

# A FAST ALGORITHM FOR INTRA-BREAST SEGMENTATION OF DIGITAL MAMMOGRAMS FOR CAD SYSTEMS

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## Introduction

Computer Aided Detection (CAD) systems always demand better performances, both in terms of sensitivity-sensibility trade off and in terms of computational time. In order to improve the performances of our CAD system [1], we present a powerful algorithm that performs an intra-breast segmentation. Starting from a digital mammogram and using a combination of different techniques—such as downsampling, filtering, thresholding and morphological operators—the proposed algorithm produces a binary map showing the locations of the breast with the highest probability of containing a suspect mass. In this way, looking for masses only in these relatively small locations, it is possible both to reduce the CAD's computational time and to improve its sensibility, while maintaining almost the same sensitivity.

## Materials

The set of 317 digital mammograms used to test our intra-breast segmentation algorithm is gathered from both the hospitals Stadspital Triemli, Zurich, Switzerland and Ospedale Maggiore, Bologna, Italy. Typical image dimensions are  $2048 \times 2816$  pixels at 12 bits of gray level resolution. Standard Pentium 4 at 1.6 GHz are used to evaluate the performances of our algorithm.

## Methods

The main purpose of our algorithm is to exclude the inner breast regions which do not surely contain masses. In Fig. 1 the flow-chart of our intra-breast segmentation algorithm is shown.

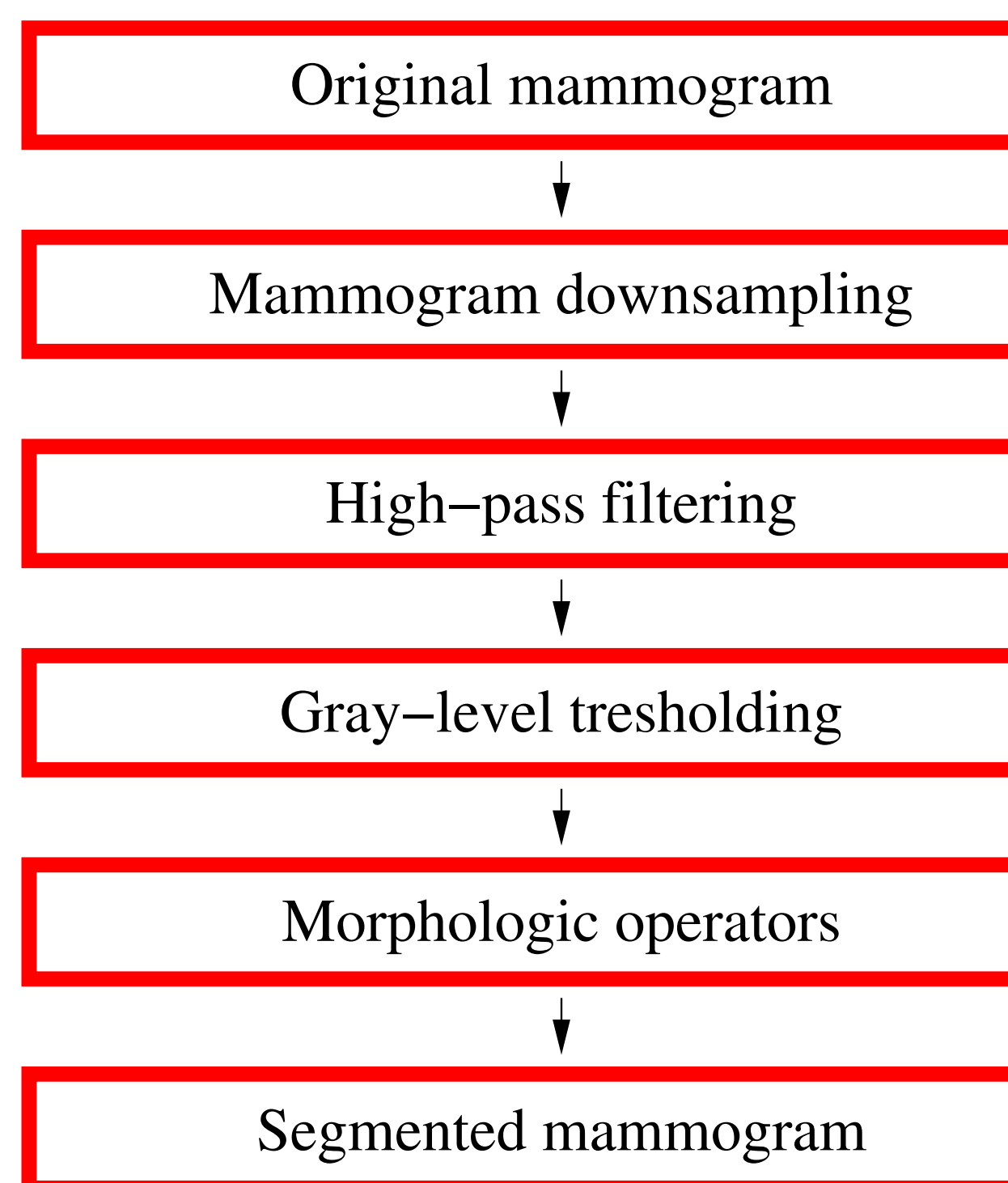


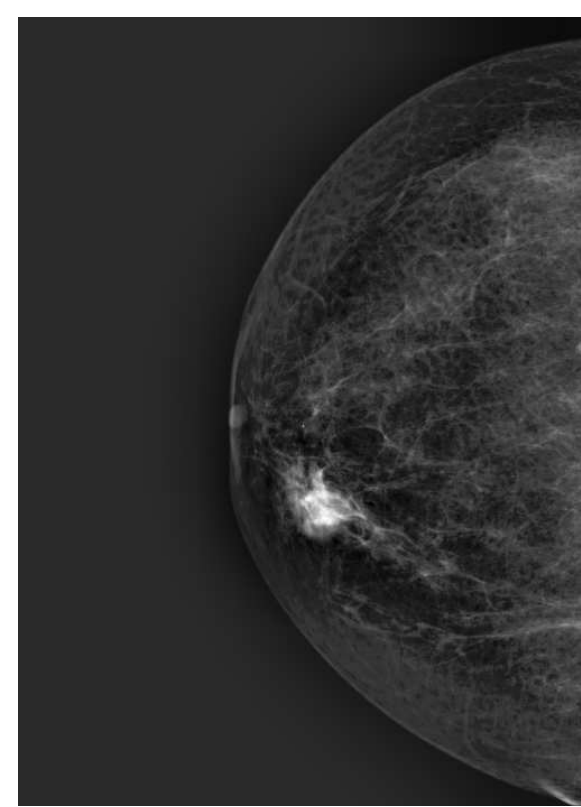
FIGURE 1: Flow-chart of the intra-breast segmentation algorithm developed.

Fig. 2 shows a digital mammogram after each step of our intra-breast

segmentation algorithm.

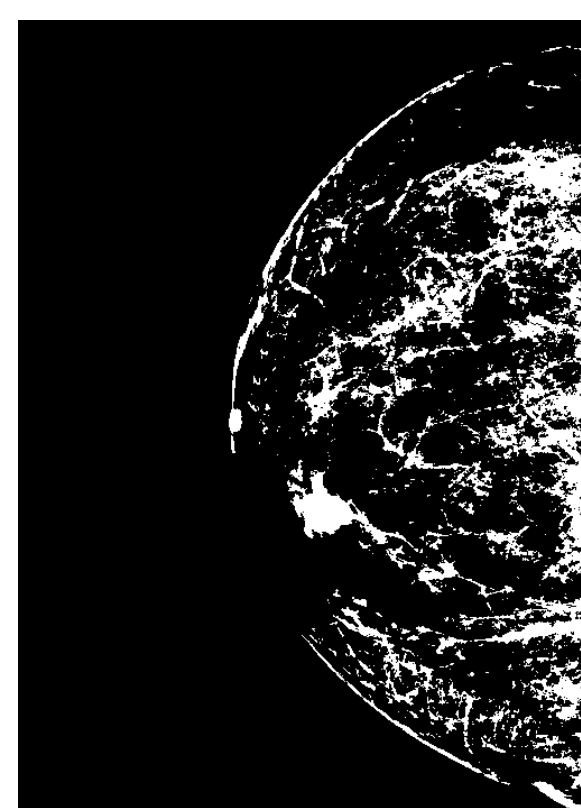
### Downsampled mammogram

We perform the convolution of the original mammogram with a  $3 \times 3$  Gaussian low-pass filter in order to reduce the dimensions down to 25% and to smooth noise imperfections.



### High-pass filtered mammogram

We perform the convolution of the downsampled mammogram with a High Boost filter [2] in order to put in evidence its features.



### Thresholded mammogram

We apply a threshold to the high-pass filtered mammogram in order to have a binary version of the mammogram.

### Thresholded mammogram after morphological operators

We apply a combination of morphological operators in order to deal with the high fragmentation of the searching regions resulting after the thresholding.



FIGURE 2: Intra-breast segmentation algorithm applied to a digital mammogram.

## Results

Experimental trials performed on our database showed that our algorithm is able to sensibly reduce the intra-breast searching area down to 6%, thus reducing the computational times from 360 s down to 10 s per image. Furthermore, it is able to improve the algorithm's sensibility from 4.20 False Positives (FP) per image up to 3.60, while maintaining almost the same sensitivity. Tab. 1 shows the results obtained.

	Area (%)	Time (s)	Sensitivity (%)	Sensibility (FP/image)
Without segmentation	100	360	100	4.20
With segmentation	6	10	98.9	3.60

TABLE 1: Results.

## Conclusions

## Acknowledgements

## Further Informations

Please, contact [lanconelli@bo.infn.it](mailto:lanconelli@bo.infn.it). More informations on this and related projects can be obtained at <http://www.bo.infn.it/~mig/>.

## References

- [1] R. Campanini, D. Dongiovanni, E. Iampieri, N. Lanconelli, M. Masotti, G. Palermo, A. Riccardi, M. Roffilli, A Novel Featureless Approach to Mass Detection in Digital Mammograms Based on Support Vector Machines, Physics in Medicine and Biology 49 (6) (2004) 961–976.
- [2] R. C. Gonzalez, R. E. Woods, Digital Image Processing, Addison-Wesley Longman Publishing Co., Inc., 1992.