GUI BASED APPLICATION FOR PARENCHYMAL BREAST DENSITY ANALYSIS

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Abstract: Leader among causes for mortality among women is breast cancer. Early detection of cancer increase chance of full recovery.

One of the best methods for early detection is mammography.

Clinical studies have indicated strong correlation between breast parenchymal density and breast cancer risk.

We are developing a new application for breast parenchymal density analysis. This software will provide support for researchers to study relationships between breast parenchymal density and breast cancer as well as enable monitoring the progress of treatment.

Test data set contains 39 mammograms. The mammograms were digitized with VIDAR film scanner.

We can divide mammograms into 2 groups. Each group contains mammograms with similar histograms. We use a histogram analysis for breast segmentation. Breast area is found automatically. When breast area is separated is possible to evaluate: parenchymal breast density, size of the breast area, size of the regions of interest and etc.

Introduction

Breast cancer is a leader among causes for mortality among women. Twelve percent of women will have breast cancer diagnosis in their lives [1].

Mammography is one of the best methods for early detection of the breast cancer. Mammography can show changes in the breast two years before patient can feel them [2]. But mammography is not advisable for everybody and any types of cancer of the breast can't be seen on the mammograms.

Young women and women who take hormones during hormone replacement therapy (HRT) have more glandular tissue in their breasts which increases density. In this case is difficult to read the mammograms.

There is a strong correlation between breast parenchymal density and occurrence of the breast cancer. Women with parenchymal densities over 60% of the breast area have about 4 to 6 times higher risk of developing breast cancer than women with parenchymal densities less than 5% [3].

Density changes with age. Women after menopause have glandular tissue replaced by fat. Fat is less dense than glandular tissue.

Radiologists commonly estimate the breast density or use BI-RADS (Breast Imaging Reporting and Data System) ultrasound and mammography lexicon. But in this case there is a large variability in the ratings among professional radiologists.

Interpretation of mammograms can be difficult because a normal breast can appear differently for each woman. Woman's breasts may also feel different at different times of the month. Breasts can feel lumpy before a period.

We are developing semi-automatic application for breast parenchymal density analysis.

Statistical and image analyses of the mammograms may help to radiologists in their decision of the patient's treatment. Image analysis and the breast segmentation are based on histogram analysis. Histogram analysis is fast and reliable method for automatic separation of the breast area.

Functions and Methods

1. Test data set

A data set consists of 39 mammograms of 5 patients. Each case contains the craniocaudal view or mediolateral-oblique view of patient's breast in the three different resolutions.

There are 2 types of mammogram images in the test data set (see Figure 1 and Figure 3). Each type has a different histogram (see Figure 2 and Figure 4).

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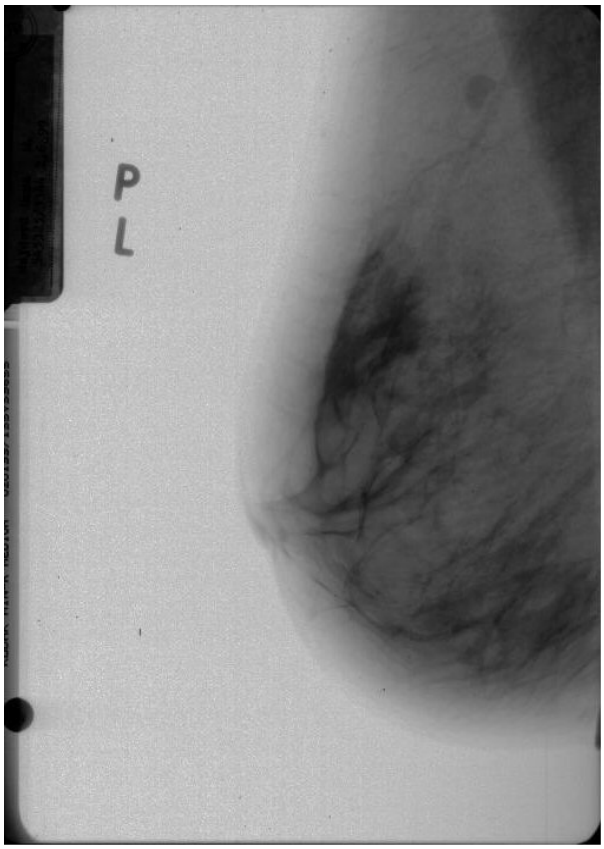

Figure 1: Mammogram image – Type I

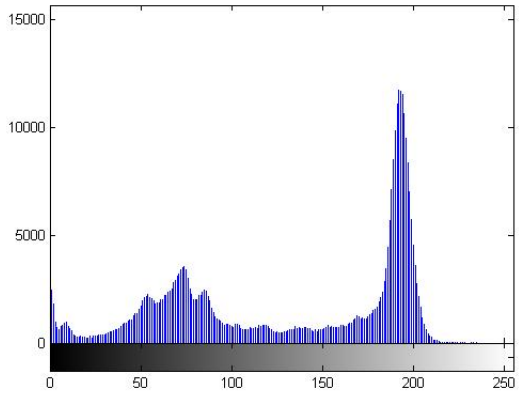

Figure 2: Histogram of Type I image

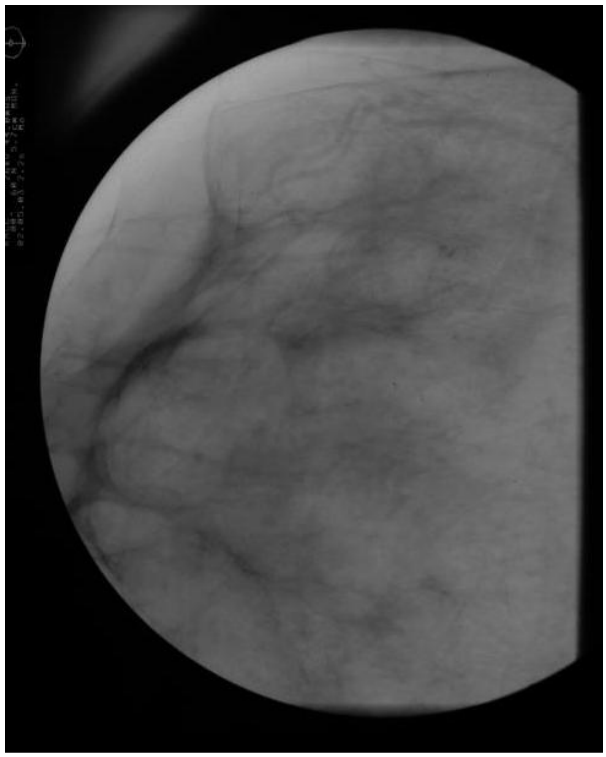

Figure 3: Mammogram image – Type II

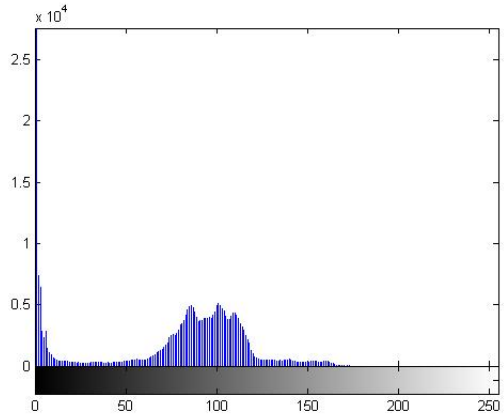

Figure 4: Histogram of Type II image

The mammograms were digitized with VIDAR film scanner with pixel side size from 80 to 320 μm and 256 gray levels. Resolution of images is between 750 x 600 and 3000 x 2400 pixels. The scanner provides an 8 or 12-bit output in the range 0 - 3.6 optical densities.

The images were processed individually without knowing their BI-RADS categories or determined diagnosis.

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2. Breast segmentation

The segmentation method of images is based on histogram analysis. Is possible to separate histogram of mammogram image to the three parts (see Figure 5). The part 1 is image background, the part 3 is exposed area background and part 2 is breast area.

Figure 5 is a histogram image of Type I mammograms. Histogram of Type II of mammogram images doesn't include the 3rd part (exposed area background).

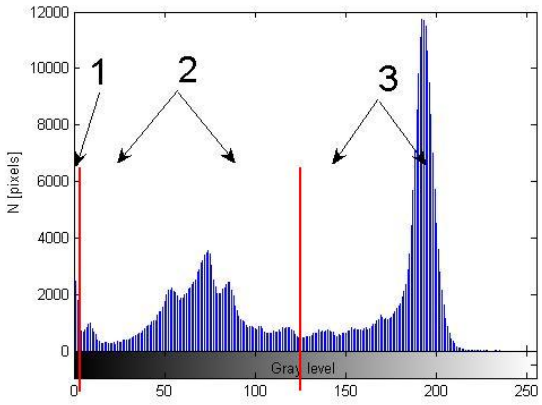


Figure 5: Segmented histogram of Type I image

Exposed area is segmented from surrounding image background by threshold at the first. The threshold is set automatically uses Otsu's method which chooses the threshold to minimize the intraclass variance of the thresholded black and white pixels.

The second step is remove background from exposed area to definite limitation of the breast area. Background from exposed area is removed by boundary detection and morphological operations. We use first and second derivation of histogram curve to place the threshold for canny edge detector.

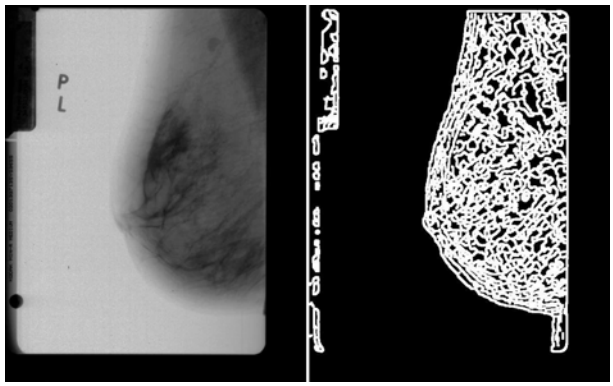
For Type I images is the threshold in the minimum of the ride-side valley of the histogram. For Type II is threshold set on the first zero value of the ride-side valley of the histogram curve. [4]

The Canny method finds edges by looking for local maxima of the gradient of the image. The gradient is calculated using the derivative of a Gaussian filter. Morphological operations are used for smoothing the boundary of the breast area (see Figure 6 and Figure 7).

3. Evaluation of parenchymal breast density

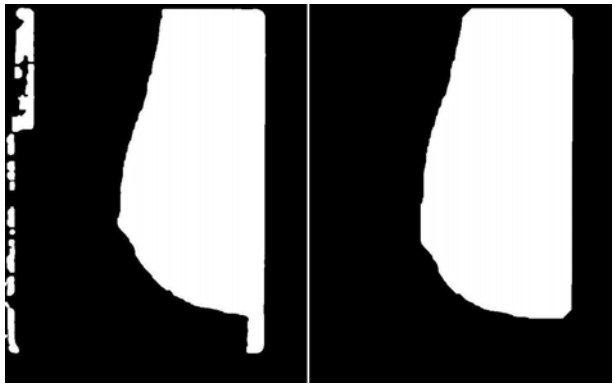
There are seven densitometric coins stored in the application. Each densitometric coin represents scanning mode of an image.

Gray level of a current pixel is compared with densitometric coin during calculation and value of density of the current pixel is set.



a. b.

Figure 6: (a) Original image. (b) Image yielded by use of the canny edge detector and thresholding.



a. b.

Figure 7: (a) Morphological operations are used for smoothing the boundary and removing uninteresting regions. (b) Segmented breast area.

Results

Developed application allows setting the reference value of parenchymal breast density and also allows evaluating the following values: mean value, median and standard deviation of density of the breast area. Size and mean value, mean value divided by reference value, median and standard deviation of density of regions of interest. Value of density of the current pixel and value of density of the current pixel divided by reference value. These parameters provide a global description of the breast area and regions of interest.

All mathematical procedures are calculated using vectorizing to get solution faster. Vectorization means converting loops to equivalent vector or matrix operation.

Application allows the image zooming in main window of application and saving the details. Application shows histogram curve of the current image (see Figure 8).

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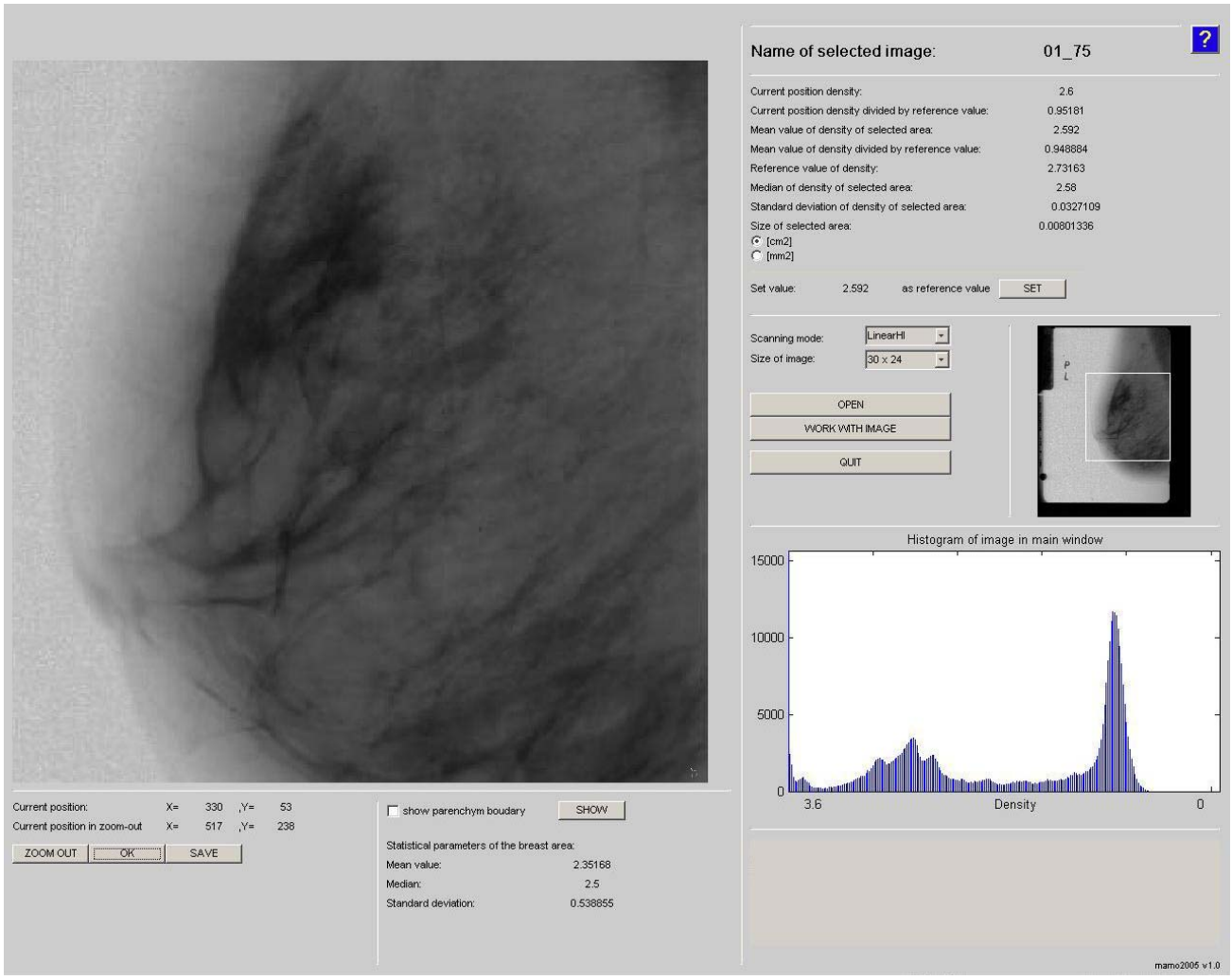

Figure 8: Image of developed application

Conclusions

The aim of this study is develop semi-automatic system for complete analysis of digital mammogram images.

Breast area is segmented automatically and statistical parameters provide global description of the mammogram image. But projection of pectoral muscle may affect evaluated parameters.

Interesting results may be also shown by quantiles of density distribution but this function is still unfinished.

Acknowledgement

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