Chapter 2
Advances in CNN-Based Breast Cancer Detection

Sana Salhi
https://orcid.org/0000-0001-6569-0952
Tunis El Manar University, Tunisia

Nour Fakhfakh
National School of Advanced Science and Technologies in Borj Cedria, Tunisia

Malak Sayeb
National School of Advanced Science and Technologies in Borj Cedria, Tunisia

ABSTRACT

This chapter investigates the recent advances in Convolutional Neural Networks for breast cancer detection in mammography. The survey reviews how emerging progress in CNN architectures are reshaping mammography interpretation and diagnostics. State-of-the-art and evaluation of optimization techniques are provided. A dedicated use case is analyzes and recommendations for model training optimization are revealed. The study is conducted on the Mammogram Mastery dataset which comprises 745 original images and 9,685 augmented images. Furthermore, the chapter addresses deep learning's potential to enhance mammographic assessment by improving diagnostic accuracy and reducing false errors. The insights presented aim to guide researchers and practitioners towards developing robust, reliable, and clinically impactful AI for breast cancer detection, highlighting key requirements for achieving advanced trustworthy and equitable outcomes.

DOI: 10.4018/979-8-3373-2706-8.ch002

1. INTRODUCTION

Breast cancer (BC) is the most prevalent cancer affecting women and has cancer-related mortality in women worldwide (Freddie, et al., 2024). Effective BC treatment poses a significant public health challenge. Early and accurate detection plays a crucial role in improving survival rates and treatment outcomes (Xiong, et al., 2025). Expert interpretation remains an essential step in current diagnostic methods such as mammography and biopsy. However, due to its perceptual nature, this process can be subject to variability besides being time-consuming. Cutting-edge progress in deep learning, notably Convolutional Neural Networks (CNNs) have offered a promising solution for automated and precise breast cancer classification and demonstrated tremendous success in medical image analysis.

This chapter presents an overview of the recent related works and highlights the existing deep learning approaches for breast cancer classification, with a special focus on CNNs. The study reports on the common methodologies and experimental outcomes, assessing each approach's efficacy and limits in accurately distinguishing benign from malignant breast tumors. The survey concludes by investigating the critical role of balanced datasets in the performance development of Convolutional Neural Networks (CNNs) for breast cancer detection in mammography. The review provides a case study that emphasizes the implications of training CNN models without applying data balancing techniques. Furthermore, this chapter reviews a bunch of deep learning techniques for breast cancer detection, emphasizing recent advances in hybrid architectures and sequence-based models. The implementation results of a case study using a CNN on the Mastery Mammogram dataset are also presented to evaluate practical performance and suggest areas for further optimization.

The organization of the rest of the chapter is as follows. The first section is dedicated to a general description of CNNs architecture and operating metrics. The second section gives an insight into current techniques for Breast Cancer (BC) detection. The Third section reviews and analyzes the recent CNNs based BC diagnosis approaches. The fourth section benchmarks recent optimization advances in CNNs and their impact on BC detection. The last section showcases a Case Study about pretrained CNN model Using the Mammogram Mastery Dataset. Results and possible optimization perspectives are given at the end of the chapter.

2. CONVOLUTIONAL NEURAL NETWORKS AND LEARNING

Tailored for image data analysis, Convolutional Neural Networks (CNNs) represent a class of deep learning models inspired by the visual cortex of the human brain. Their design incorporates concepts like local receptive fields and weight sharing