Article

Fully Automated Breast Density Segmentation and Classification Using Deep Learning

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Abstract: Breast density estimation with visual evaluation is still challenging due to low contrast and significant fluctuations in the mammograms' fatty tissue background. The primary key to breast density classification is to detect the dense tissues in the mammographic images correctly. Many methods have been proposed for breast density estimation; nevertheless, most of them are not fully automated. Besides, they have been badly affected by low signal-to-noise ratio and variability of density in appearance and texture. This study intends to develop a fully automated and digitalized breast tissue segmentation and classification using advanced deep learning techniques. The conditional Generative Adversarial Networks (cGAN) network is applied to segment the dense tissues in mammograms. To have a complete system for breast density classification, we propose a Convolutional Neural Network (CNN) to classify mammograms based on the standardization of Breast Imaging-Reporting and Data System (BI-RADS). The classification network is fed by the segmented masks of dense tissues generated by the cGAN network. For screening mammography, 410 images of 115 patients from the INbreast dataset were used. The proposed framework can segment the dense regions with an accuracy, Dice coefficient, Jaccard index of 98%, 88%, and 78%, respectively. Furthermore, we obtained precision, sensitivity, and specificity of 97.85%, 97.85%, and 99.28%, respectively, for breast density classification. This study's findings are promising and show that the proposed deep learning-based techniques can produce a clinically useful computer-aided tool for breast density analysis by digital mammography.

Keywords: breast cancer; breast density; deep learning; mammograms; generative adversarial networks; convolutional neural network

1. Introduction

Breast cancer is one of the most common causes of cancer mortality in women across the world, caused by abnormal cells that have grown uncontrollably. Those cells may also grow in some places in the human body where they are generally not found. When that happens, the cancer is termed metastatic. Mammography is a standard and most famous radiology tool to detect breast cancer early, possibly before it has outspread. However, investigating these mammographic images is not