CHAPTER 2
DETECTION OF PECTORAL MUSCLES USING A DEEP LEARNING NETWORK

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2.1 INTRODUCTION

Breast cancer affects millions of women worldwide, with 2.26 million new cases reported in 2020 making it the most common cancer among women after skin cancer. According to the World Health Organisation (WHO, 2022), breast cancer ranks among the top five causes of cancer-related deaths, with 685,000 fatalities in 2020. In Malaysia, 8,418 new cases of breast cancer were reported among females in 2020, representing 32.9% of all new cancer cases and making it the most prevalent cancer at 17.3% (WHO, 2022). Early detection through screening is crucial, as it significantly improves the chances of successful treatment and survival. Research suggests that screening can reduce breast cancer mortality rates by up to 40% through early detection (Iranmakani et al., 2020; Spuur et al., 2011).

Mammography is a key screening tool for detecting breast cancer, providing detailed images of breast tissues in two standard projections: Craniocaudal (CC) and mediolateral oblique (MLO). The MLO projection is favoured for its ability to clearly show the pectoral muscle, which plays a crucial role in mammogram images. Research suggests

that breast cancer is often found in the upper outer quadrant, making the MLO projection particularly valuable (Karnati, 2021; Ma et al., 2019; Murphy et al., 2021; Sweeney et al., 2018; Wang et al., 2019) Studies have identified six principal descriptors for evaluating the appearance of the pectoral muscle in MLO images, including width, length, angle, posterior nipple line, nipple level (NL), and shape (Chan et al., 2017; Murphy, 2021; Siotos et al., 2018)

Machine learning, including deep learning techniques such as convolutional neural networks (CNN), has been widely applied in computer-aided diagnosis for medical imaging, particularly in mammography (Latif et al., 2019; Summers, 2017; Suzuki, 2017; Walton et al., 2019). CNN, a type of deep learning, has demonstrated exceptional performance in distinguishing breast lesions and segmenting the pectoral muscle in mammograms (Ma et al., 2019; Carneiro et al., 2017). Its multi-layered neural networks can learn from extensive data, enabling image identification, recognition, and classification. Using a trained deep CNN algorithm, automated pectoral muscle assessment in MLO projections of mammograms can be achieved.

The pectoral muscle plays a crucial role in ensuring optimal mammographic images by capturing all breast tissues. However, variations in muscle presentation due to individual differences can impact image quality (Murphy et al., 2021; Wang et al., 2019). Achieving adequate visualisation of breast tissues requires consideration of the amount of pectoral muscle in the mammographic image, often measured by its width and length in relation to the nipple. Past research has identified challenges in determining appropriate muscle width and length measurements. (Spuur et al., 2010, 2011; Taylor et al., 2017).

Manual assessment of the pectoral muscle by radiologists is time-consuming. Deep learning algorithms, particularly CNN, have demonstrated high success rates for tasks such as image classification, segmentation, and object detection (Gupta et al., 2021; Karnati, 2021). Several powerful models, including U-Net, holistically edge detection (HED), RetinaNet, DeepLabv3+, and SegNet, have been used to segment the pectoral muscle in mammograms. However, previous

studies have not applied the segmentation results to measure the width and length of the pectoral muscle. This study focused on implementing DeepLabv3+ with ResNet-18 and ResNet-50, SegNet, and U-Net CNN models to evaluate the segmented pectoral muscle from MLO projections of mammography (Zhou et al., 2022).

This study aims to establish an optimal breast positioning technique for the MLO projection in mammography to ensure complete inclusion of all breast regions in the image. The implementation of a deep learning approach for pectoral muscle segmentation offers improved accuracy and reliability in evaluating the muscle. By assessing the pectoral muscle, the adequacy of its appearance in the mammogram can be determined. This advancement supports radiologists in analysing the breast region in mammography images, particularly in the MLO projection. Additionally, it reduces patient revisit rates and minimises the risk of missed breast cancer detection caused by suboptimal mammography image quality.

This chapter is structured as follows: Section 2.2 introduces the pectoral muscle and the fundamentals of deep learning networks. Section 2.3 outlines the CNN modelling approach for the pectoral muscle in the MLO (mediolateral oblique) projection. Section 2.4 explores the segmentation of the pectoral muscle within the MLO projection, while Section 2.5 presents the verification process of the CNN model during the training phase. Section 2.6 details the segmentation and measurement of the pectoral muscle. Lastly, Section 2.7 summarises the key findings and conclusions of the study.

2.2 PECTORAL MUSCLE AND DEEP LEARNING NETWORK

Understanding the anatomy of the pectoral muscle is essential for accurate mammographic analysis, as it helps in differentiating normal tissues from abnormalities. Mammography is a crucial imaging technique for early breast cancer detection, where the anatomical structures, particularly the pectoral muscle, play a significant role in