

Automatic Enhancement of Mammography Images using Contrast Algorithm

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Abstract: *These Mammography imaging is an incontestable vital tool for diagnosis, it provides in non-invasive manner the internal structure of the body to detect eventually diseases or abnormalities tissues. Unfortunately, the presence of speckle noise in these images affects edges and fine details which limit the contrast resolution and make diagnostic more difficult. The main objective of this study was to enhance of mammography images using Filtering Technique in order to evaluate contrast enhancement pattern in different breast images such as grey color and to evaluate the usage of new nonlinear approach for contrast enhancement of soft tissues in breast images. The data analyzed by using MatLab program to enhance the contrast within the soft tissues, the gray levels in both enhanced and unenhanced images and noise variance. The main techniques of enhancement used in this study were F special convolution kernel technique and Deblurring images using Wiener Algorithm. In this thesis, prominent constraints are firstly preservation of image's overall look; secondly preservation of the diagnostic content in the image and thirdly detection of small low contrast details in diagnostic content of the image. As shown in previously, state of the art methods provide non-convincing results. The new approach is funded on an attempt to interpret the problem from the view of blind source separation (BSS), thus to see the breast image as a simple mixture of (unwanted) background information, diagnostic information and noise.*

Keywords: mammography, image processing, breast, filter technique.

1. Introduction

High quality mammography requires efficient equipment and trained radiologic teams. All mammographs need approximately the same designed generators (tungsten anode system, molybden target or rhodium target for dense breast photo-tim ing, small focal spot sizes) but there are two types of signal reception : Classical Screen Field Mammography (SFM) that requires scatter-reducing grid, and high definition films, and more recently Full field digital mammography (FFDM): this technique is divided in CR (Computed radiology) where ERLM Screens receive the signal that is then read by laser spot or DR (Digital Radiology) ; in this former the detector transmits the signal to a numerical reading system. FFDM permits acquisition, storage and facilitates the comparison. It has been demonstrated that FFDM offers quite the same accuracy in terms of detection and diagnosis of breast pathology, especially for the examination of dense breast tissue and for the microcalcifications. FFDM and SFM offer the same specificity (almost 92 %) and quite the same sensibility except in the subgroup of dense breasts (BIRADS 3-4) of women under 50 years old. FFDM is now also available for the Breast cancer screening, subject to quality control as in SFM. Physical examination should always precede mammography. Mammography in every technique uses compression of the breast between parallel rigid plates, permitting projection of the breast unto the surface film. The dose delivered to the breast should remain within acceptable limits and seems to be lower with FFDM. Usually cranio-caudal and oblique views of both breasts are obtained. For the cranio-caudal view the breast must be well drawn, centered, the nipple perpendicular projecting out of the

breast. The oblique view compresses the breast along a 45 to 60axis (the beam parallel to the pectoralis muscle extending from the axilla to the lower quadrants of the breast) and projects more breast tissue than straight lateral view. Additional views are obtained completing the check: Mediolateral side view permits to localize an abnormality. We will choose mediolateral or lateromedial access depending if the image is in the outer or in the inner quadrant (minimal distance between the image and the receptor); the magnified views in SFM and high resolution, if possible magnified views in FFDM complete microcalcifications analysis. For the examination of a densification or a mass it could also be useful to rotate the breast or to use a small compression plate to differentiate normal breast tissue from a true mass. The analysis of microcalcifications requires magnified views in high resolution to identify the morphology and shape of the group. Some techniques are developing like Digital Breast Tomosynthesis: In Tomosynthesis the breast is compressed in the same manner but the X-ray tube allows the acquisition of many low dose images rather than only one on FFDM. Then these slices are reconstructed by 3D software. This new technique is in evaluation for analysis of densification and geometry of clusters of micro calcifications [1].

Matlab is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation [2][3][4]. Typical uses include Math and computation, Algorithm development, Modeling, simulation, and prototyping, Data analysis, exploration, and visualization, Scientific and engineering graphics, Application

development, including graphical user interface building Matlab is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or Fortran[5][6]. Magnetic resonance imaging (MRI) has become a common way to study brain tumor. In this paper we pre-process the two-dimensional magnetic resonance images of brain and subsequently detect the tumor using edge detection technique and color based segmentation algorithm. Edge-based segmentation has been implemented using operators e.g. Sobel, Prewitt, Canny and Laplacian of Gaussian operators. The color-based segmentation method has been accomplished using K-means clustering algorithm. The color-based segmentation carefully selects the tumor from the pre-processed image as a clustering feature. The present work demonstrates that the method can successfully detect the brain tumor and thereby help the doctors for analyzing tumor size and region. The algorithms have been developed on MATLAB version 7.6.0 (R2008a) platform [7][8].

2. Methods and Materials

2.1 Contrast enhancement

The command that implements contrast processing is the `imadjust`. Using this, the contrast in an image can be enhanced or degraded if needed. Moreover, a very useful result can be the inversion of colors, especially in greyscale images, where an object of interest can be efficiently outlined. The general function that implements contrast enhancement is the following:

```
J=imadjust(I,[low_in high_in],[low_out high_out],gamma);
```

While the function for color inversion is the following:

```
J = imadjust(I,[0 1],[1 0],gamma); or J = imcomplement(I);
```

Suppose that J, is the new image, I, is the initial image and gamma factor depicts the shape of the curve that describes the relationship between the values of I and J. If the gamma factor is omitted, it is considered to be 1.

2.2 Filtering in MatLab

Using Image Processing Toolbox design and filters for image data was implemented.

2.3 Fspecial filter:

For linear filtering, MatLab provides the `fspecial` command to generate some predefined common 2D filters. `fspecial` creates Gaussian filters using as following equation:

$$h_g(n_1, n_2) = e^{-(n_1^2 + n_2^2)/(2\sigma^2)}$$

$$h(n_1, n_2) = \frac{h_g(n_1, n_2)}{\sum_{n_1} \sum_{n_2} h_g}$$

`fspecial` creates Laplacian filters using following equation:

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}$$

$$\nabla^2 = \frac{4}{(\alpha + 1)} \begin{bmatrix} \frac{\alpha}{4} & \frac{1-\alpha}{4} & \frac{\alpha}{4} \\ \frac{1-\alpha}{4} & -1 & \frac{1-\alpha}{4} \\ \frac{\alpha}{4} & \frac{1-\alpha}{4} & \frac{\alpha}{4} \end{bmatrix}$$

`fspecial` creates Laplacian of Gaussian (LoG) filters using following equation:

$$h_g(n_1, n_2) = e^{-(n_1^2 + n_2^2)/(2\sigma^2)}$$

$$h(n_1, n_2) = \frac{(n_1^2 + n_2^2 - 2\sigma^2)h_g(n_1, n_2)}{2\pi\sigma^6 \sum_{n_1} \sum_{n_2} h_g}$$

This equation above describes the commands' package that can be used for the application of the mean (average) filter in a SPECT slice for different convolution kernel sizes (for 3×3, 9×9, 25×25 average filter).

2.4 Image segmentation

The image segmentation describes the process through which an image is divided into constituent parts, regions or objects in order to isolate and study separately areas of special interest. This process assists in detecting critical parts of a nuclear medicine image that are not easily displayed in the original image.

3. The results

MatLab allows matrix computation, implementation of algorithms, simulation, plotting of functions and data, signal and image processing by the Image Processing Toolbox. It enables quantitative analysis and visualization of breast images of several modalities where a Computed Tomography system (CT) is incorporated to the SPECT system. The main objective of this study was to enhance of SPECT images using Filtering Technique in order to evaluate contrast enhancement pattern in different SPECT images such as grey color and to evaluate the usage of new nonlinear approach for contrast enhancement of soft tissues in SPECT images.

3.1 Contrast enhancement

The command that implements contrast processing is the `imadjust`. The general function that implements contrast enhancement is the following (figure 1):



Figure 1.a & b: Shows Original Image, bone scan image after adjustment

3.2 Filtering in MatLab

Using Image Processing Toolbox design and filters for image data was implemented.

Results of Contrast enhancement using gamma factor



Figure 3: Shows contrast enhancement using gamma factor

Special filter:

Results Convolution kernel size code

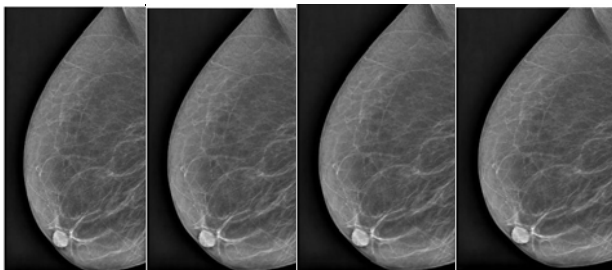


Figure 4: Shows Convolution kernel size (for 3x3, 9x9, 25x25 average filter)

For linear filtering, MatLab provides the fspecial command to generate some predefined common 2D filters. `h = fspecial (type)` creates a two-dimensional filter `h` of the specified type. `Fspecial` returns `h` as a correlation kernel, which is the appropriate form to use with `imfilter`.

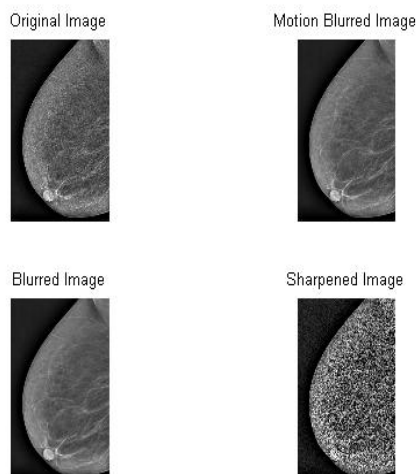


Figure 5: Shows Fspecial filter

Convolution kernel filter Original image:

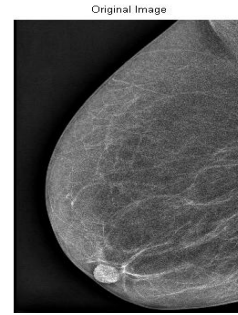


Figure 6. Shows Original Image

Convolution kernel filter with different factors:

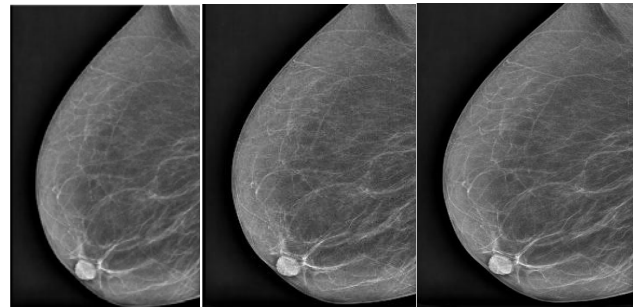


Figure 7: Shows kernel filter of [3 3], [9 9] and [25 25] fspecial filter of figure 5

Removal impulse noise from a SPECT slice

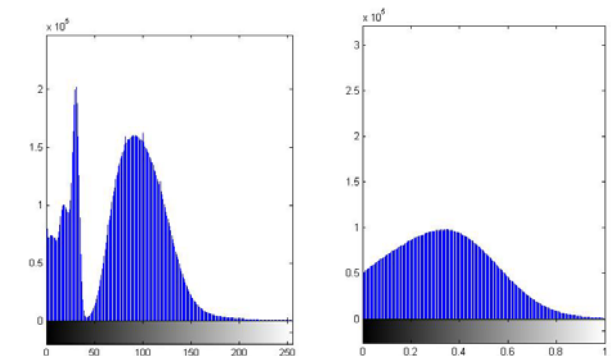
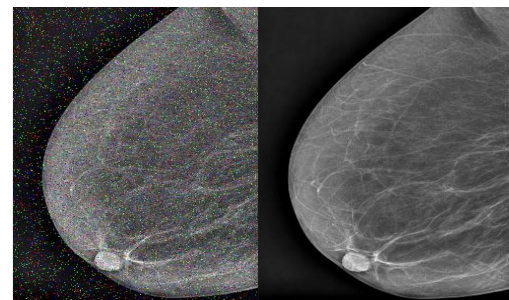


Figure 8: Impulse noise elimination by median filter. (a) The image with impulse noise (b) the image on which the noise is suppressed with the median filter. [(a) To (b) from left to right]

Removing Noise by Adaptive Filtering

The `wiener2` function applies a Wiener filter (a type of linear filter) to an image adaptively, tailoring itself to the local image variance. Where the variance is large, `wiener2` performs little smoothing. Where the variance is small, `wiener2` performs more smoothing. This approach often

produces better results than linear filtering. The adaptive filter is more selective than a comparable linear filter, preserving edges and other high-frequency parts of an image. In addition, there are no design tasks; the `wiener2` function handles all preliminary computations and implements the filter for an input image. `wiener2`, however, does require more computation time than linear filtering. `Wiener2` works best when the noise is constant-power ("white") additive noise, such as Gaussian noise.

The example below applies `wiener2` to an image of Saturn that has had Gaussian noise added.

1. Read in an image. Because the image is a true color image, the example converts it to grayscale.
2. The example then adds Gaussian noise to the image and then displays the image. Because the image is quite large, the figure only shows a portion of the image.
3. Remove the noise, using the `wiener2` function. Again, the figure only shows a portion of the image

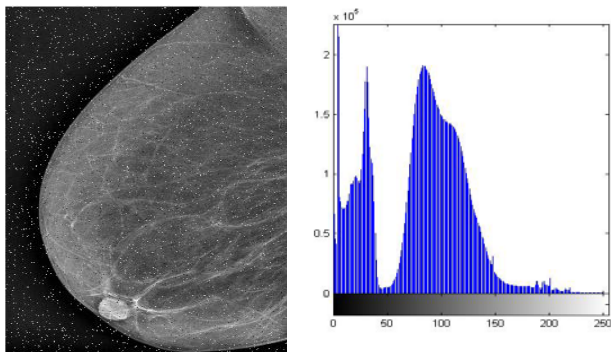


Figure 9: Shows Portion of the Image with Noise Removed by Wiener Filter

4. Conclusion

For high diagnostic accuracy, breast images must be of high contrast. The image contrast is principally affected by the radiopharmaceutical that is used for imaging and the scattered radiation. In general, it is desirable to use a radiopharmaceutical which has a high uptake within the target organ. Spatial resolution is defined as the ability of the imaging modality to reproduce the details of a non-uniform radioactive distribution. The spatial resolution is separated into intrinsic resolution (scintillator, photomultiplier tubes and electronic circuit) and system resolution. This was an experimental study to study the enhancement of ultrasound image using filtering technique using image processing technique (MatLab version R2009a). In addition to evaluate contrast enhancement pattern in different mammography images such as grey color in order to evaluate the usage of new nonlinear approach for contrast enhancement of soft tissues in mammography images. The main techniques of enhancement used in this study was For linear filtering, MatLab provides the `fspecial` command to generate some predefined common 2D filters. `h = fspecial (type)` creates a two-dimensional filter `h` of the specified type. `fspecial` returns `h` as a correlation kernel, which is the appropriate form to use with `imfilter`. The results of this technique agreed the results of other authors who used non-linear

filtering based methods to enhance the breast images. The another technique was Convolution kernel filter. Filtering is a technique for modifying or enhancing an image. For example, researchers can filter an image to emphasize certain features or remove other features. Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement. Filtering is a neighborhood operation, in which the value of any given pixel in the output image is determined by applying some algorithm to the values of the pixels in the neighborhood of the corresponding input pixel. A pixel's neighborhood is some set of pixels, defined by their locations relative to that pixel. Linear filtering is filtering in which the value of an output pixel is a linear combination of the values of the pixels in the input pixel's neighborhood.

So conclusion of this research that image processing and analysis applied to breast images for diagnosis, improve the acquired image qualitatively as well as offer quantitative information data useful in patient's therapy and care. Advanced techniques of image processing and analysis find widespread use in nuclear medicine. MatLab and Image Processing Toolbox enable both quantitative analysis and visualization of breast.

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