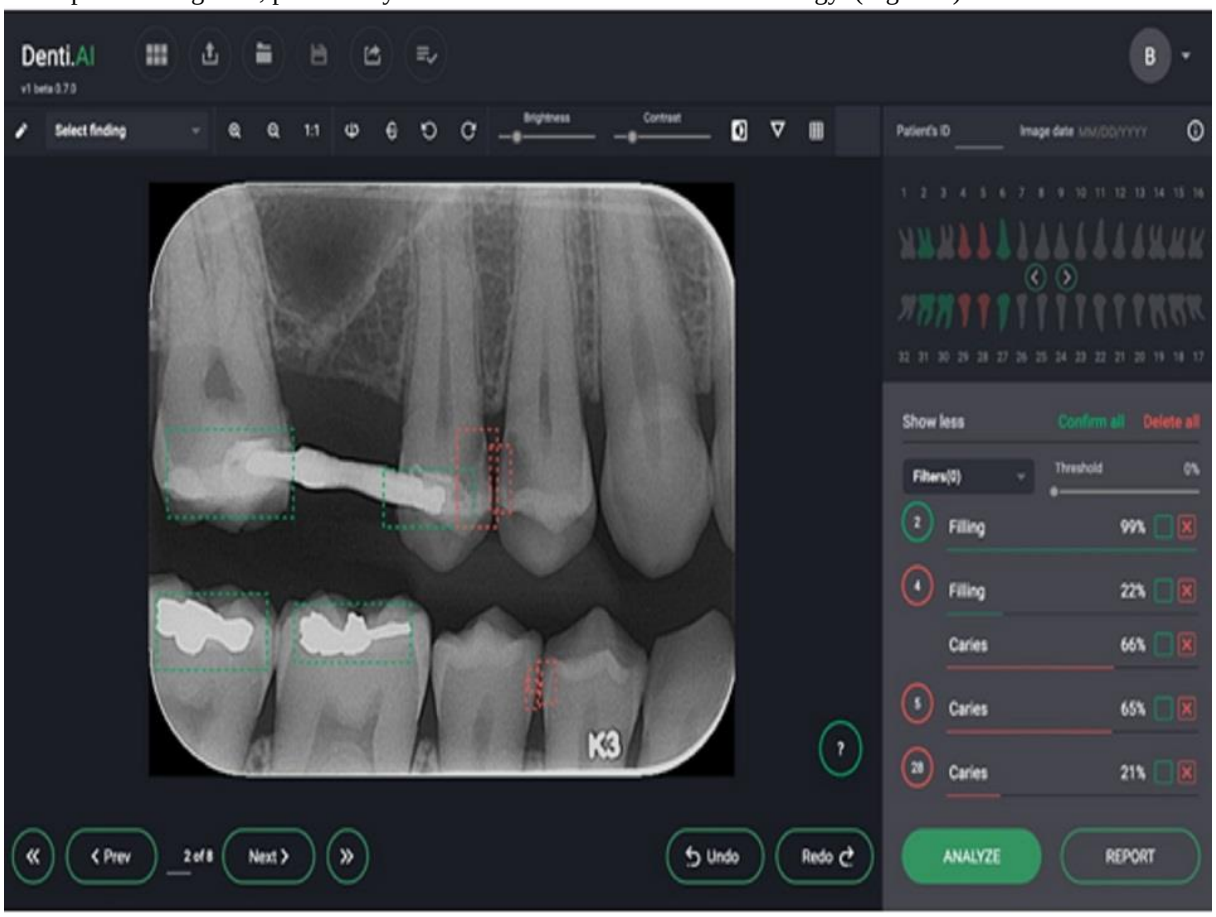

Figure 2- Use of AI in Bitewing radiography.(Source- Denti.AI)

The neural network, through radiological (X-rays, panoramic, lateral cephalograms) images, recogni- zes and separates the major anatomical regions (jaws, teeth,etc).Thus distinguishes different diseases and illnesses by determining (normal appearance, filling, crown, root canal, implant, periapical pathosis, etc.)(Figure 3) and gives a probable range of diagnosis.

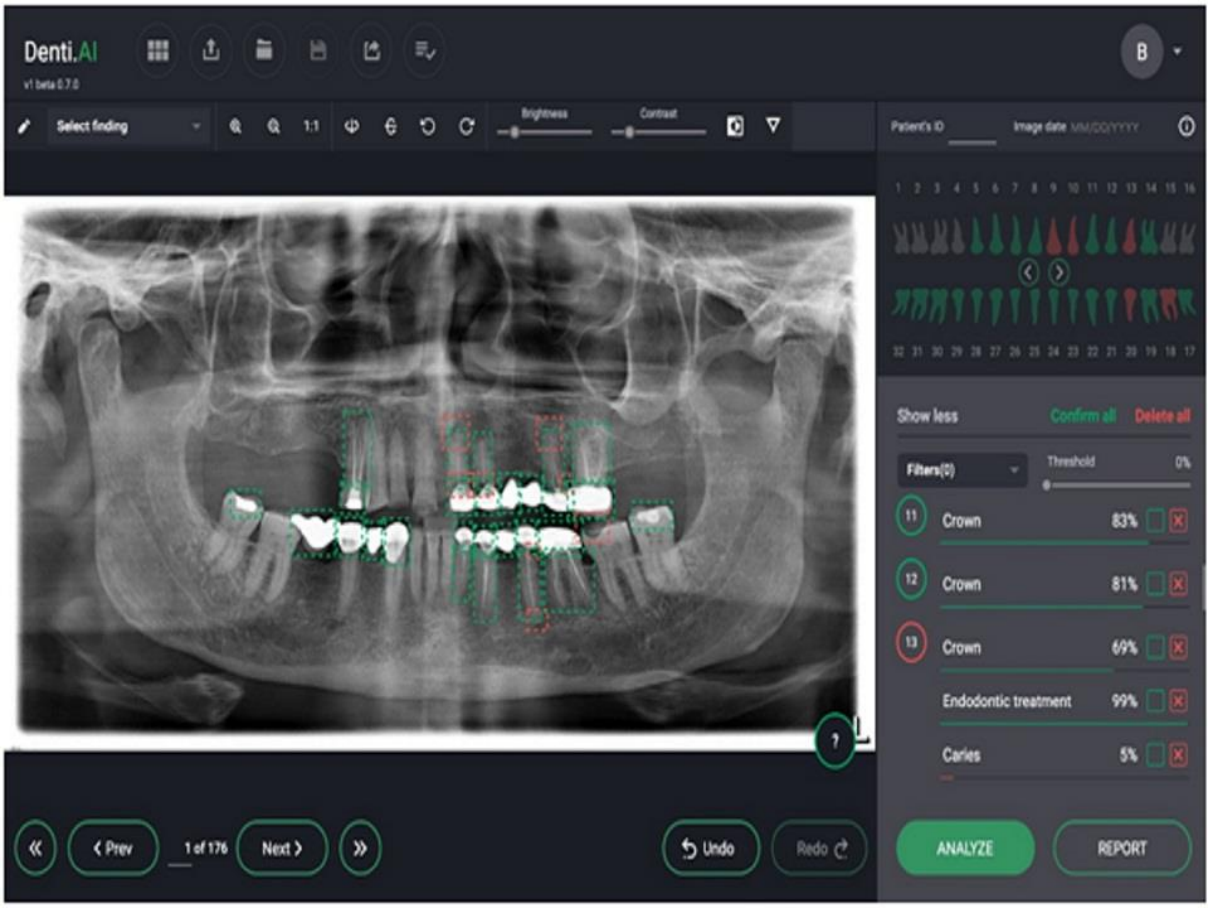

Figure 3- Use of AI in Orthopantamograms.(Source - Denti.AI)

AI in automated analysis – For training set, the clinical expert analyze and prepare a certain dataset from vast amount of radiographs available. The annotation of the training data is done by a oral radiologist or a experienced clinician manually following which the AI software is trained, using those datasets to create a adapting dataset. The accuracy of the adapting data set is evaluated in the testing dataset (a fresh set of radiographs not evaluated previously). Thus AI helps in automated analysis of the dental radiographs. Tuzoff et al (2019) found a sensitivity of 0.9941 and a precision of 0.9945 for automated teeth detection whereas for tooth numbering, the sensitivity and specificity was
0.9893 & 0.9994 respectively.[19]

AI in anatomical landmarks detection - Convolutional neural networks (CNN) permit exact edge recognition, and edge-based, region-based, and knowledge-based algorithms are utilized to find cephalometric landmarks .It can help to locate landmarks which are of low contrast, overlapping or of bad quality thus making it difficult to detect for a naked human eye. CNN helps in detection of anatomical in more accurately using pixel by pixel elaboration and knowledge based algorithms.[**20]** Thus automated analysis of dental radiographs enables the exact confinement of landmarks and can also be utilized with CT and MRI to recognize variations from the norm in pictures that may go unnoticed.[**21]**

AI in dental caries detection - AI helps to identify interproximal caries using a series of bitewing radiographs. A pre-trained deep learning network can be used for diagnosis of dental caries in bitewing, periapical and as well as panoramic radiographs.[**22]** Lee et al (2018) found that within 3000 dental radiographs, the accuracy of identifying dental caries in premolars, molars, and both premolars and molars are 89%, 88%, and 82%, respectively. [**23**]

AI in periapical pathologies detection – AI can help in detection of periapical pathologies such as periapical cyst, garnulomas and abcess which sometimes gets unnoticed by a clinicians eye.AI can accurately locate the exact boundaries of the lesions and enable proper detection. In the future, these systems will help in the early detection of peri-implantitis with appropriate interventions.[21]

AI in detection of bone loss - ANN will help radiologists to reduce cognitive bias and diagnostic efforts and further increase the diagnostic accuracy of the periodontal pathology . Koris et al (2019) found that neural network showed higher diagnostic performance, with an accuracy of 81%, than individualclinicans, who showed an accuracy of 76%, in the radiographic detection of periodontal bone loss (*P*=0.067). [24]

AI in detection of oral cancer – AI can also help in early diagnosis of oral carcinomas. ANN also been helpful in detection of cervical lymph node metastasis which may result in improving the prognosis of head and neck cancer. Kim et al (2019) found that deep learning improved prediction of cancer survival and helping experts in selecting better treatment options and reducing unnecessary treatment protocols. The accuracy they found of the training and testing sets,were 81% and 78.1%,

respectively.[**25]** Ariji et al(2019) mentioned the use of CNN enhanced the diagnosis of cervical lymph node metastasis. The performance of a CNN image classification system resulted in an accuracy of 78.2%, a sensitivity of 75.4%, and a specificity of 81.0%, comparable to that of experienced radiologists.[**26]**

Current Scenario and Future Prospects

Without doubt, AI seems to have a promising future ahead of it as a potentially 'game-changing' device in oral radiology. However, this unprecedented technical progress has not come without the emergence of an aspect of uncertainty in the field of radiological research, a concern that has generated insecurity among the radiological communities around the world, as certain radiological practitioners doubt whether AI can eliminate the need for qualified radiologists.

As a consequence, AI software showed itself to be a capable second reader, still constrained by a important, although changed, fal se positives. However, IBM's $1 billion expenditure in its Watson Health Initiative, an algorithm already deployed in healthcare, s hows faith in the potential of imaging AI. This expenditure would see Watson take 30 billion images to study from.[27]With such data tools, future AI technologies might be able to rely on algorithms that are far more reliable and effective, resolve high false po sitives and recall problems and identify anomalies in any imaging modality, including the detection of unusual and challenging ca ses that would otherwise be overlooked.

CONCLUSION

AI, which is waiting to be accepted worldwide, seems to be a positive adjunctive resource for diagnosis and treatment planning lo oks like a trustworthy, hardworking partner rather than a foe to oral radiologists.[21,28]With an exponential rise in the volume of data and the prospect of utilizing AI to classify observations that are either detectable or not identified by the human eye, radiology is already shifting from a subjective observational capability to a more analytical method. Radiologists who have been at the forefront of the modern revolution will lead the application of AI to healthcare.[28]Radiologists will not be substituted as ra diology requires predictive coordination, recognition of patient interests and needs, professional decision, quality control, research works.

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