Artificial Intelligence and How it Renovates the World of Dentistry

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Abstract

In the era of information and technology with the importance that data have in our daily life, advanced intelligence systemsare the new necessity to process and integrate those data and help us understand it efficiently. Artificial Intelligence (AI) with its computational and data processing powers provides a way to demonstrate intelligence which helps taking intelligent and effective decisions easy and effortlessly. This behavior of artificial intelligence has made it ever so significant in the field of dentistry. Using artificial intelligence in the field of dentistry would reduce cost and time of diagnosis, probability of medical error, and has the potential to improve the dental health of the public and in turn improve patient care. It assists dentists to be more proficient in their trade. This article tries to throw some light on the usefulness of artificial intelligence and how it can impact the world of dentistry in the upcoming future.

Keywords: *Artificial Intelligence; Dentistry; Applications; Diagnosis.*

Introduction

Artificial Intelligence (AI), the term coincided in 1956, is intelligence demonstrated by machines by accepting percepts from the environment and performs certain actions. This branch of computer science imitates the cognitive functions, such as learning and problem solving,similar to a way that the human mind or natural intelligence performs. The technology involves a set of complex mathematical algorithms which with a given set of data, analyzes and reaches to an intelligent conclusion. Apart from providing an intelligent conclusion, it also makes itself learn by correlating and analyzing the data and the corresponding result pattern for a better and more accurate output in the next iterations that follows. This process is also termed as deep learning, which is a part of the Machine Learning technique and entirely based on analyzing, inferring, and learning from complex forms of data.[1]

In the field of AI, there are so many variables, debates, and questions that it is simply impossible to have a single universally accepted definition for it. How exactly intelligence be defined or measured? What should make a machine intelligent? To understand the complete picture of AI, we need to know what intelligence exactly means and how we can relate it to a machine.

What is Intelligence?: From the simplest behavior to the most complex thinking can be attributed to intelligence. The AI and all the research around it mostly signify on certain components of intelligence such as learning, reasoning, unraveling, and adaptability using algorithms that are specifically designed to perform these actions using real-time data from different sources.[2]

a. The learning aspect of intelligence comes from information processing. This gives a dynamic feel to the intelligence of a machine that otherwise would be static and symbolic. There are different ways to make a machine learn, such as trial and error, generalization – learning from experience.

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b. The reasoning aspect points to the decision making factor. Any intelligent machine needs to draw an appropriate conclusion based on the situation. A conclusion can be deductive or inductive. The deductive conclusion is based on the facts that guarantee a true conclusion, while the inductive conclusion is based on the previous examples that provide support to the conclusion.

c. Unraveling is the approach of solving a complicated problem by formulating them into several simpler problems. These smaller problems are then solved through a range of possible actions to arrive at a predefined solution.

d. The adaptability factor helps a machine termed as 'intelligent' to adapt based on changing situation by compiling information and reaching to an apt decision.

Now that we have gained a good understanding of artificial intelligence, let us see how it is being used and the opportunities where it can be applied in the future in the field of dentistry.[2]

How is AI currently used in dentistry?: Artificial Intelligence is a big revolution in the field of technology which is rapidly progressing and improving at the same time, thanks to all the extensive R & D being done in the field of machine learning. Medical science along with the field of dentistry has seen a substantial uptake of this technology. Every field of medical science has been integrated with this power of technology to help make it better and more efficient.[1-3]

Diagnostic capability is a primary work that dentists have to perform on any problem. In general, diagnosis is done through several investigating techniques such as X-rays, CT scans, MRIs. The results are then interpreted by a dentist to reach to a conclusion. Now what if, the analysis is being done by an 'intelligent' machine and directly provides probable conclusions to the dentist? The dentist can simply take a suited action. This is achieved through image processing and recognition using artificial intelligence algorithms and making a machine learn and determine as to what exactly a particular or a set of image(s) indicates. This reduces error probability, helps to identify even minor deviations from normal, eliminates differences in subjective diagnosis, decreases overall time by removing the predictable tasks and these would provide a much better patient care. Artificial Intelligence also helps in analyzing and predicting any possible genetic disorder that could lead to a bigger concern like oral cancer.[2,4]

Clinical decision support systems (CDSS) are complex algorithms that assist health care personal in clinical decision-making tasks. A working definition for CDSS was proposed by Robert Hayward which says – "Clinical decision support systems link health observations with health knowledge to influence health choices by clinicians for improved health care". The involvement of computers and software that are integrated with available medical records of individuals has become a necessity in dentistry. The CDSS can assist in that part efficiently. It consists of a link between the vast medical knowledge block and an interpretation process that are a set of researched-based rules. An example of such a system is the one used to forecasts the genetic disorder and differences by using a form of genetic mutation algorithm. Thus a CDSS effectively helps in reducing the gap between a doctor, medical knowledge, and a patient.[2,4]

Artificial Intelligence provides the platform to integrate data from several domains such as the dental history of the patient, prior scans images and tests,socio-demographic details, pre-existing health conditions. Processing these data will provide a better understanding of the problem to a dentist and in turn, helps take an appropriate route for diagnosis. Artificial intelligence helps streamline a large number of routine activities such as scheduling and reminding appointments, patient record keeping, diagnostic assistance systems, self-monitoring, and management by patients. As part of a health monitoring system, AI provides a much deeper learning about any underlying health conditions and diseases, the impact of medicine on the patient.[5]

There is a vastapplications of artificial intelligence in the field of dental surgery. With the advancement of robotics handed surgery and in combination with the machine learning algorithms, almost all of the complex human operating motions and intelligence can be programmed and simulated in an environment where a dentist can perform those surgeries and have expertise on them without actually risking any real patient. This also assists surgeons for better planning and execution time of the procedures. Although virtual reality provides a simulated environment, it still is a great way of learning and gaining practical experience for inexperienced surgeons. The effect visualization makes it more real than anything.[6]

Augmented reality is another aspect where there is a growing contribution by artificial intelligence and it has slowly started its impact in the field of medicine. The augmented reality has helped reduce the complexity in the process of delivering aesthetic prostheses. With the help of AI systems integrated with augmented reality, patients can now check the prosthesis virtually and see how it fits them. This helps the patient and the dentist to make any number of changes and the final prosthesis outcome will be more accurate as per the indicated specifications. Augmented reality helps in obtaining accurate facial measurements, bone structures which assist dentists as a surgical guide for implants.[7]

Artificial Intelligence has also helped to enhance the learning methodologies and skills of dentists around the world. It has been successfully integrated into the dental education system to enhance the theoretical as well as practical learnings and trainings in the field of dentistry. The AI technology has the facility to envision and create a virtual reality (VR) environment that would help simulate different complex surgical techniques. Dentists can achieve expertise in various techniques of surgeries without actually operating on a real clinical patient. They can learn to design the best possible prosthesis using an AI-supported designing tool. Professors can efficiently impart quality education through a simulated environment. This method of learning is very effective, has no risks (no error-prone), a better way to practice, and an in-depth transfer of knowledge and information.[7,8]

Forensic Odontology is another segment where the usage of AI and its advancements has been done. This involves an examination of the dental forensic evidence found at a crime scene and thus this holds a larger interest for justice. It becomes extremely critical to properly and accurately analyze the evidences. Systems enabled with AI technologies and algorithms can be very helpful in this scenario. A varied array of image processing techniques integrated with AI algorithms will help provide an accurate and systematic overview of human age estimation and facial identification that can be used to track the probably criminal involved. The enhanced system can be integrated with neural networks to learn and effectively predict the age and possible facial structure.[9,10]

Future for dentistry: Rise of AI

In this paper, a brief explanation by relating the usage of artificial intelligence in every possible aspect of dentistry. Artificial Intelligence (AI) has indeed similarly revolutionized the field of dentistry that it has impacted the field of technology. It has showcased a wide range of applications and exceptional accomplishments in the field of medical science in general. From enhanced clinical decision-making process to easier diagnosis, from improved patient care to an efficient way of performing complex dental surgeries, in every way AI has helped not only to improve the existing process but also assist dentists to become better. Having said that, this technology is on many levels still improving and every day something new gets added to it for better. There is a minimum doubt that in the future it will have a major impact throughout every aspect of dental care and be an integral part of it. Although the human knowledge, intellect, and decision making cannot be replaced completely, the main purpose of using AI integrated systems is to assist dentists to perform efficient diagnosis, accurate and risk-free surgeries, and better dental care for patients.

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