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Applications of Artificial Intelligence in Medical Science: A Review

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ABSTRACT

Artificial Intelligence (AI) has practiced enormous and fastest progression in little time. It has spread its applications in business field, economic sector, geographic sector, defense area, security, industrial sector and medical sector too. AI in medical science is a great development which has given medical field a novel way deal with numerous diseases and complex operations. In initial age, there was no need of medicines as diseases were treated using natural herbs in the forests. As soon as humans started gaining knowledge about AI, they discovered medicine to cure diseases. Progressively, the evolution took place and lastly AI came into existence that made human work easy and also supported them in their stacks of work. The motivation of this article is to discuss the ways in which artificial intelligence is applied in abundant applications of medical science and the progress accomplished by AI in the medical segment.

Keyword: - AI, Development, Applications, Use in Medical science.

1. INTRODUCTION

In Artificial Intelligence, "Artificial" means objects that are produced by human beings, and "Intelligence" is the capability to form tactics to achieve goals by interacting with huge information [1]. Artificial intelligence (AI) is a multidisciplinary field aimed at automating tasks that currently need human intelligence. Despite its lack of general familiarity, AI is a technology that is revolutionizing every aspect of life [2]. AI refers to the simulation of human intelligence by a system or a machine. The goal of AI is to develop a machine that can think like humans and mimic human behaviors, including perceiving, reasoning, learning, planning, predicting, and so on. Intelligence is one of the main characteristics that distinguishes human beings from animals. With the interminable occurrence of industrial revolutions, an increasing number of types of machine types continuously replace human labor from all walks of life, and the imminent replacement of human resources by machine intelligence is the next big challenge to be overcome. Numerous scientists are focusing on the field of AI, and this makes the research in the field of AI rich and diverse [5].

The importance of AI can be observed through easy access to data and significant healthcare business inventions. It is suggested that every healthcare sector must include AI as an integral part of its business to embrace its activities with renovation in current operations. These techniques provide economic growth in terms of competition and operational efficiency and manage social change through better healthcare services. AI has the capability of handling complex data and figures in a more accessible and simplified process [4].

Recently AI techniques have sent vast waves across healthcare, even fuelling an active discussion of whether AI doctors will eventually replace human physicians in the future. We believe that human physicians will not be

replaced by machines in the foreseeable future, but AI can definitely assist physicians to make better clinical decisions or even replace human judgement in certain functional areas of healthcare (e.g. radiology). The increasing availability of healthcare data and rapid development of big data analytic methods has made possible the recent successful applications of AI in healthcare. Guided by relevant clinical questions, powerful AI techniques can unlock clinically relevant information hidden in the massive amount of data, which in turn can assist clinical decision making [3].

2. LITERATURE REVIEW

No field of digital technology has recently received more attention by the general public than AI [22]. AI is not new, but there have been rapid advances in the field in recent years. This has in part been enabled by developments in computing power and the huge volumes of digital data that are now generated. A wide range of applications of AI are now being explored with considerable public and private investment and interest [23].

A short angle of history of AI is given below:

1956 - John McCarthy coined the term ‘artificial intelligence’ and had the first AI conference.

1969 - Shakey was the first general-purpose mobile robot built. It is now able to do things with a purpose vs. just a list of instructions.

1997 - Supercomputer ‘Deep Blue’ was designed, and it defeated the world champion chess player in a match. It was a massive milestone by IBM to create this large computer.

2002 - The first commercially successful robotic vacuum cleaner was created.

2005 - 2019 - Today, we have speech recognition, robotic process automation (RPA), a dancing robot, smart homes, and other innovations make their debut.

2020 - Baidu releases the LinearFold AI algorithm to medical and scientific and medical teams developing a vaccine during the early stages of the SARS-CoV-2 (COVID-19) pandemic. The algorithm can predict the RNA sequence of the virus in only 27 seconds, which is 120 times faster than other methods [29].

Artificial intelligence (AI) was first described in 1950; however, several limitations in early models prevented widespread acceptance and application to medicine. In the early 2000s, many of these limitations were overcome by the advent of deep learning. Now that AI systems are capable of analysing complex algorithms and self-learning, we enter a new age in medicine where AI can be applied to clinical practice through risk assessment models, improving diagnostic accuracy and workflow efficiency [10].

Great advances have been made in using artificially intelligent systems in case of patient diagnosis. For example, in the field of visually oriented specialties, such as dermatology, clinical imaging data [21], robot-assisted surgery, drug analysis, pharmaceutical products, managing records and data of patients, etc.

Machine learning is a statistical technique for fitting models to data and to ‘learn’ by training models with data. Machine learning is one of the most common forms of AI. In healthcare, the most common application of traditional machine learning is precision medicine – predicting what treatment protocols are likely to succeed on a patient based on various patient attributes and the treatment context. The great majority of machine learning and precision medicine applications require a training dataset for which the outcome variable (e.g., onset of disease) is known; this is called supervised learning [24].

In particular, the development of deep learning (DL) has had an impact on the way we look at AI tools today and is the reason for much of the recent excitement surrounding AI applications. DL allows finding correlations that were too complex to render using previous machine learning algorithms. This is largely based on artificial neural networks and compared with earlier neural networks, which only had 3–5 layers of connections, DL networks have more than 10 layers. This corresponds to simulation of artificial neurons in the order of millions [25].

In healthcare, AI could be beneficial in mining medical records; designing treatment plans; forecasting health events; assisting repetitive jobs; doing online consultations; assisting in clinical decision making; medication management; drug creation; making healthier choices and decisions; and solving public health problems etc. AI could be very helpful in areas where there is scarcity of human resources, such as rural and remote areas. AI technology has been helpful in dealing with COVID-19 in India. It has helped in preliminary screening of COVID-19 cases, containment of coronavirus, contact tracing, enforcing quarantine and social distancing, tracking of suspects, tracking the pandemic, treatment and remote monitoring of COVID-19 patients, vaccine and drug development etc [26]. One notable advantage is that, unlike traditional stethoscopes, the readings may be taken even in noisy environments, allowing for more accurate diagnosis. The records can be obtained by anybody and telemetered to the doctor because there is no need for training to use the digital instrument. This also lowers their chance of contracting COVID-19 and makes it easier to provide better medical care in inaccessible areas and for chronically ill patients [27].

Auxiliary decision-making is used to improve the speed and accuracy of doctors' diagnoses. It uses data mining technology to establish a classification model based on medical multi-dimensional data, and provides the corresponding diagnosis according to the new patient symptoms [28].

Taking all above evidence into consideration, AI is developing rapidly and along with this, many applications are available in the field of medicine. Recently, many research papers ([29], [30]) have been published showing the development of AI in medical sector.

3. APPLICATIONS OF AI

In healthcare: The first breakthrough of artificial intelligence in healthcare comes in 1950 with the development of turning tests. Later on, in 1975, the first research resource on computers in medicines was developed, followed by NIH's first central AIM workshop marked the importance of artificial intelligence in healthcare. With the development of deep learning in the 2000s and the introduction of DeepQA in 2007, the scope of artificial intelligence in healthcare has increased. Further, in 2010 CAD was applied to endoscopy for the first time, whereas, in 2015, the first Pharmbot was developed. In 2017, the first FDA-approved cloud-based DL application was introduced, which also marked the implementation of artificial intelligence in healthcare. From 2018 to 2020 several AI trials in gastroenterology were performed [6]. Some of the areas where AI is used in medical are:

1. Accurate Cancer Diagnosis

2. Early diagnosis of Fatal Blood Diseases

3. Treatment of rare diseases

4. Robot-assisted Surgery

5. Automation of Redundant Healthcare tasks

6. Development of New Medicines

Managing Medical Records and Other Data: Nowadays, Artificial Intelligence (AI) is used extensively in medical sciences and is transforming the healthcare industry. The adoption of this technology in healthcare is

primarily applied to patient diagnoses, drug discovery, and development, clinician-patient interaction, transcribing medical documents and prescriptions and improving data discovery and extraction that helps in personalized treatments.

AI helps manage such vast datasets and assists clinicians in treating their patients by automating tasks and analyzing them in a meaningful way. It readily makes information available whenever and wherever it is needed and categorizes data in a patient-specific manner. It holds promise to deliver improved quality of healthcare by increasing productivity, accelerating digital health, improving personalized care, and supporting clinical decision-making at a lower cost. AI can improve productivity by generating structured data representations of medical concepts, functional features, and associations between variables for downstream analysis and automation.AI plays a critical role in developing digital scribes that support voice recognition and record a conversation between a doctor and a patient, deconstruct the text and use it to capture relevant information in the patient's electronic medical record. AI helps identify response patterns to any treatment and perform outcome predictions. This functionality is utilized to tailor specific treatments to cater to the needs of an individual [14].

Precision Medicine: The field of precision medicine is similarly experiencing rapid growth. Precision medicine is perhaps best described as a health care movement involving what the National Research Council initially called the development of "a New Taxonomy of human disease based on molecular biology," or a revolution in health care triggered by knowledge gained from sequencing the human genome [8].

Precision medicine offers healthcare providers the ability to discover and present information that either validates or alters the trajectory of a medical decision from one that is based on the evidence for the average patient, to one that is based upon individual's unique characteristics. It facilitates a clinician's delivery of care personalized for each patient. Precision medicine discovery empowers possibilities that would otherwise have been unrealized [8].

Much of the use of AI in the development of personalized medicines is focused on the treatment of individuals with overt disease: identifying the underlying pathology, determining which interventions might make most sense to provide given what is known about that pathology and the mechanism of action of the intervention, and testing to see if the intervention works. Thus, the vast majority of AI-based products and tools used in advancing personalized medicine focus on the diagnosis, prognosis and treatment of individuals. This makes sense as there is a great need for advances and efficiency gains in treating patients given the costs of current treatments, especially in the context of cancer. However, the application of AI to disease *prevention* is gaining a great deal of attention and traction [19].

In Surgeries: Its use in surgery, however, took a longer time than in other medical specialties, mainly because of missing information regarding the possibilities of computational implementation in practical surgery. Thanks to fast developments registered, AI is currently perceived as a supplement and not a replacement for the skill of a human surgeon. And although the potential of the surgeon-patient-computer relationship is a long way from being fully explored, the use of AI in surgery is already driving significant changes for doctors and patients alike [18].

In Cancer Detection: A more specific concept, namely machine learning (ML), is becoming increasingly prevalent. ML is a subset of AI, and is used to construct predictive models that learn logical patterns from mass historical data so as to predict the survival rate of a patient. ML has been used extensively for improving prognosis. Prognostication is an important clinical skill, particularly for clinicians working with cancer patients. ML methods have been shown to improve the accuracy of cancer susceptibility, recurrence, and survival predictions, three aspects that are fundamental to early diagnosis and prognosis in cancer research. ML can provide good results with regard to the clinical management of patients. This aspect has motivated researchers in the biomedical and bioinformatics fields to develop more effective ML tools that can classify cancer patients into high- or low-risk recurrence groups for refined prognosis management [7].

In Pharmaceutical Products: Involvement of AI in the development of a pharmaceutical product from the bench to the bedside can be imagined given that it can aid rational drug design; assist in decision making; determine the right therapy for a patient, including personalized medicines; and manage the clinical data generated and use it for future drug development. E-VAI is an analytical and decision-making AI platform developed by Eularis, which uses ML algorithms along with an easy-to-use user interface to create analytical roadmaps based on competitors, key stakeholders, and currently held market share to predict key drivers in sales of pharmaceuticals, thus helping marketing executives to allocate resources for maximum market share gain, reversing poor sales and enabled them to anticipate where to make investments [13].

4. LATEST APPLICATIONS IN MEDICAL USE

Diagnosing Diseases: Detecting any irresistible ailment is nearly an afterward movement and forestalling its spread requires ongoing data and examination. Hence, acting rapidly with accurate data tosses a significant effect on the lives of individuals around the globe socially and financially. The best thing about applying AI in health care is to improve from gathering and processing valuable data to programming surgeon robots [15].

Designed with intent, artificial intelligence in medical diagnosis can not only reduce the pressure on physicians when working through vast quantities of information and imaging, but it can be used to undertake a large percentage of the administrative burden. The right solutions, developed specifically for the healthcare sector, can be used to provide medical practitioners with essential support as they manage increasing volumes of data, information and imaging volumes [17].

Fig -1: Artificial Intelligence (AI) for Disease Diagnosis [16].

Medical Imaging: Medical Imaging techniques have been used by the Healthcare industry to diagnose diseases for many years. But Artificial Intelligence is now taking Medical Imaging technology further by enabling higher automation and increased productivity. It is even said that AI-powered Medical Imaging technology can identify anomalies and diseases better than doctors! AI is currently being used to detect neurological diseases like Amyotrophic Lateral Sclerosis (ALS), indicate the patient's risk of cardiovascular disease, abnormalities in common medical tests like chest X-ray, Diabetic Retinopathy (DR) and early cancer/malignancy diagnosis. It is also assisting with quantifying blood flow and providing visualization [9].

Fig -2: AI in Medical Imaging [9].

Automation of Redundant Healthcare Tasks: Healthcare organizations like hospitals, physicians' groups, and other entities have effectively implemented Robotic Process Automation (RPA) to remove redundancies and improve the patient care experience. Implementing robotic process automation technologies is a valuable cost-saving measure that simultaneously reduces the risk of human input errors [11]. Beyond permitting healthcare professionals to focus more on patient care, attended automation bots triggered by a customer service agent can uphold the patient's call centre experience by quickly analyzing relevant data and making rule-based decisions that address issues quickly [12].

Fig -3: Removing Redundancies from Healthcare Revenue Cycle Management (RCM) with Robotic Process Animation [11].

Drugs Analysis: The computational drug discovery process initiates from the drug target identification, target evaluation, and finding the suitable drug candidates. Hence, target selection plays an imperial role in disease pathology, assessing the druggability of lead molecules and prioritizing candidate targets. However, due to the complex nature of the human disease, the target selection process needs comprehensive methods that take part in the heterogeneous data and understand the molecular-level mechanism of disease phenotypes and also help to identify the patient-specific changes. Advanced methods like AI/ML have been applied to overcome these challenges [20].

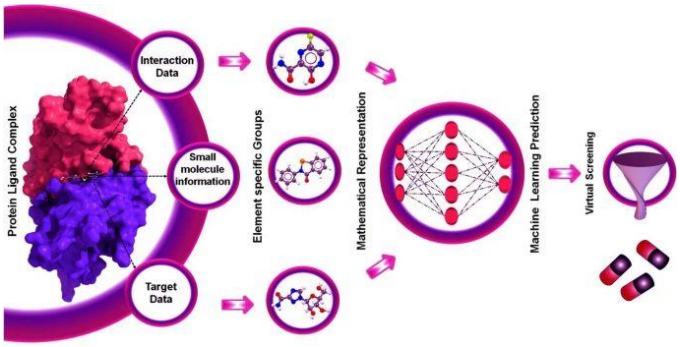

Fig -4: AI and ML based prediction for the high throughput virtual screening [20].

4. CONCLUSION

AI is attaining place in every field that led economic and static development of our country. The contribution of AI in Medical Sector is precise gigantic. It led to infinite development which has given new scenery to this field. This paper stretches a view from history of AI to development done in medical arena. Though the applications of AI has many limitations in accepting new technology to this field, researchers and doctors made it possible to apply these technologies with best of their use and advancement in treatment of every disease (minor or major) without harming any environmental living being. AI technologies and its vast solicitations made it probable to solve every challenging problem in the field of medicine. Clinical practicing, medical imaging, robot-assisting surgeries, drug formation and analysis, pharmaceutical products making, managing large amount of data, etc. are some of the applications of AI, that reduced human labor and assisted physicians in their hard work. Thus, when technologies applied in proper way, reduces the risk of blunder in the treatment of patient and life risking situations. Hence, AI is considered the most appropriate way to develop new things to reduce human effort and labor.

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