

Comparison of mass segmentation methods for mammography

Marta Vicentini¹, Martina Oria^{1,2}, Caterina Fracchia³, Paola Lamberti³, Sara Remogna³, and Alessandra Manzin¹

Abstract— Accurate segmentation of breast cancer lesions in mammograms is crucial for early diagnosis and treatment planning. However, the lack of standardized criteria presents a challenge to ensure consistency between different methods. In this study, we compare semi-automatic image segmentation techniques and assess how their performance can be optimized in relation to image preprocessing.

Clinical Relevance—This study aims to improve the reliability of mass segmentation, providing a tool for introducing virtual annotations in mammography images.

I. INTRODUCTION

The accurate detection of breast cancer lesions in medical images is crucial for early diagnosis and effective treatment [1]. For lesion characterization and classification, the determination of mass morphological features (size, shape, and margins) is essential, and accurate image segmentation is needed. Currently, no standardized criteria for segmentation in mammography images are available, and the search for optimized image preprocessing and mass detection techniques remains an area of ongoing interest. In this work, we compare different image segmentation techniques, including the Otsu algorithm and two active contour models (snakes), based on geometric active contour (GAC) [2] and gradient vector flow (GVF) snake [3]. A performance evaluation is carried out, by applying the methods on real medical images with different appearance (sharpness, contrast, gray level distribution).

II. METHODS

In the preprocessing phase, morphological operations are first applied to the normalized image, followed by Gaussian filtering or principal component analysis (PCA) to reduce noise. Contrast adjustment techniques are also used to enhance lesion visibility. During the segmentation process, the image is divided into two regions, i.e. the lesion area and the rest of the image. Otsu's algorithm determines an intensity threshold, by minimizing intra-class variance, which separates pixels into the two regions. GAC and GVF models iteratively refine lesion boundaries; GVF uses gradient vector flow diffusion, while GAC is based on a level set formulation. Segmentation performances are assessed by means of the following metrics: Intersection over Union (IoU), Dice Similarity Coefficient (Dice), Precision, Recall.

¹ M. Vicentini, M. Oria and A. Manzin are with the Istituto Nazionale di Ricerca Metrologica, Torino, Italy, e-mail: m.vicentini@inrim.it.

² M. Oria is also with Politecnico di Torino, Torino, Italy.

³ C. Fracchia, P. Lamberti and S. Remogna are with the Università degli Studi di Torino, Torino, Italy.

III. RESULTS

The methods are tested on mammography images extracted from the Cohort of Screen-age Women (CSAW) [4] and VinDr-Mammo [5] databases, containing data acquired with Hologic and Siemens scanners, respectively. As an example, Fig. 1 shows the application of the Otsu and GAC method on an image acquired with Hologic equipment.

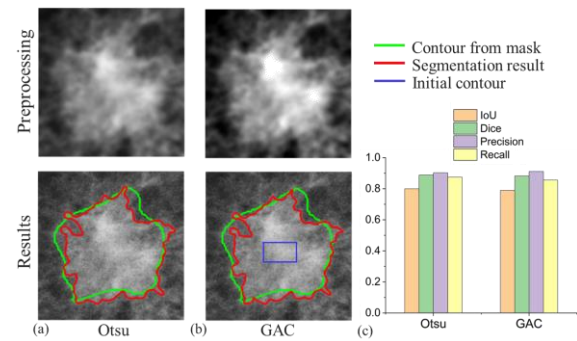


Figure 1. Preprocessing and segmentation results for Otsu (a) and GAC (b), with the corresponding evaluation metrics in (c).

IV. DISCUSSION & CONCLUSION

The optimization of segmentation methods can strongly depend on the mammogram features and preprocessing steps. The availability of images from different vendors has allowed us to assess the robustness and generalizability of mass segmentation for very different image appearance. Moreover, it has enabled to individuate the optimal procedure that can be used for supporting radiologists with a virtual annotation tool.

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