Chapter 11
Improved Breast Cancer Detection in Mammography Images: Integration of Convolutional Neural Network and Local Binary Pattern Approach

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ABSTRACT

Cancer, characterized by uncontrolled cell division, is an incurable ailment, with breast cancer being the most prevalent form globally. Early detection remains critical in reducing mortality rates. Medical imaging is vital for localizing and diagnosing breast cancer, providing key insights for identification. This study introduces an automatic hybrid feature recognition method for breast cancer diagnosis using images from two mammography datasets. The method employs a convolutional neural network (CNN) and local binary pattern (LBP) for feature extraction. Correlation-based feature selection techniques reduce dimensionality, enabling faster computation and improved accuracy. The proposed model's superiority is established through comparative analysis with cutting-edge deep models, achieving 96% accuracy across the MIAS and INbreast datasets. The hybrid method demonstrates high accuracy with minimal computational tasks.

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1. INTRODUCTION

Breast cancer stands as the most frequently diagnosed cancer across the globe. According to a World Health Organization (WHO) study, more than 2.26 million new cases of breast cancer were estimated in 2020 (Wilkinson & Gathani, 2022). Belgium and the Netherlands reported the highest age-standardized incidence rates of breast cancer, while developing nations like Somalia and Syria experienced the highest breast cancer-related mortality. In a more recent study, Siegel et al. (2023) underscore that breast cancer continues to be the most prevalent cancer diagnosed in women in 2023, constituting 31% of female cancer cases. Notably, female breast cancer incidence rates have exhibited a gradual increase of about 0.5% per year since the mid-2000s, with excess body weight being identified as a contributing factor (Pfei et al., 2018).

This disease is characterized by disruptions in the cell cycle, enabling uncontrolled cell division, often surpassing the healthy limits. The repercussions of this excessive cell division include the assault on neighboring tissues and the potential to spread to other body tissues via the bloodstream (Kaszak et al, 2022; Chow 2010). Among the various types of cancer, breast cancer predominantly afflicts women, with an estimated incidence of 8-9% among this demographic (Kuo et al., 2016). Currently, standard cancer treatments primarily involve surgical procedures and chemotherapy. However, when the severity reaches a certain threshold, often referred to as the final stage or the tau tolerance limit, these treatments yield less significant results. Consequently, early detection plays a pivotal role in minimizing the adverse outcomes (Schiffman et al., 2015).

Regrettably, many women remain unaware of their breast cancer status. A crucial step they can take is performing manual self-examinations to detect any abnormal lumps in the breast area. Should any such anomalies be identified, it is imperative to pursue further evaluation to determine if they indicate breast cancer. Consulting a medical professional for additional assessments is essential, yet this step is sometimes overlooked, leading to exacerbated conditions in the future.

Despite dedicated efforts by medical professionals and researchers, a definitive method for treating breast cancer remains elusive, and reliable evidence for its prevention has yet to be established (Al-Antari et al.,2020). Certain components within breast cancer tissues exhibit high malignancy, posing a severe threat to patients' lives as they can metastasize to vital organs (Punitha et al., 2021; Mao et al.,2022). The proliferation of mammary cells can give rise to tumors in women, which are classified as benign or malignant based on criteria such as their size, location, and Breast Imaging Reporting and Data System (BI-RADS) scores (Byra, 2021). While benign tumors are non-life-threatening and can be managed with medication to inhibit further growth, malignant tumors have the potential to spread to other parts of the body through the lymphatic system or blood, rendering them much more perilous (El Zarif & Haraty, 2020; Jansson et al., 2021). This uncontrolled cell proliferation in the breast results in the formation of malignant tumors, which can only be addressed through surgery or radiation therapy (Song, 2021).

Early detection of breast cancer is pivotal for precise diagnosis and analysis, prompting many researchers to turn to biomedical imaging to assist specialist radiologists. Various techniques such as Magnetic Resonance Imaging (MRI), mammography, and ultrasound are employed for breast carcinoma identification (Sadad et al., 2018; Jubeen et al., 2022). However, the extensive volume of images challenges radiologists in pinpointing potential cancerous areas. Therefore, an efficient automated method is necessary, with computer-aided diagnostic (CAD) systems now being utilized to aid radiologists in the detection of cancerous breast tumors (Zeebaree ET AL., 2021).