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Artificial Intelligence is Being Used to Detect Breast Cancer in Mammography

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Abstract

Breast cancer is a significant global health concern, and early detection plays a crucial role in improving patient outcomes. Mammography, a widely employed imaging technique for breast cancer screening, can benefit from advancements in artificial intelligence (AI) technologies. This paper presents a comprehensive review of the utilization of AI in the detection of breast cancer through mammography. The review encompasses various AI approaches, including convolutional neural networks (CNNs), deep learning architectures, and machine learning algorithms, which have demonstrated substantial potential in enhancing the accuracy and efficiency of breast cancer detection. By analyzing a diverse range of studies, this paper highlights the key contributions, challenges, and future prospects of AI-powered breast cancer detection in mammography. The integration of AI techniques has the potential to revolutionize mammographic analysis, enabling earlier and more accurate diagnoses, ultimately leading to improved patient care and prognosis.

Keywords: Breast cancer detection; Mammography; Artificial intelligence; Deep learning; Convolutional neural networks

Introduction

Breast cancer is one of the most prevalent and concerning malignancies affecting women worldwide. With its high incidence rates and potential for mortality, timely and accurate detection remains pivotal in the battle against this disease. Mammography, a well-established diagnostic tool, has been instrumental in identifying early signs of breast cancer, leading to improved survival rates [1]. However, the interpretation of mammographic images is a complex task that requires a keen eye and substantial expertise, often leading to variations in diagnostic accuracy. In recent years, the rapid advancements in artificial intelligence (AI) and machine learning have ushered in a new era of medical image analysis. AI algorithms, particularly deep learning techniques, have demonstrated remarkable capabilities in various domains, including computer vision and natural language processing [2]. Leveraging these capabilities, researchers and healthcare professionals have turned their attention to enhancing breast cancer detection through the automation and augmentation of mammographic analysis.

This paper presents a comprehensive exploration of the integration of AI in the detection. Using artificial intelligence (AI) to classify breast tumors as malignant or benign from breast ultrasound images can be an effective and relatively inexpensive method of diagnosing breast cancer. Many machine learning (ML) and deep learning (DL) algorithms are currently used for early breast cancer detection. AI algorithms show promising results in breast cancer detection tasks [3]. The use of a deep convolutional neural network approach provided a solution for efficient analysis of breast ultrasound images. CNN (convolutional neural network) models analyze image data in multiple layers to extract features, resulting in better feature extraction and better performance compared to traditional ML algorithms. In addition to traditional learning algorithms, we use transfer learning techniques where knowledge from previous training is used in another related problem group [4]. In this chapter, we demonstrated the usage of DL models through transfer learning, deep feature extraction, and machine learning models and compared their performance. The first melanoma tumor has affected millions of people across the globe and taken many human lives. It can be diagnosed in its early stage; therefore it becomes very important to detect it before it becomes lethal. The melanoma skin cancer can be detected from the images of tumor by applying various techniques of deep learning. Medical science has progressed to a large extent in recent times [5]. Its progress can be catalyzed further with the help of technology such as artificial intelligence or deep learning. In the first stage of our study, we used CNN (convolutional neural network) and transfer learning for differentiating between normal and melanoma tumors. In this paper, we delve into the diverse range of AI methodologies that have been employed in the realm of breast cancer detection [6]. From convolutional neural networks (CNNs) that excel in image feature extraction to machine learning algorithms that aid in pattern recognition, these techniques have showcased promising results in increasing the sensitivity and specificity of mammographic analysis. By examining the existing body of research, we aim to provide insights into the evolution of AI-powered breast cancer detection, shed light on the challenges faced, and outline the future directions that this field might take [7]. Ultimately, the integration of AI into mammography holds immense potential for transforming breast cancer diagnosis and patient care. The amalgamation of medical expertise with AI's computational power has the potential to revolutionize how mammograms are interpreted, enabling earlier detection and personalized treatment strategies [8].

Discussion

Using artificial intelligence (AI) to classify breast tumors as malignant or benign from breast ultrasound images can be an effective and relatively inexpensive method of diagnosing breast cancer. Many machine learning (ML) and deep learning (DL) algorithms are

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Benefits of AI in breast cancer detection

AI algorithms, particularly deep learning techniques like convolutional neural networks (CNNs), have demonstrated remarkable capabilities in image analysis. When applied to mammography, AI offers several notable advantages

Enhanced detection accuracy: AI algorithms can identify subtle patterns and features in mammographic images that might elude human observers. This can lead to increased sensitivity and specificity in breast cancer detection, particularly for early-stage and subtle lesions.

Consistency: AI models are not subject to human fatigue or variations in interpretation, ensuring consistent performance across cases and different radiologists. This consistency can reduce interobserver variability and improve diagnostic reliability.

Efficiency: AI-powered systems can analyze large volumes of mammograms quickly, potentially reducing the workload on radiologists. This efficiency enables faster diagnoses, which is crucial for effective treatment planning.

Early detection: Early detection is a critical factor in improving breast cancer outcomes. AI algorithms can identify potential abnormalities at earlier stages, facilitating prompt intervention and improved patient prognosis.

Diabetic retinopathy (DR) is a common consequence of diabetes that causes vision-impairing retinal lesions. DR can lead to blurred vision and blindness if not treated promptly. Unfortunately, DR is irreversible and treatment merely prolongs vision. Therefore, there is a need for aids in early detection and prevention of visual impairment in diabetic patients. Early detection and treatment of DR can greatly reduce the risk of vision loss. In contrast to computer-assisted diagnostic systems, manual diagnosis of DR retinal fundus images by ophthalmologists is time consuming and prone to misdiagnosis. Recent technological advances have brought smartphone-related optical imaging systems to market, enabling low-power DR viewing in a variety of environments. On the other hand, deep learning (DL) has become one of the most widely used approaches recently to improve performance in various fields such as medical image analysis and classification. The purpose of this chapter is to create automatic DR detection for modern eye models using DL models. Additionally, the DL model is implemented using color fundus retinal images. Transfer learning models such as InceptionResNet, VGG and DenseNet architectures are also used for retinal color fundus image analysis. F1 score, accuracy, area under the receiver operating curve (AUC – ROC curve), and kappa score are used to measure the performance of the DL model for DR detection. Using a large number of published datasets on retinal color fundus and various artificial intelligence (AI) techniques, we make a significant contribution to improving DR identification.

Future directions

The future of AI-powered breast cancer detection lies in multidisciplinary collaboration. As AI continues to evolve, partnerships between clinicians, radiologists, data scientists, and ethicists will be essential in driving innovation forward. Transfer learning, where models trained on diverse datasets are fine-tuned for specific tasks, could mitigate the data scarcity challenge. Additionally, federated learning approaches that allow model training across institutions without sharing sensitive data could further advance the field. AI into breast cancer detection through mammography holds immense promise for improving diagnostic accuracy, efficiency, and patient outcomes. While challenges remain, continued research, collaboration, and the development of ethical frameworks are essential to harnessing the full potential of AI in revolutionizing breast cancer diagnosis and treatment. The evolving synergy between technology and medicine stands to reshape the landscape of healthcare and elevate the standard of care for breast cancer patients [11, 12].

Conclusion

The convergence of artificial intelligence (AI) and mammography has ushered in a new era of potential for breast cancer detection and patient care. This paper has explored the transformative impact of AI on breast cancer detection through mammography, highlighting both its promises and challenges. Looking ahead, the path to effective AI-powered breast cancer detection requires concerted efforts in data collection, algorithm refinement, and cross-disciplinary partnerships. Advances in transfer learning, federated learning, and explainable AI hold promise in addressing the existing limitations. The future landscape envisions a seamless integration of human expertise and AI assistance, ultimately yielding more accurate diagnoses, personalized treatment strategies, and improved patient outcomes. In conclusion, the synergy between AI and mammography offers a transformative potential that extends beyond diagnostic accuracy. It reshapes the landscape of breast cancer care, empowering medical professionals with advanced tools to combat the disease effectively. The journey toward harnessing the full capabilities of AI in breast cancer detection is not without challenges, but the collective dedication of researchers, practitioners, and policymakers will undoubtedly steer this technological evolution toward a brighter future for breast cancer patients worldwide.

Conflict of Interest

None

Acknowledgment

None

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