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APPLICATION OF ARTIFICIAL INTELLIGENCE IN HEALTHCARE: CHANCES AND CHALLENGES

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Abstract: ***Artificial intelligence (A.I.) technologies are proving to be an essential discussion regarding their use in healthcare A.I. has become of increasing importance due to the multiple uses it has. Techniques such as machine learning have become of prime importance, but it is only one of several vital to enhance the quality of the doctor-patient relationship. However, despite the efficiencies A.I. provides to doctors, patients, and researchers, the discussion around it still points to a limitation which would mean that A.I. would not supersede human involvement in healthcare anytime soon. This paper traces the discussion on A.I. in healthcare by giving information about A.I. and the forms of it which are used in healthcare and the role each has to play. Through data, the potential and improvements brought about by A.I. in healthcare are highlighted, followed by the shortcomings and limitations which prove that in spite of the many enhancements provided by A.I., there are still shortcomings that prevent it from being fully embedded into the healthcare sector.***

Keywords: Artificial Intelligence, Machine Learning, Healthcare, prevention.

I. INTRODUCTION

Emerging Artificial Intelligence (A.I.) technologies are proving to be valuable tools to assist human doctors in the field of healthcare. Technologies such as machine learning[1] have been significant in medical care, especially for precision medicine,[2] with their ability to utilize models designed with training data that allows them to identify the input. This technology helps predict appropriate treatment to be given to a patient based on past data. Other uses of A.I. are listed as follows:

1. Diagnosis and Treatment Design- A.I. has been integral in providing accurate diagnosis and designing treatment plans for patients utilising the data provided about their medical history.[3] A.I. technology such as IBM's Watson, through its increasing ability to read radiological images such as C.T. scans, MRI, and X-rays, can swiftly identify diseases and lay down the appropriate plan of treatment and monitoring for the patient. Various techniques such as neural networks, decision trees, and artificial neural networks have been successful in diagnosing diabetes and cardiovascular diseases.[4]

2. Electronic Health Records- A.I.'s role in maintaining and analysing electronic health records aids precision medicine. The records, including the patient's medical history and past treatments, can be analyzed to create an algorithm that identifies the connection and causality to provide an accurate diagnosis. Using previous medical records to identify the correct medical situation helps treat patients efficiently.

3. Drug Interactions and Discovery- Developing an A.I. algorithm that analyses various drug interactions in case of multiple medication intakes and their effects helps prevent risk to the patients as doctors would know the drugs in their systems, leading to prescription accordingly. Furthermore, the process of discovering new drugs, which is usually tedious and time-consuming, has been shortened with the aid of machine learning technology,[5] this can quicken the discovery of new compounds needed to create the drug. It also allows for finding multiple applications of those tested compounds.

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4. Dermatology- Deep learning techniques can read dermatology's contextual, micro, and macro images, leading to accurate image processing. Techniques like convolutional neural networks have an accuracy level of 94% in differentiation between skin lesions and skin cancer.
5. Radiology- As mentioned above, A.I. can accurately and quickly read radiological imaging such as C.T. scans; for instance, an experimental algorithm at Stanford could detect pneumonia in patients faster than human radiologists.[6] Physical robots read X-rays and radio scans faster. Medical Sieve, developed by IBM,[7] Acted as a cognitive assistant with clinical knowledge and analytical capabilities, requisite for helping physicians.
6. Psychological Conditions and Primary Care- A.I. can provide primary care to patients, reducing the workload of physicians. Chabot's have been developed to replicate human behaviour to analyse the signs of depression and anxiety. Psychological conditions in children can be identified, for instance, autism, through technology developed by Right Eye LLC. This invention tracks eye movement to detect any autism spectrum disorder.[8]

II. ARTIFICIAL INTELLIGENCE

Artificial intelligence, which is the intelligence of machines,[9] emulates human skills to execute an efficient functioning and leads to machine learning.[10] A.I. algorithms are executed by a conceptual framework called the Artificial neural network that functions similar to the human brain[11] In healthcare, A.I. is used for processes such as diagnosis, treatment, drug development, monitoring, and patient care, by analysing the medical data and the required outcomes for patients.[12] It is popularly used for cancer classification,[13] nervous system-related diseases,[14] cardiovascular diseases[15], etc. Support vector machine classifies subjects into groups.

Different techniques such as machine learning, neural networks, and Deep Learning are used in healthcare. Machine learning allows the system to learn and act based on predetermined training data sets. Different types of machine learning are as follows:

1. Supervised Learning- In this, previously learned data that trains the model is applied to the new data to provide an output. The algorithm compares the actual output with correct outputs and updates itself in case of inconsistencies.[16]
2. Unsupervised Learning- The learning process does not occur from any pre-existing data. It includes algorithms such as clustering, anomaly detection, and neural networks, used for data analysis to find patterns or grouping in data. This learning also allows the user to perform processing tasks, though it is more unpredictable than other learning processes.[17]
3. Semi-supervised Learning- This type of learning balances supervised and unsupervised learning, processes labeled data to learn and applies it to unlabeled data.[18]
4. Reinforcement Learning- In this, the algorithm uses reinforcements to train the system. Correct outcomes reward the system and incorrectly receive penalties.
5. Deep Learning- This method, inspired by processing and communication in biological

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[17] Ibid.
[18] Ibid.

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neurons, is machine learning. Artificial Neural Networks (ANN), a network of artificial neurons, are trained in deep learning. ANN has a minimum of three layers: the input layer, which intakes the input; the hidden layer, which trains based on the data provided in the input; and the output layer, which provides the final result. Deep Learning is rapidly gaining popularity and constitutes convolutional networks, artificial neural networks used to process and classify images.

III. DIFFERENT DEEP LEARNING ARCHITECTURES APPLIED IN HEALTHCARE

1. Neural Network- Neural networks work like the human brain and recognize underlying relations in a dataset. These are also known as artificial neural networks. A neuron, when stimulated, is called a node. A node combines input from data with weights that either enhance or reduce the input and assign it to the algorithm it tries to learn. The output of one layer becomes the input of the next.[19]

2. Convolutional Neural Network- This artificial deep neural network is essential in image classification and recognition. CNN identifies the input image and gathers the objects classified into appropriate clusters depending on connections and weights. This is followed by subsampling.[20] A CNN structure constitutes the following layers:

i. Input Layer- The input layer contains image data reshaped into a single column and added as input. The output of one layer becomes the input for the next.
ii. Convolutional Layer- This layer begins processing the data by identifying features of the input image, such as colour, shape, and elements of the object. This layer increases the non-linearity of the image and provides a better-extracted image. This is in addition to a pooling layer that reduces the spatial volume of the image after convolution.
iii. Fully Connected Layer- This layer categorises the image through training and contains neurons that are connected to another through the use of this layering.
iv. SoftMax Layer and Output Layer- This last layer is utilised for binary classification of the input image. This is followed by an output layer that provides a final output label for the input.[21]

CNN is employed primarily for image analysis and can recognise anomalies more accurately than the human eye. This includes identifying problems in MRI images, X-rays, retinal imaging, and cancer classifications. It also plays a role in health risk assessment, discerning the possibility of occurrence or recurrence of diseases, which is essential for designing a treatment plan. CNN is also used in drug discovery and detailing patients' plans on existing drugs.

3. Recurrent Neural Network (RNN)- In this, a neural network repeats over time in a loop pattern.[22] These networks, developed in 1980, are emulated from feed-forward neural networks, which plot input vector into output vector. RNNs have the following variants:

1. The echo state network connects to a random hidden layer, and only the weights of the output neurons can be trained.
2. Independent RNN deals with the problems of traditional RNN, such as gradient vanishing and exploding.
3. Recursive neural networks repeatedly apply a similar set of neuronal weights on a different graph in topological order.
4. Long short-term memory is a pattern of deep learning that avoids the problem of vanishing gradient through "forget gates," which help the long short-term memory function. This avoids issues such as backpropagation errors, vanishing, and exploding and can handle mixing high and low-frequency components.
5. Gated recurrent units perform a gating function for RNN and work similarly to the long short-term memory.
6. The continuous-time recurrent neural network uses simple differential equations to model the effects on a neuron of an incoming spike train.[23]

[19] Available: https://wiki.pathmind.com/neural-network.
[20] Available: https://en.wikipedia.org/wiki/Recurrent_neural_network
[21] Ibid.
[22] Ibid.
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IV. DISCUSSION

Artificial intelligence has the potential to revolutionize healthcare[24] through its functioning in treatment planning, drug discovery, cancer classifications, image recognition, and data management. With the massive volumes of medical knowledge being researched every day,[25] A.I. aids in analysing and collaborating to utilise this evolving body of knowledge in providing the best decisions for patients. It also reduces the workload of medical staff significantly.[26] As it performs routine tasks such as test analysis, X-rays, and C.T. scans.[27] This is essential for cardiology and radiology, where the study is intensive and time-consuming.

The quality of treatment has also undergone improvement. A.I. recognises symptoms and occurrences of anomalies and diseases in radiological images faster than human clinicians, allowing early detection, and potentially life-saving. With the advent of mobiles and messaging features, healthcare bots facilitate patients and manage their medication by informing them about the need for medication and the required dosage to be consumed.

Deep Learning has gained ground in skin cancer diagnosis. Research has found that by 2021, 6.3 billion people will have subscriptions on mobile phones that diagnose skin cancer.[28] Dataset from HAM1000 had been used to train, and 80% of these images were used to train and 20% to validate the learning, with the help of CNN models such as DenseNet201, etc.[29] Another research saw the use of work transfer learning on the AlexxNet model where the classification layer was replaced with a softmax layer as the softmax layer can detect and classify color images into nevus, seborrheic keratosis, and melanoma, necessary to recognize skin lesions.[30]

To identify malignant skin types, CNN was trained using 4867 clinical images obtained from a hospital's dataset from 2003 to 2016.[31] This research saw an increasing accuracy in detection. However, the CNN architecture is not foolproof and has the potential for misclassification due to adversarial attacks caused by alterations in colour balance and rotation image. Another study, using the ResNet model, calibrated the model with 19, 398 images and managed to classify 12 types of skin diseases.[32]

A.I. techniques have been used to identify psychological disorders in children.[33] A.I. has been utilised in identifying early-onset autism in kids and persons up to the age of forty[34] through the use of eye-tracking mechanisms that determine the condition of the brain and their response to images.[35] A.I. has also been indelible in experimentation for improvement of the environment in relation to diseases like pulmonary, cardiovascular, cancer, and psychiatric disorders. A study of air pollution's effect on children's cognition used machine learning.[36] Though this method was useful, the collection of data globally and environmental factors caused a hindrance.

A.I., mentioned above, has also played an essential role in drug discovery and invention and has been a part of clinical trials to design and create data mines. Feed forward feature selection has been used to predict depression

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from cross-trails.[37] Social media such as Twitter, Facebook, and Instagram have been linked with an increase in cardiovascular diseases. Digital media has resulted in a rise in hyperactivity disorders in adolescents aged 15-16 years.[38] Research on social analytics and mind health detected suicidal ideation and depression risks.[39]

Another research saw the use of deep learning and model-based integration to determine emission rates and rate of survival for cancer.[40] The researcher-built models by using data and creating aggregating model outputs. Deep Learning has also been employed for the diagnosis of retinal diseases.[41] The process of diagnosis included segmentation of images from 3D optical coherence tomography images. CNN then analysed the segmented images to formulate a diagnosis. Retinal image scanning for diabetic retinopathy requires an image to be scanned and uploaded on the software, which detects whether the patient requires the professional help of an ophthalmologist and a rescreen in 12 months.[42]

However, there are shortcomings to the methods of image analysis. Image analysis relies on natural images to train the system, which is enhanced to create a more accurate image. These raw images come from mobile phones and cameras and have different lightings, which may affect the outcome of the image. Another emerging critical issue is data security in healthcare, where confidentiality of patients' data is of utmost importance.

V. LIMITATIONS AND DRAWBACKS

Though the use of artificial intelligence is slowly becoming essential, it comes with its challenges. Deep Learning requires a large amount of data, which cannot always be obtained as patients are often reluctant to share their data due to privacy concerns. A.I. also struggles with the detection of variants in diseases[43] as it differs from individual to individual. The data from healthcare institutions is often ambiguous and incomplete, causing hardship in applying A.I. effectively. Furthermore, the adoption of A.I. by clinicians has been a slow movement as they are unable to adapt to technological advancements. Therefore, A.I. applications need to be made more user-friendly to allow people to access them.

VI. CONCLUSION

Artificial intelligence is becoming indispensable in healthcare to provide faster and more efficient outcomes. Technologies such as machine learning and deep learning can assist in diagnosing diseases such as cancer and cardiovascular diseases and surgeries. However, there is a need to further the research and support from the government for the betterment of A.I. to be more widespread in the healthcare system. A.I. is potentially life-saving and cost-effective, improving the country's quality of life and health. Needs further study on the application of such products and processes in India. Also need a comprehensive look on use of such technology through automation process and legal complications.

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