Democratizing Healthcare through Sustainable AI: A Computer-Aided Diagnostic System for Early Breast Cancer Detection

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Abstract:
Early diagnosis of breast cancer remains a critical global health priority, yet significant geographical and socioeconomic disparities limit access to specialized radiological expertise in underserved regions. Aligning with sustainable development goals for equitable healthcare, this paper presents an innovative, low-cost Computer-Aided Diagnosis (CAD) framework designed to optimize screening workflows using the mini-MIAS database. The proposed system evaluates two technological pathways, combining advanced adaptive preprocessing (Wiener filtering and CLAHE) with high-fidelity region-of-interest (ROI) segmentation (Morphological Thresholding versus Active Contours). Hybrid feature extraction was conducted by fusing second-order textural parameters (GLCM) and micro-geometric shape descriptors across six machine learning architectures. The active contour framework paired with Random Forest and Ensemble Learning models achieved a definitive 100% classification accuracy in distinguishing normal, benign, and malignant tissues. To translate this research into sustainable educational and clinical practices, the system was successfully deployed as a desktop interface. This scalable, client-server infrastructure allows non-specialist frontline healthcare workers in remote areas to acquire diagnostic support within seconds. By shifting complex computational requirements to a centralized server, this work demonstrates how accessible, resource-efficient AI technologies can bridge the healthcare gap, providing a tangible model for sustainable digital health infrastructure and clinical training.

Keywords:
Sustainable Healthcare, Computer-Aided Diagnosis, Artificial Intelligence, Mobile Health, Cloud Computing, Breast Cancer Screening.