

Artificial Intelligence in Dentistry – An Overview

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ABSTRACT:

In order to quickly solve complicated problems, artificial intelligence (AI) empowers machines to extract, integrate, exchange, and evaluate huge heterogeneous datasets. Many computer scientists, doctors, and decision-makers have embraced the promise of AI in healthcare and medicine. In order to better the health of people and populations, reduce health disparities, cut healthcare costs, and increase general human well-being.

Artificial intelligence has a big part to play in health care data. It offers updated and better analytics. Many diseases can be found, identified, and treated with the use of AI analytics. It aids in the provision of more specialised care for those battling medical diseases or challenges. When employed in the healthcare industry, several AI technologies improve patient outcomes. Robotics is utilised for repetitive jobs like deciphering CT and X-ray scan findings, among other things. Healthcare chores are being carried out by Artificial robots. Artificial intelligence is also being used as a diagnostic tool in dentistry for better treatment planning and treatment outcome.

Keywords: Artificial intelligence, Computer-aided diagnosis, Machine learning, Deep learning.

INTRODUCTION:

The phrase "artificial intelligence" (AI) refers to the use of machines and technology to accomplish human-like tasks. According to "BARR and FEIGENBAUM," artificial intelligence is the area of computer science that deals with creating a computer system that is intelligent and demonstrates traits we associate with intelligence in human behaviour, such as

language comprehension, learning, reasoning, problem-solving, and many more. (Ahmed N, Shakhoor M, Zuber F. 2021)

Researchers and technologists have been working hard to solve the human brain's complexity since the beginning of science, which is a maze of neurons connecting to one another and relaying messages to the entire body. The scientific community continues to struggle with how to design a model that accurately mimics the functioning of the human brain. The evolution of "Artificial Intelligence" is the outcome of years of devoted study effort. The concept of creating machines that can carry out jobs that are typically completed by humans is described by the word, which was first used in 1950. It is occasionally referred to as artificial intelligence. (Tandon D, Rajawat J. 2020)

Early philosophers helped artificial intelligence become precisely defined throughout the 1700s and beyond. If it was possible to automate and regulate non-human machine intelligence artificially, philosophers pondered this question. Atanasoff Berry Computer (ABC), the first programmable digital computer, was created in the 1940s as a result of the work of classical philosophers, mathematicians, and logicians who first studied the mechanical manipulation of symbols. This work eventually sparked interest in artificial intelligence (AI). This particular technology has been the driving force behind the creation of an "electronic brain," or artificially intelligent being.

Mathematician Alan Turing came up with a test to determine how closely a machine could mimic human behavior. The term "artificial intelligence" was first used by computer and cognitive scientist John McCarthy at a summer conference held at Dartmouth College in the middle of that decade. (Ahmed N, Shakhoor M, Zuber F. 2021).

With the advancement of computer technology, AI will be able to process vast datasets, computationally disclose human behaviour, and enable contact with humans. This intelligent capability can be realised by a series of algorithms. This technology has a positive impact on people's lives and has a lasting impact on the globe.

For instance, Amazon Alexa (Amazon) was introduced as a virtual assistant with the capacity to identify and comprehend various dialects and voices. It started assisting people in doing their daily duties since it had the ability to add abilities.

The Apple A13 bionic chip, found in the iPhone (Apple), was created to handle the software requirements of machine learning procedures, such as the immediate rectification of low-light images.

As an AI solution with cognitive computing, IBM Watson was also unveiled. In numerous professional sectors, this self-learning technology was created to provide solutions to issues without human intervention. (Rajawat J., Tandon D. 2020).

These are the several fields where artificial intelligence is used: “virtual assistants or chatbots, farming and agriculture, autonomous flying, retail, shopping, and fashion, security and surveillance, sports analytics and activities, manufacturing and production, livestock and inventory management, self-driving cars or autonomous vehicles, healthcare and medical imaging analysis, warehousing, and logistic supply chain”.

The future of healthcare originally felt like science fiction. Artificial intelligence (AI) is a rapidly developing technology that allows machines to carry out jobs that were previously only performed by humans. AI developments hint at potential health advantages like fewer unneeded treatments, higher quality of life, lower postoperative complications, and better decision-making. AI may significantly enhance diagnosis accuracy and revolutionise care when used in the medical and dental fields. Identifying normal and abnormal structures, diagnosing disorders, and predicting treatment outcomes are just a few of the uses of AI that are already prevalent in dentistry. AI is also widely utilised in dentistry laboratories and is becoming more and more important in dental education. Kyle Stanley and Yo Wei-chen

Dental cavities were significantly detected in periapical radiographs using a deep learning-based convolutional neural network (CNN) approach. Additionally, it was effective in identifying and categorising impacted supernumerary teeth in patients whose maxillary permanent incisors had fully emerged on panoramic radiographs. When segmenting teeth automatically on panoramic images, the fully deep, fine-tuned mask R-CNN model performed well. It was also applied to the detection of apical lesions on panoramic radiographs. Recently, research revealed that artificial neural networks (ANNs) might serve as a second opinion to identify the apical foreman on radiographs and to improve the precision of working length determination by radiography. The estimation of shade, light-curing unit, and composite Vickers hardness ratio of bottom-to-top composites were also made possible by ANN in a different in vitro investigation. AI technology has been demonstrated to be helpful in reducing the likelihood that composite restorations may debond in restorative dentistry. Additionally, a robotic system that is automated can prepare teeth in three dimensions (3D) with accuracy and safety, meeting the needs of standard dental procedures. Dental arches can be categorised and removable partial dentures can be created using the AI convolutional neural network (CNN). AI can determine how orthognathic treatment affects the look of age and the attractiveness of the face. It provides a novel feature that enables objective and repeatable grading of apparent age and face attractiveness. Dentists can analyse the location and shape of the maxillary anterior teeth with the help of automated integration of facial and intraoral pictures of the teeth. To put it briefly, there have been several advances in artificial intelligence technology during the past ten years. It is still unclear, nevertheless, how information about AI found in the literature can help with the diagnosis, organisation, and management of dental problems. (Ahmed N, Shakhoor M, Zuber F. 2021).

HOW DOES ARTIFICIAL INTELLIGENCE WORK?

Artificial intelligence can be broadly classified into narrow artificial intelligence, general artificial intelligence and super Artificial intelligence. Narrow artificial intelligence is what we are seeing in today's computers. As computers are programmed to carry out specific tasks. Examples of narrow artificial intelligence are 'Siri' a virtual assistant, which is able to recognise voice and works on commands. Another example is self-driving cars. Recommendation engine on online shopping apps which give suggestions to buy based on history of products (Nick Heath.2021).

Google assistant, Google translate are example of artificial narrow intelligence. Narrow artificial intelligence can process data and complete the task in very short span of time as compared to humans. With the help of narrow AI, we are able increase our productivity, efficiency and quality of life. IBM's Watson is based on narrow artificial intelligence, which is helping medical health professionals to make decisions based on data' (Tannya D. 2018). Artificial general intelligence has the ability to exhibit human intelligence. General artificial intelligence is going to reason, plan, make decisions and will be able to think creatively.^[6] Artificial super intelligence is a form of AI that is capable of surpassing human intelligence by manifesting cognitive skills and developing thinking skills of its own. (Vijay kanade 2022)

Artificial intelligence has multiple subfields through which it is able to perform various tasks. Like Machine learning, Deep learning, and artificial neural network. Machine learning is all about extracting knowledge from data available.

MACHINE LEARNING:

Machine Learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy. (IBM cloud education 2020).

DEEP LEARNING:

In a study Lee et al used 3000 periapical radiographs as input, and trained deep learning system to identify dental caries. They incorporated QLF Quantitative light-induced fluorescence to compare the results. Results show 88% accuracy (Sara brown 2021).

DEEP CONVOLUTIONAL NEURAL NETWORK:

In a study deep convolutional neural network was used to detect osteoporosis on a panoramic radiograph. Radiologists with 10 years of experience agreed to diagnosis done by computer-aided diagnosis system. (Jae Seo lee 2018) 200 panoramic radiographs were selected. Single-column convolutional networks and multicolumn deep convolutional networks were used for the training process. This data was used as input data for the programming and the trained set

was tested against a test set consisting of both normal radiograph and osteoporosis radiograph.

ARTIFICIAL INTELLIGENCE IN HEALTHCARE:

With the advancement of data science, algorithms and neural network, now it is a possible that these data and digital records are used to diagnose the disease, pre-treatment evaluation of outcome of disease and determine prognosis of the disease more accurately and efficiently. Thus, reducing unnecessary procedures and making health professional's task easier. (Anita Aminoshariae. 2021).

Artificial Intelligence in health care have many applications like diagnostics, drug therapy prognosis of treatment, and precision medicine. Artificial intelligence has the potential to give diagnosis based on image analysis. Artificial intelligence can be used in many specialities like, biomedical engineering, tissue engineering, pathology, ophthalmology. (Kevin Dzobo 2019).

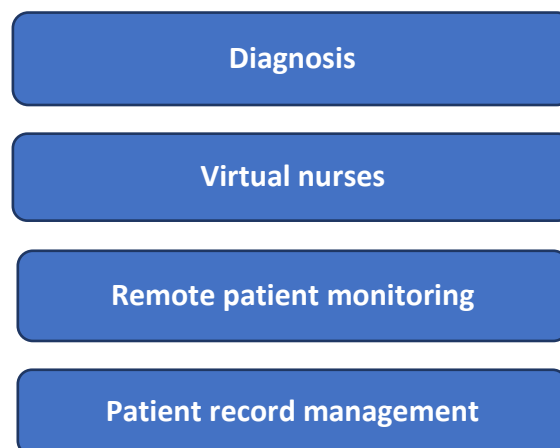


Fig. Application of Artificial intelligence in Health care

There are various computational algorithms that are helping healthcare system to be more efficient. Apple smart watch is based on kardiaband algorithms, which is proved to be efficient in detecting atrial fibrillation. Aidoc is AI based tool can provide CT scan of the whole body, can detect intracranial haemorrhage and able to notify radiologist. (Kevin Dzobo 2019).

Drug designing and development is very essential research area for pharmaceutical companies as well as for health care system and patients. High cost, time consumption, complex and extensive data of clinical trials, genomics pose obstacle in drug delivery. Machine learning, deep learning, artificial neural network algorithms have emerged as solution to these obstacles. (Rohan Gupta 2021)

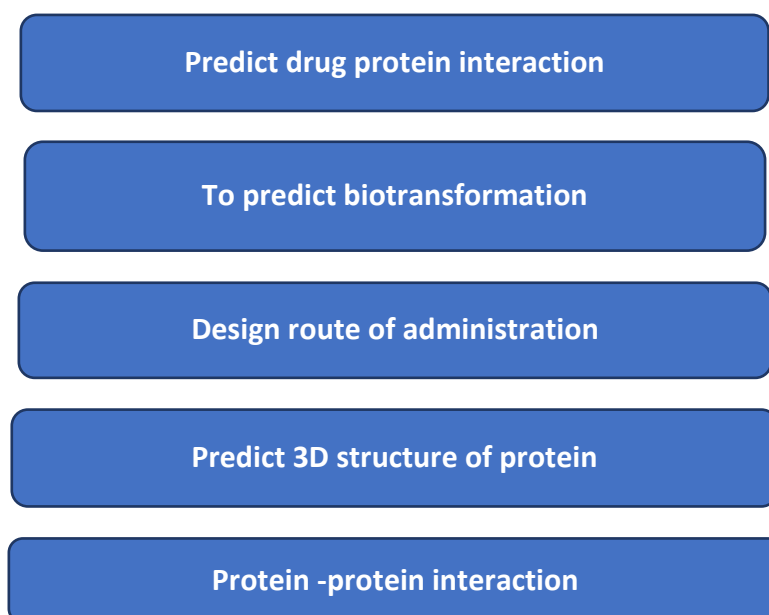


Fig. 7 Artificial intelligence in drug design

DISCUSSION:

In dentistry images play an important role in diagnosis, treatment planning. Data is in the form of clinical records and history. Data are collected multiple times. This information can be utilized to train the machine learning systems. (F. Schwendicke.2020). AI systems can learn and adapt as they make decisions. for example, machine learning was used to detect mesiodens on panoramic radiograph. Dmitry V. Tuzoff et al conducted a study to evaluate the efficiency of a convoluted neural network for teeth numbering and classification of teeth. (Tuzoff DV, Tuzova LN, Bornstein MM, et al. 2019).

Hatice Kok et al conducted a study to compare the growth and development of cervical vertebrae using 7 different algorithms Artificial neural network, decision tree, random forest, Support vector machine, and logistic regression. (Koç H, Acilar AM, İzgi MS. (2019).) Xiaoqiu Xie et al evaluated if extraction is required for orthodontic treatment by constructing a decision-making expert based on an artificial neural network. (Xie X, Wang L, Wang A. 2010).A study was conducted to correlate periodontal health with systemic diseases using artificial intelligence. (Gregory Yauney et al 2019). Bhornsawan Thanathornwong, conducted a study to evaluate the efficiency of a Bayesian-based system to assess orthodontic treatment needs. (Thanathornwong B. 2018) The performance of the deep convoluted neural network-based system was evaluated to detect osteoporosis on panoramic radiographs. (Lee JS, Adhikari S, Liu L, Jeong HG, Kim H, Yoon SJ. 2019) An artificial intelligence-based system was tested to evaluate its accuracy in predicting surgical or non-surgical treatment plans (Hyuk-II Choi et al2019) Conducted a study based on deep learning to detect caries using near-infrared transillumination. (F. Casalegno 2019) H.J. Yu et al (2020) conducted a study on a convoluted neural network-based model for skeletal classification. (Yu HJ, Cho SR, Kim

MJ, Kim WH, Kim JW, Choi J. 2020). A retrospective study for gender determination using mandibular morphometric parameters with the help of artificial intelligence. (Vathsala Patil et al 2020) An ex-vivo study for the detection of vertical root fracture using a probabilistic neural network. (Masume Johari et al 2016) A study Conducted to classify cancerous tissue laser endomicroscopic images of oral cavities using a deep learning algorithm. (Marc Aubreville et al (2017) A study Applying a deep learning system for diagnosis of maxillary sinusitis using panoramic radiographs and explain how well it performs in terms of diagnosis. conducted a study to detect vertical root fracture on panoramic radiographs using artificial intelligence. (Motoki Fukuda et al 2020)

CONCLUSION:

In recent years, Artificial intelligence has transformed dentistry. Studies demonstrate that these artificial intelligence-powered automated systems delivered outstanding results in a range of situations. Few authors found them to be more precise than dental professionals. The results do show that Artificial Intelligence can be taken into consideration for clinical applications, even though they do not make them superior to dentists. These technologies add a lot of value to the table by strengthening clinical decision-making, increasing the accuracy of diagnosis, and forecasting treatment outcomes, which can assist doctors in providing patients with the highest standard of care.

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