Deeply Supervised U-Net for Mass Segmentation in Digital Mammograms

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Abstract

Mass detection is a critical process in the review of mammograms. The shape and texture of the masses are key indicators in the prognosis of the medical condition. Hence, semantic segmentation is found to be useful in this context rather than mere object detection (or) localization. The main challenges involved in the semantic segmentation of masses in mammograms include (1) higher signal to noise ratio (SNR) (2) indiscernible mass boundaries and (3) more false positives due to significant overlap in the intensities between the normal parenchymal regions and masses. To address these challenges, we propose DS U-Net (Deeply Supervised U-net model) coupled with Dense CRF (Conditional Random Fields). Most of the state-of-art approaches for semantic segmentation uses Encoder - Decoder based model. Encoder captures low-level features such as presence of mass in multiple stages. Decoder path provides the precise segmentation in multiple stages by combining the intermediate results from the encoder at each stage through skip connections. The resulting segmentation map lack the ability of capturing the non-conspicuous and spiculated mass boundaries. In the proposed work, deep supervision is integrated with popular Encoder - Decoder model (U-net) to monitor the low level features for proper attention of the boundaries of suspicious regions and higher level features for accurate segmentation of the entire mass. The final segmentation map is obtained by fusing the intermediate outputs with the final output using learnable weights. The resulting segmentation map is fine tuned using Dense CRF to enhance the edges. We evaluated the model on two publicly available benchmark datasets CBIS-DDSM and INBREAST. DS U-Net with DenseCRF provides Dice score

of 84% for CBIS-DDSM and 82.6% for INBREAST.
Keywords: Mass Segmentation, Deep Supervision, Mammograms, Conditional Random Fields

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Introduction

Global Cancer Observatory Database released in 2018 reports that Breast cancer is contributing to over 25.4% of all the new cases diagnosed [][1]. Henceforth, Governments are conducting screening programmes to curb the disease. Mammograms are widely adopted as the primary screening tool to diagnose breast cancer. A mammogram is an x-ray image of the breast which captures the changes in the breast tissue. Presence of masses and microcalcifications in the mammogram characterize the disease. The detection of these regions in mammograms are difficult as their pixel intensities often correlate with normal tissue.

CAD (computer aided detection) tools uses digitally captured images of the mammogram and employs artificial intelligence based techniques to detect suspicious regions in them. CAD has been constantly evolving with the advent of new techniques in the domain to provide accurate results. With the recent success of deep neural networks in most of the vision oriented challenges, they are been explored for medical diagnosis.

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