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ARTIFICIAL INTELLIGENCE IN BIOMEDICAL ENGINEERING: REQUESTS AND FUTURE ASPECTS

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ABSTRACT

Artificial intelligence (AI) has become the recent and advanced technology that offers innovative solutions in healthcare. Here, the terminology “Biomedical Engineering” appears and tries to successfully help big issues in the field of healthcare. AI exists in almost every part of recent technologies to solve patients’ problems starting from diagnosis, monitoring, and treatment of diseases. Under AI umbrella, a lot of techniques exists such as machine learning (ML), deep learning (DL), and Internet of Things (IoT) which insert more accuracy, efficiency, reliability, and durability of medical devices. However, these techniques insert a lot of advances in imaging systems, signal processing, and clinical decision support systems. On the other hand, there are some limitations and restrictions that accompany these new technologies such as data collected and overfitting. In fact, these issues still delay the full adoption of AI-based systems in healthcare. This paper presents the applications and future directions of AI in healthcare.

KEYWORDS: Disorders Artificial intelligence, Machine learning, Deep learning, Medical Imaging, Biomedical engineering.

INTRODUCTION

Biomedical engineering is one of the important fields in engineering in general and in electrical and electronic engineering in specific. This field of engineering plays an important role in integrating the aspects of electronics engineering, biology, and medicine to develop technologies that improve healthcare delivery and patient outcomes. Recently, digital data and computational power play a significant role in integrating artificial intelligence (AI) in biomedical engineering.

AI refers to the capability of computing schemes to perform tasks frequently related to human intelligence. It creates and examines approaches and software that qualify devices to observe their surroundings and use learning and intelligence to perform schedules which expand their likelihoods of reaching set goals. In healthcare field, AI refers to the custom of algorithms to diagnose, predict, detect, and solve healthcare issues. It is also used to improve the efficiency of medical devices. However, AI-based approaches can analyze big data related to patients competently, affording precise and reliable results.

There is a promise for a more personalized, efficient, and accessible healthcare system in the future due to its potential to revolutionize patient care, diagnostics, and operational efficacy. Before integrating AI into the healthcare part, principled, authorised, and educational contemplations should be wisely inspected as the technology improves. Overcoming these challenges will allow AI to fulfil its promise of transforming healthcare into a more equitable and efficient system where human decision and methodological expertise work together to deliver better care.

AI TECHNOLOGIES IN BIOMEDICAL ENGINEERING

There are many AI technologies that applied in biomedical engineering and aim to help in healthcare fields such as machine learning, deep learning, and Internet of Things.

A. MACHINE LEARNING

This approach enables systems to learn patterns from data without being explicitly programmed. Its algorithms are widely used in biomedical engineering such as Support Vector Machines (Guido et al. 2024), Neural Networks (Sordo 2002), K-Nearest Neighbours (Shouman, Turner, and Stocker 2012) and Decision Trees (Abdulqader and Abdulazeez 2024). These algorithms are used for classification, detection, and prediction tasks.

When Alan Turing anticipated the first system that may learn and converted artificially intelligent in the 1950s, machine learning began to be utilized. Since its beginning, machine learning has been employed to several fields, from face detection for security services to enlightening public transit efficiency and lowering risk, and more newly, to different planes of biotechnology and healthcare (Muggleton 2014).

Large portions of feature extraction and data processing are carried out before entering the data into the algorithm because models are single layered. For these machine learning algorithms to make accurate predictions and prevent overfitting or underfitting the training dataset, they need extensive data preprocessing without the additional layers.

A decision assistance tool that starts with a single node and determines the latent consequences of that decision is called a decision tree algorithm. Until it reaches a final product, the tree keeps going with the outcome of that choice and the subsequent choices.

Support Vector Machines (SVM) are classification algorithms that utilize supervised learning for classifying features in two group problems via identifying the best fit for arranging the data and the biggest margin hyperplane to divide it.

An input layer, one or more hidden layers, and output layers make up Artificial Neural Networks (ANNs), in which functional units or neurons in one layer are connected to each neuron in the layer before and after. ANNs are considered the classical algorithms that make the basic for many techniques (Sordo 2002).

B. DEEP LEARNING

Healthcare is changing in previously unheard-of ways due to deep learning. This technology allows robots to simulate human cognitive processes like pattern recognition and decision-making by utilizing sophisticated algorithms and large datasets. Massive volumes of medical data are processed by deep learning in the healthcare industry to reveal previously unachievable insights. It has a significant and wide-ranging impact on everything from early disease detection to customized treatment regimens (Esteva et al. 2019).

This technology utilizes multi layers and hidden layers to model complex data representations. Deep learning models are trained on large datasets in the healthcare industry to carry out tasks including predictive modeling, image analysis, and natural language processing. Deep learning has multiple layers that develop data to recognize composite outlines. In deep learning, there is a necessity to train massive datasets as well as diverse datasets to improve model accuracy. Moreover, deep learning involved advanced algorithms that enable continuous learning and adaptation. Deep learning uses advanced computing power where it needs high-performance GPUs to accelerate data processing (Jeon et al. 2021). The implementation of deep learning conveys many compensations, making healthcare more operative and manageable.

Deep learning contains some techniques such as convolutional neural networks (CNNs) which are more sophisticated types of neural networks that are mostly used for a variety of tasks involving images and videos. They are highly helpful for applications like object detection, medical imaging, and facial recognition since they are made to learn features straight from the input, automatically identifying patterns like edges, textures, and forms (Wassan et al. 2024).

Another technique in deep learning is used to overcome the vanishing gradient problem, which is a particular kind of RNN that is the Long Short-Term Memory (LSTM) (Narla, Valivarthi, and Peddi 2019). It can acquire several dependencies in data to discover its claim in many applications. LSTM finds its way to help biomedical engineers to implement algorithms with different hidden layers to predict deterioration in patients either in ICU or in general wards.

APLICATIONS OF AI IN HEALTHCARE

A. MEDICAL IMAGING

AI in biomedical engineering uses its approaches in almost every medical device belongs to imaging field. Algorithms are always used to detect tumers and process images. New AI-based technologies improve models to write high accurate medical reports for patients. Deep learning models, particularly CNNs, have shown remarkable accuracy in detecting tumors, fractures, and abnormalities (Ahad, Kobashi, and Tavares 2018).

Algorithms associated with image processing uses codes to improve resolutions and feature extraction. In fact, deep learning, which can learn hierarchical representations straight from raw data, has overcome many of the constraints of conventional techniques. The emergence of multi-layered neural networks allowed models to automatically identify complicated patterns and features that were previously unattainable using manual procedures. This change from handmade feature engineering to automated feature learning was a critical point in image processing, allowing for major advances in both accuracy and generalizability across a broad range of applications (Alnaggar et al. 2024).

B. EARLY DISEASE DETECTION AND PREDICTION

AI is a main layer of detection for heart disease and lung cancer. AI-based systems enable specialized precision in retinal scans, detecting diabetic retinopathy and launching treatments ahead of visual degradation.

The United Kingdom government has supported various experiments that forecast the number of years until Alzheimer's, helping people to prevent and prepare for the disease. Imperial College developed a stethoscope that combines heart sounds and ECG to quickly detect heart failure and arrhythmias. This demonstrates the global usage of artificial intelligence in the medical field (Getsios et al. 2012).

THE FUTURE OF AI IN HEALTHCARE

Digital platforms have democratized access to information and healthcare services, encouraging individuals to take an active role in their own well-being. Telehealth systems allow for remote consultations and increased access to specialized treatment, breaking down geographical restrictions. mHealth apps empower individuals to monitor and control their own health, promoting proactive health management practices (Spinean et al. 2024).

The advancement in algorithms associated with machine learning and deep learning rise the outcomes of healthcare. Recently, almost all medical devices change from detection to prediction in diseases causes. The prediction holds the healthcare to a new era that is capable to warn the medical teams early and before a good response time.

CONCLUSION

AI-based systems and technologies provide a big help to healthcare field. It employs its new high technologies in all medical devices. Applications of AI in healthcare distributed in many fields especially in imaging systems. This new technology needs to be employed in the optimal way to reach the success.

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