Enhanced Breast Cancer Diagnosis Using Machine Learning on Patient Data and Deep Learning

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Abstract:

Breast cancer remains one of the leading causes of mortality among women worldwide. Early diagnosis significantly improves survival rates. This paper presents an intelligent breast cancer detection system using microwave imaging and deep learning techniques. Convolutional Neural Networks (CNNs) are employed to classify reconstructed breast images into normal and cancerous categories. The proposed approach is non-invasive, radiation-free, and cost-effective compared with traditional methods such as mammography and MRI. Experimental analysis indicates that deep learning models can provide accurate and fast tumor detection, assisting clinicians in decision making.

Keywords

Breast Cancer Detection, Deep Learning, CNN, Microwave Imaging, Medical Image Processing, Artificial Intelligence

I. Introduction

Breast cancer is a major healthcare challenge. Conventional screening methods include mammography, ultrasound, MRI, and biopsy. These methods may involve radiation exposure, high cost, discomfort, or dependence on expert interpretation. Recent progress in AI enables automated image analysis for accurate diagnosis. Microwave imaging detects dielectric differences between healthy and malignant tissues and offers a safer screening alternative. The rapid growth of digital healthcare data, combined with advances in computational power, has accelerated the adoption of artificial intelligence (AI) techniques in medical diagnosis. Machine learning (ML) and deep learning (DL), as subsets of AI, have demonstrated remarkable potential in extracting meaningful patterns from large-scale clinical and imaging datasets. Machine learning approaches utilize statistical and algorithmic techniques to analyze structured patient data, such as tumor size, texture, shape, and clinical attributes, enabling automated classification of breast tumors as benign or malignant.

II. Literature Review

Prior studies have applied machine learning and deep learning to tumor detection. CNN architectures such as ResNet, DenseNet, MobileNet, and Inception have demonstrated strong performance in medical image classification. Microwave imaging combined with AI has shown promise for early-stage tumor localization.

III. Proposed Methodology

The system consists of data acquisition, preprocessing, image reconstruction, feature extraction, classification, and report generation. Microwave signals (S11 and S21) are collected and denoised. DAS and DMAS algorithms reconstruct 2D/3D images. CNN models extract features and classify tumors as benign or malignant. Region-based methods may be used for localization.

IV. System Architecture

Modules include Patient Registration, Data Acquisition, Preprocessing, Image Reconstruction, CNN Classification, Visualization, and Diagnostic Report Generation.

V. Results and Discussion

Fig. 1 Benign

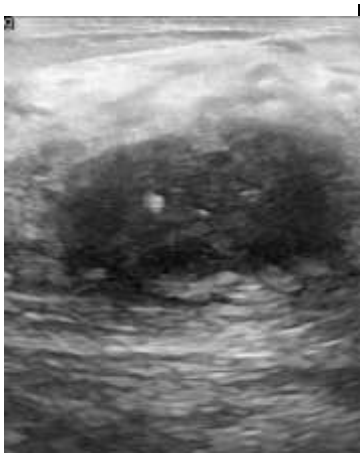

Fig. 2 Maligant

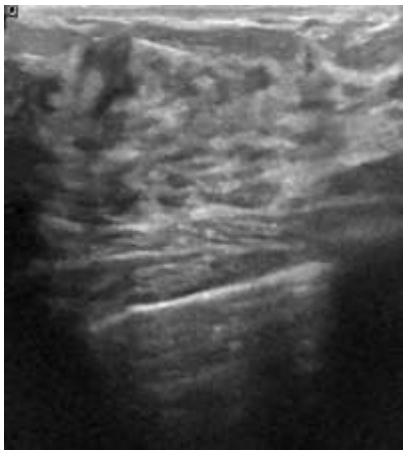

Fig. 3 Normal

The trained model is evaluated using accuracy, loss, AUC, precision, recall, and confusion matrix. Comparative analysis shows that advanced transfer learning architectures can achieve high diagnostic performance. The system reduces manual workload and improves screening efficiency.

VI. Advantages

1) Non-invasive and radiation-free.
2) Faster diagnosis.
3) Lower operational cost.
4) Improved consistency.
5) Supports telemedicine and remote healthcare.

VII. Conclusion

The proposed deep learning based breast cancer detection system demonstrates the potential of AI-assisted healthcare. By integrating microwave imaging with CNN models, the system can support early detection and better clinical outcomes. Future work includes larger real-patient datasets, explainable AI, and mobile/cloud deployment.

References

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