JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

ARTIFICIAL INTELLIGENCE IN HEALTHCARE (APPROACH, BENEFITS & LIMITATIONS)

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Abstract: Artificial intelligence (AI) is a set of technologies that allow machines to perform tasks that are usually associated with human intelligence. AI is being effectively utilized in a multitude of setting such as hospitals, and clinical laboratories as well as in research approaches. The basic or salient feature of AI in the medical field is treatment management as well as its diagnosis. AI systems in health care are succeeding because of the advanced algorithms for learning numerous characteristics from a huge amount of health care data that helps in problem-solving and achieved highest success rate in diagnosis that is futile for humans. The algorithms can be furnished with auto-learning to improve performance and accuracy. AI systems are utilized to facilitate physicians with advanced medical knowledge about journals, clinical papers to brief patient care and medical textbooks. AI can offer less diagnostic and therapeutic errors. AI uses medical data, especially from a patient's medical history, to learn to improve itself. There are many types of AI that can be used in the healthcare field, including biomarkers, natural language processing, rule-based expert systems, and physical robotics. AI is used to improve patient outcomes, enable more precise treatment, facilitate precision medicine, and optimize healthcare management.

1. INTRODUCTION:

Artificial Intelligence (AI) and its related technologies are widely used in various fields including healthcare. AI is currently being effectively applied in a wide range of environments, such as hospitals, clinical laboratories, and research methods. While its use in engines and machines is growing, AI is playing an important role in the advancement of the electronic health record (HER) and the life sciences and neurosciences. The primary function of AI in the medical field is to find the disease and treatment of diseases. AI originates from the field of science and engineering that focuses on the computational understanding of intelligence and intelligent behavior, leading to the creation of artefacts that exhibit such behavior.

Furthermore, AI can be defined as the ability of a machine to imitate intelligent human behavior using specialized computer software for tasks normally performed by humans. Intelligence is required, all while doing it more efficiently and at a lower cost. The main objective of AI is to develop systems that can think and act like human brains, resulting in what are known as intelligent agents. Formally, AI is described as a scientific domain devoted to computationally understanding intelligent behavior and creating intelligent agents that exhibit such behaviors. This can be interpreted as machines exhibiting human-like capabilities to perform tasks traditionally performed by humans.

British mathematician Alan Turing (a pioneer in modern computer science and AI) created a Turing test. This Turing test checks the ability of computers to engage in human-like tasks. AI has skills and the ability to complete particular tasks. AI aims to understand, imitate intelligence, and perform different tasks with minimal human intervention. “Different functions and related challenges are to be solved.”

AI systems in healthcare succeed because of advanced algorithms that learn various features from vast amounts of healthcare data, solving problems at a speed and scale unreachable by humans. These algorithms can be enhanced with auto-learning capabilities to increase performance and accuracy. AI supports physicians by providing access to extensive medical knowledge from journals, clinical papers, and textbooks, thereby improving patient care and reducing diagnostic and therapeutic errors. For learning purposes, AI can use medical data, especially from patient populations. Intelligent agents employed in AI systems consist of a computational core with physical actuators and sensors, often referred to as robots. Alternatively, an infobot operates solely in a computational environment, while a decision support system combines an advisory program with human expertise.

There are many applications related to the health sector that use AI to predict disease risks, assess treatment efficacy, manage treatment complications, enhance patient care, conduct clinical research, and drug development. AI is also used to assist researchers in performing surgeries, treating diseases, and designing expensive clinical trials.

2. TYPES OF AI:

AI is doing great work in healthcare. It will improve patient outcomes, streamlining operations and providing new insights into medical conditions and treatments. Different types of AI are implemented in healthcare, each with unique capabilities and potential applications. Here's a breakdown of the main AI types in healthcare and how they're shaping the industry:

2.1 MACHINE LEARNING (ML) AND DEEP LEARNING:

Machine learning and deep learning, is the foundation of AI in the healthcare field and plays an important role. Machine learning algorithms can analyze large amounts of data, learn new patterns, and make predictions without having to set up special programs for each task. In healthcare, ML and DL are applied in areas such as:

2.1.1 MEDICAL IMAGING AND DIAGNOSTICS:

Machine learning is primarily used to interpret complex images such as X-rays, MRIs and CT scans. Deep learning algorithms, particularly convolutional neural networks (CNN), can easily detect tumors, fractures or other abnormalities with accuracy equal to or greater than that of a human expert. These algorithms reduce diagnostic errors and allow radiologists to detect abnormalities faster and more accurately with the technique.

2.1.2 PREDICTIVE ANALYTICS:

Machine learning algorithms analyze patient data (eg. patient medical history, demographics) to predict improvements in patient health, risk of patient relapse, or likelihood of treatment.

2.1.3 DRUG DISCOVERY AND DEVELOPMENT:

ML accelerates drug discovery by predicting the efficacy and safety of potential drugs. AI-powered platforms screen millions of compounds, analyze molecular structures, even predict how they will affect human cells. Companies use it to reduce the time and cost of drug development, helping to identify drug candidates faster.

2.2 NATURAL LANGUAGE PROCESSING (NLP):

Natural language processing is a type of AI that enables computers to understand, interpret and produce human language. In healthcare NLP is used in:

2.2.1 ELECTRONIC HEALTH RECORD (HER) DATA EXTRACTION:

EHRs contain large amounts of unstructured data, such as clinical notes, lab results, and patient histories. NLP algorithms process this data to extract relevant information such as medical conditions, treatments and outcomes. It can provide physicians with overview information reduce time spent checking patient records and allow them to focus more on patient care.

2.2.2 CLINICAL DOCUMENTATION:

NLP-powered solutions can transcribe and summarize patient-physician interactions, reducing the documentation burden on healthcare providers. With NLP, providers can generate real-time clinical documentation from conversations, improving accuracy and efficiency of record keeping.

2.2.3 CHATBOTS AND VIRTUAL HEALTH ASSISTANTS:

AI chatbots and virtual health assistants are proving to be very useful. These use NLP to interact with patients, answer questions, provide medication reminders, or diagnose symptoms. These tools are accessible 24/7 and provide support to patients outside of clinical settings and reduce the burden on healthcare professionals.

2.3 ROBOTICS AND ROBOTIC PROCESS AUTOMATION (RPA):

Robotic technologies, with the help of AI, play an important role in surgery, rehabilitation and management processes:

2.3.1 SURGICAL ROBOTS:

AI-powered robotic surgeries have the potential for greater precision and control. Improves outcomes in procedures such as orthopedic surgery and minimal physical damage. For example, the da Vinci surgical system enables surgeons to make precise incisions and operate with minimal invasiveness, reducing recovery times and complication rates.

2.3.2 REHABILITATION ROBOTS:

These robots assist patients in physical therapy, assist with movement and track progress. AI-powered rehabilitation robots adapt to patients' abilities, creating a personalized therapy experience that speeds recovery.

2.3.3 ADMINISTRATIVE AUTOMATION WITH RPA:

Robotic process automation in the healthcare sector automates repetitive tasks and reduces human workload. Processing duties, time tables, billing, and claims can be simplified using RPA. It can reduce costs. This will help the staff to take better care of the patients.

2.4 ARTIFICIAL NEURAL NETWORK (ANNS):

Artificial Neural Networks (ANNs) are helping in diagnostics and treatments. Modeled after the neural structure of the human brain, ANN processes large amounts of medical data to identify patterns and relationships that can be challenging for human practitioners to detect. ANNs help in understanding and interpreting complex imaging such as MRIs and CT scans in diagnostics. These are often more accurate than experts. They also help identify diseases at an early stage such as diabetic retinopathy, cancer, or cardiovascular conditions. ANNs create treatment plans based on patient data, including genetic profiles, medical history and lifestyle factors, so that medicine is maximally effective.

2.5 CLINICAL DECISION SUPPORT SYSTEM (CDSS):

An artificial clinical decision support system (CDSS) in healthcare is a digital tool that uses AI to aid in clinical decision making. CDSS provides treatment recommendations for patients by analyzing large amounts of medical data, patient histories, and laboratory results. CDSS provides treatment recommendations for patients by analyzing large amounts of medical data, patient histories, and laboratory results. It can recommend treatment plans that help high-risk conditions make the right decisions, helping clinicians provide more accurate and timely care.

3. APPLICATIONS OF AI:

With the help of AI, AI is harnessing some of the most important approaches to healthcare, from diagnostics and treatment to patient care and administrative efficiency. Some of the main applications are as follows:

3.1 DIAGNOSTICS AND IMAGING:

3.1.1 MEDICAL IMAGING:

Algorithms using AI can administer X-rays, MRIs and CT scans to detect abnormalities such as cancer or fractures more accurately and quickly than human radiologists.

3.1.2 EARLY DETECTION OF DISEASES:

Models using machine learning are used to detect diseases like cancer and diabetes at an early stage so that their treatment can be more effective and the patient can be treated sooner.

3.2 PREDICTIVE ANALYSIS AND RISK ASSESSMENT:

3.2.1 DISEASE PREDICTION:

AI models predict the probability of diseases by analyzing data. For example: - By looking at the patient's lifestyle and past health records, they can assess the risk of cardiovascular disease and maintain the necessary data.

3.2.2. HOSPITAL OPERATIONS:

Using multiple models helps hospitals manage patient flow, staffing, and resource allocation by predicting future patient admissions and emergency room needs.

3.3 DRUG CREATION:

Machine learning algorithms are used to reduce drug discovery time. This can aid in the discovery of new compounds as potential drugs for a disease. It can also be used to identify previous applications Therefore, AI can be skillfully combined with in-memory computing technology. For use in drug creation and this increases the potential to offer rapid drug discovery and development.

3.4 VIRTUAL HEALTH ASSISTANTS AND CHATBOTS:

3.4.1 PATIENT INTERACTION:

Chatbots provide regular support, answering patient questions, reminding them about medication schedules, and gathering basic information before appointments.

3.4. MENTAL HEALTH SUPPORT:

AI-powered apps and conversational tools such as Woebot and Wysa provide support for mental health. AI presents therapeutic conversations and conditions like anxiety as well as depression are managed by AI.

3.5 REMOTE MONITORING AND MANAGEMENT OF CHRONIC DISEASES THROUGH WEARABLE DEVICES:

Smart watches monitor patient activities and use AI to detect abnormalities in the management of chronic diseases such as diabetes.

3.6 PATIENT CARE ROBOTS:

AI-powered robots can help patients to walk and monitor their important needs. These robots can act as assistant of elders. TELEMEDICINE AND REMOTE MONITORING: AI software's can analyz data from watches and smart bands and support remote diagnosis and treatment, It is very helpful for patients in rural areas..

4. ADVANTAGE OF AI:

Artificial intelligence (AI) in healthcare has many advantages, which are the following:

ENHANCED DIAGNOSTICS:

AI algorithms, especially in fields such as medical, can detect diseases like cancer, heart disease, and neurological conditions earlier and more accurately than older methods, allowing for faster treatment and in many cases, improved patient outcomes.

PREDICTIVE ANALYTICS:

AI can analyze large amounts of patient data to predict outbreaks, patient deterioration, or complications, enabling preventative measures and better resource allocation.

PERSONALIZED TREATMENT:

AI enables personalized treatment plans by analyzing history, environmental and lifestyle factors. For example, it can help in precision medicine by suggesting customized drug treatments for individual patients.

EFFICIENCY AND COST REDUCTION:

AI-powered automation in administrative tasks such as scheduling, billing, and data entry reduces costs, reduces human error, and allows healthcare providers to focus more on patient care.

REMOTE MONITORING AND TELEMEDICINE:

AI-powered wearable devices and telemedicine platforms enable remote monitoring of patient vitals, aid in the management of chronic diseases and provide care in underserved or remote areas.

DRUG DISCOVERY AND DEVELOPMENT:

AI helps speed up drug discovery by identifying potential drugs and analyzing data to simulate their effects, significantly shortening development time and scope. And reduces the expenses incurred on it.

IMPROVED WORKFLOW:

AI optimizes hospital workflow, predicts patient admission and discharge times, which helps manage bed availability and staffing, and improves the overall quality of care delivery.

Overall, AI in healthcare supports clinicians, improves patient outcomes, and increases efficiency in healthcare delivery, paving the way for a more proactive, personalized, and accessible healthcare system.

5. LIMITATIONS OF AI:

AI in healthcare presents significant potential, but it faces several problems that affect its effectiveness. There are some key limitations which are as follows.

DATA PRIVACY AND SECURITY CONCERNS:

Healthcare data is highly sensitive, and the need to access large datasets effectively is met by AI. Compliance with regulations such as the Health Insurance Portability and Accountability Act is essential to ensure data privacy, as improper data handling can lead to privacy violations.

INTERPRETABILITY AND RELIABILITY:

Many AI models, especially deep learning models, act as “black boxes,” meaning their decision-making processes are difficult to interpret. In healthcare, where transparency and trust are key components, this lack of clarity can hinder adoption, as clinicians and patients may be wary of AI but may not understand it.

REGULATORY AND ETHICAL CHALLENGES:

Healthcare is a critical sector, and given the pace of regulatory processes, implementation of AI tools may be delayed. In addition, ethical concerns, such as the potential for AI to affect life-death decision-making or patient autonomy, require careful consideration.

INTEGRATION INTO CLINICAL WORKFLOWS:

AI tools must integrate seamlessly with existing clinical workflows to be effective, but many existing AI solutions are not user-friendly or compatible with existing health record systems, leading to resistance from healthcare providers. And the workload increases.

RELIANCE ON HUMAN SUPERVISION:

While AI can aid in diagnosis and treatment recommendations, it is not yet capable of independent clinical judgment. Human supervision is still necessary to confirm AI recommendations, which can limit the speed and efficiency gains promised by AI.

COST AND RESOURCE REQUIREMENTS:

The use of AI technology requires substantial financial investment in infrastructure, skilled workers, and its maintenance. This can be difficult for smaller healthcare organizations or those with limited budgets.

LIMITATIONS IN CLINICAL JUDGMENT AND NUANCE:

AI lacks the intuitive and contextual understanding that healthcare providers bring to complex cases. Many aspects of patient care, such as empathy, ethical decision-making and critical judgment, are difficult for AI to replicate, particularly in personalized or end-of-life care situations.

While AI has the potential to transform healthcare, addressing these limitations is essential to achieving safe, ethical, and effective AI integration into clinical practice.

6. CONCLUSION:

Artificial Intelligence has a sanguine effect on healthcare because it has the capability accommodate and analyze gigantic data that produce more precise results. With the use of AI technology, doctors will have to rethink the manner in which they treat their patients .Robotics used in Al play a vital role in the automatic processes in medical science. These robots are used in performing surgeries, and monitoring patients. Using Al in healthcare would reduce cost and would be convenient to extend medical care to remote areas where health support limited.

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