# Automatic segmentation of microcalcifications based on the fusion of different algorithms over CC and MLO views

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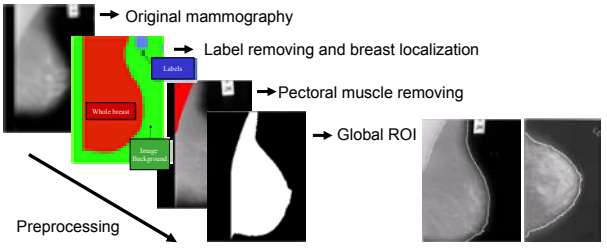
## Abstract

The study of mammographic microcalcifications has shown to provide useful information for the early diagnosis of breast cancer. In order to develop a computer-aided diagnosis system named HRIMAC, this work focuses on the automatic and reliable detection of microcalcifications. Our proposal of microcalcification detection is based on the fusion and validation of the results provided by different segmentation algorithms over the CC and MLO X-ray images of the same breast.

## 1. Gross Segmentation

The method starts with an automatic gross segmentation of both images which results on the detection of regions of interest.




## 2. Automatic seed detection algorithm

An automatic seed detection algorithm (1 of 3) based on local histogram analysis detects initial pixels belonging to the microcalcification region. The parameters of this algorithm are set up to obtain always an over-segmented result.

### 2.1. Histogram

The histogram of the region of interest is used in order to obtain a global threshold.

Image Binarization.

The seeds are the brightness points.

### 2.2. Adaptative

A local thresholding is applied over a set of subwindows.

The seed pixels are those which satisfy this expression:

$$threshold = mean + (std/sensitivity)$$

The result is overseeded: many seeds do not correspond to real abnormalities.

Based on Kevin Woods PhD work.

### 2.3. Mixed

For each window a global and a local threshold is used.

We choose the seed pixels which are largers than the global threshold and also those which satisfies the following expression inside the window:

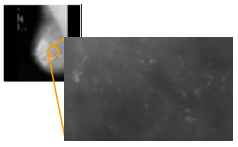
$$threshold - minimum\_intensity + (mean/sensitivity)$$

The microcalcification seeds with an intensity value less than the global threshold are localized.

## 3. Segmentation of the abnormalities

Three different specific algorithms begin independently the segmentation of the abnormalities.

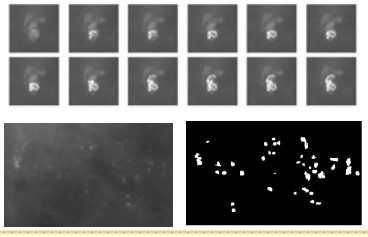
1) **Region growing method** (based on the proposal of Shen).
2) **Method based on mathematical morphology operations** (inspired on the Mossi and Albiol proposal).
3) **Method based on gradient information** (following the work of Bankman et al).



### 3.1. Region Growing method

a) The initial seeds grow to larger regions following a region grey level homogeneity function fitted by τ.

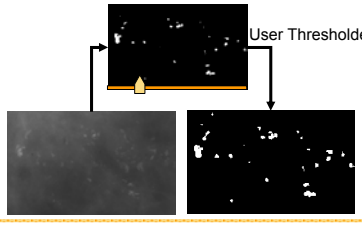
$$(1+\tau)(F_{max}+F_{min})/2 \geq p(i,j) \geq (1-\tau)(F_{max}+F_{min})/2$$



### 3.2. Mathematical Morphology

a) Top-Hat operator that performs opening operations using specific structural elements in order to enhance possible microcalcifications.

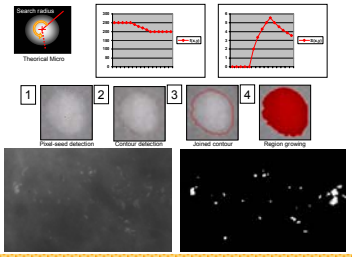
b) Substraction of the enhanced image and the original one, and binarization of this result image.




### 3.3. Gradient Information

a) Validation of each initial seed as a possible microcalcification finding the gradient along the M-lenght radius for discrete angles.

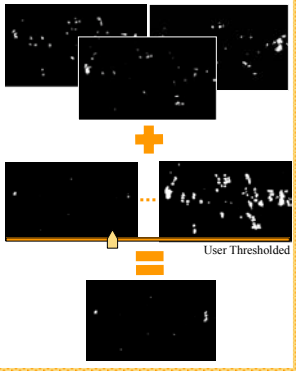
$$s(x,y) = \frac{f(x_0,y_0) - f(x,y)}{dist((x_0,y_0),(x,y))}$$



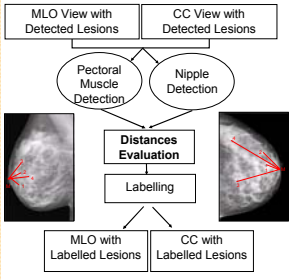

## 4. Merging the results

The results obtained by the algorithms are merged and refined by eliminating the false positive finding the correspondences between the CC and MLO views.

### 4.1. Fusion




### 4.2. Correspondence




## 5. Results and Conclusions

The method is tested over a set of 40 cases from different image sets specially developed for this research. That cases are being integrated to HRIMAC, a Content Based Image Retrieval System, to perform a final evaluation with radiologists.

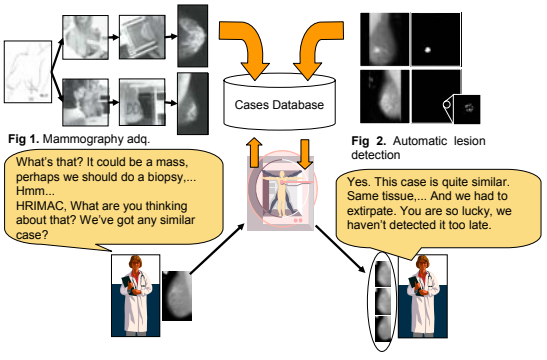



**Fig 1.** Mammography adq.

**Fig 2.** Automatic lesion detection