Identification of Suspicious Region in Secured Stegno-Mammograms with Two Dimensional Wavelets and Genetic Operators

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Abstract— The progress in multimedia and communication technology nowadays have offered new approaches to store, access and distribute medical data in a digital format. For this reason, by recognizing finest location on the mammogram to implant the patient's information without disturbing the quality of the image will be studied. A technique to automatically detect suspicious regions on stegno-mammograms based on identity asymmetries between left breast image and right breast image. The proposed system consists of two steps: First step is detection of the breast border and nipple on digital mammograms. To detect the breast border, an algorithm that computes the two dimensional wavelet is applied. Genetic algorithm is identifying the nipple position using genetic operators such as reproduction, crossover and mutation. Second, using the border and the nipple position of left and right mammograms; the images are correlated and subtracted to extract the suspicious regions. Before subtraction the mammogram images are normalized and pectoral muscle regions are removed. Breast border and nipple position is used to align right and left breast images to subtract. The algorithms are tested on 161 pairs of digitized mammograms from MIAS database and 125 pairs of mammograms obtained from various hospitals. The breast border and nipple position as references, bilateral subtraction technique applied both left and right mammogram can be made and obtained asymmetries extracted from back ground tissue. This investigation suggested a stenographic technique for mammograms, which conceal patients' information in mammograms without altering their significant information. In particular, the proposed technique can extract the hidden information from stegno-mammograms without the aid of the original images.

Keyword- stegno-mammograms, privacy and security, two-dimensional wavelets, genetic operators, bilateral subtraction, asymmetries

I. Introduction

In recent years, the importance of the security and privacy issues occured by medical databases has become a major concern due to the information technology advances. Since there is lot of advantages of medical images are exposed and it is regularly used in the medical domain, majority hospitals are facing with problems to manage huge volume of data storage such as managerial document, patient's data and medical images. Therefore, it is significant to handle those data correctly to avoid issues of lost, tampering and mishandling record at the hospital. The goal of the paper is to create an authentication method of watermarking mammogram using the DCT and DWT technique, And also to discover the finest location on the mammogram to embed the patient's data without disturbing the quality of the image. The improvement of authentication techniques for mammogram watermarking can be as one of the substitute to avoid the mishandling of medical images.

In this paper, bilateral subtraction of corresponding left right matched image pairs, based on the symmetry between both images. The detection of breast border should be a first step in bilateral subtraction.

Computerized detection of breast border and nipple allows the alignment of right and left breast images to subtract left and right mammograms. The subtraction of left and right mammograms should allow the computerized detection of asymmetries. In this paper a novel method, the combination of 2-D wavelet and genetic operators (reproduction, crossover, mutation) is applied to identify the breast boarder and nipple on digital mammograms. Applying the border coordinates and nipple position of left and right mammograms, the images are aligned and subtracted to extract the suspicious regions from back ground tissue.

II. Authentication Techniques for Mammogram

Investigation on the medical image watermarking is used for copyright protection, authentication and patient management system. The forthcoming medical applications, it will predict the integration access with the complete databases of the personal medical information of each patient. Encrypted patient's data can be implanted in an footnote while the tampering can be detected using fragile watermark. The embedded patient's data not only saves storage space, it also offers privacy and security. Furthermore the medical images in digital form must be stored in a secured environment to preserve the patient privacy. The DCT and DWT techniques are used to watermark the mammogram images [13-14].

In this paper, the breast area will be identified first before the process of watermarking. The analysis on the mammogram image has been done. Moreover, since different medical image will have different background color level, the background color of each mammogram samples will be checked by using data cursor tool in MATLAB software to get the suitable range for dark value. The development of algorithm and the prototype has been done by using MATLAB software. The input is a mammogram image and patient's information. Identifying breast area will be done before the embedding process. After that, extracting process will be executed and finally, the output will be a watermarked mammogram images. The Authenticated stegno mammogram images are used to identify the suspicious region using the preprocessing and Segmentation method.

III. Median Filter

Image pre-processing and enhancement methods inquire about to improve the visual appearance of the mammograms. Median filtering has been found to be very powerful in removing noise from two-dimensional signals without blurring edges [9]. This makes it particularly suitable for enhancing mammogram images. To apply median filtering to a mammogram, the pixel value is replaced by the median values in a neighborhood of the pixel [12].

IV. Breast Border Detection

Segmentation of the breast region and non-breast region is a necessary prerequisite for further bilateral subtraction. This section presents various border detection methods.

A. Previous Methods

Mendez et al., [10] developed a fully automatic technique to detect the breast border and the nipple, this being a necessary prerequisite for further bilateral subtraction. Chandrasekhar and Attikiouzel [3] developed a simple method for detecting the breast border. In this method, mammogram images are enhanced by logarithmic transformation, and morphological operations are performed to extract the breast border. The table 1 shows the Existing methods for identifying suspicious region.

B. Detection of the Breast Border using Wavelet

The Wavelet decomposition is an alternative representation of image data but the number of bits used to store it has not changed. To compress the image data, they must decide which coefficients to send and how many bits to use to code them [1, 2]. The proposed algorithm consists of taking the low-pass sub band in full, and then deciding which coefficients within the remaining sub bands to keep the problem is to decide which of the nonzero wavelet transform coefficients correspond to noise and which visually important details of the image [11, 12] in particularly, to preserve the edge-like information within the image. Simply thresholding each of the coefficients would leave extra noise and visually unimportant information in the compressed image. Figure 1 shows the Border Detection Using Wavelet. The algorithm to find the breast border detection as follows:

a) Low-pass and high pass filters are generated to decompose the image.
b) Using the filters 2-D discrete wavelet transformation is performed on the image to get approximation and detail coefficients.
c) The approximation coefficient is a gray scale image that is converted to binary image using thresholding.
d) Now the image is segmented as breast region and non-breast region.
e) In the breast region the interior pixels are removed using morphological dilation and erosion operation.
f) After the morphological operation, the binary image contains only the border pixels alone.
g) The border pixels in the binary image can be mapped with the original gray level image, using spatial coordinates.

Fig. 1. Border Detection Using Wavelet

V. Identification of the Nipple

The nipple may appear either in profile or not in profile. The nipple is located on the mammogram close to where the rate of change among gray-levels is larger than in the rest of the breast. In this method, first the nipple position is finding out by using the second derivative method. From that nipple position fifty border pixels towards left and fifty more border pixels towards right from the border is extracted. Now, this new set of hundred pixels intensity values are considered as the values for initial population for the genetic algorithm. The intensity values of the border points are then converted as binary strings, and these values are considered as population string for genetic algorithm. Now the genetic operators reproduction, crossover, and mutation are applied to get new population of strings [8,10]. Figure 2shows the Nipple identification using Genetic algorithm and Table I shows the List of fitness values and region Population strings.

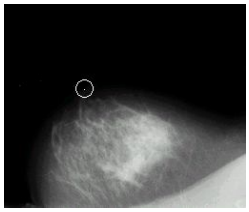

Fig. 2. Nipple identification using Genetic algorithm

Table I: List of fitness values and region Population strings

Sl.No	Initial Population		30th Generation	
	Fitness	Population	Fitness	Population
1	24	00011000	255	11111111
2	22	00010110	254	11111110
3	23	00010111	255	11111111
4	23	00010111	255	11111111
5	*22*	*00010110*	*15*	*00001111*
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
	Max:255	Min:7	Max:255	Min:10

VI. Bilateral Subtraction

A. Removal of Pectoral Muscle

To increase the reliability of boundary matching, the pectoral muscle can be removed from the extracted breast region if it is visible in the image. The pectoral muscle appears as a bright triangular region in the image corner towards the chest wall and the top of the breast region. In processing mammogram views known to contain a pectoral muscle, such as medio-lateral oblique views, the following algorithm attempts to remove the pectoral muscle region from the breast region.

a) Apply median filter to enhance the mammogram image.
b) A histogram-based thresholding technique is used to separate the pectoral muscle region. The highest peak in the histogram is select as the threshold value. The intensity values smaller than this threshold are change to black (0), and the gray values greater than the threshold are change to white (1).
c) The erosion and dilation operators are used to better preserve the pectoral muscle region.
d) The gray level mammogram image is converted to binary image to segment the breast region.
e) Search for the white pixels in the pectoral muscle region from the lower left corner of the mammogram image. When it finds any white pixel, the coordinate is found out, and the corresponding pixel in the segmented breast region image is change to black (0).
f) If only a small portion of the muscle is visible in the image the algorithm simply matches the full breast region outline for the images being compared.

Figure 3 shows the Mammogram Image (mdb057.pgm), Binary Image, Pectoral Muscle Region, and Extracting pectoral muscle region from the binary image.

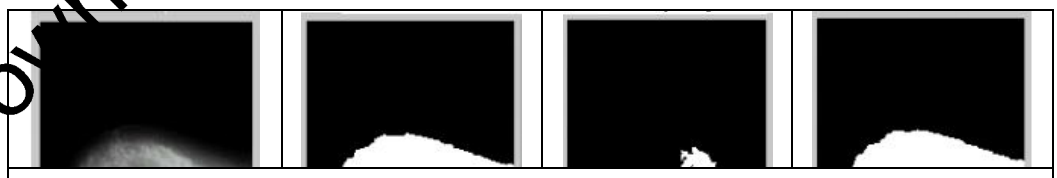

Figure 3. (a) Mammogram Image (mdb057.pgm), (b) Binary Image, (c) Pectoral Muscle Region, and (d) Extracting pectoral muscle region from the binary image

B. Normalization of Mammograms

Images are corrected to avoid differences in brightness between the left and right mammograms caused by the recording procedure. This permitted use of single set of parameters in the automated detection scheme

for all mammograms. In order to reduce the variation, and achieve computational consistency, the images are normalized, by mapping all mammograms into a fixed intensities range r1 and r2 ($0 \le r1 < r2 \le 255$). Figure 4. Shows the Original Mammogram and Normalized mammogram

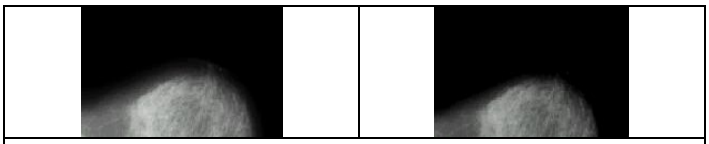

Figure 4. (a) Original Mammogram.(b) Normalized

C. Alignment of Mammograms

In this study the right breast image is always transformed. To align the images, the right mammogram is both displaced and rotated. The coordinates of the detected nipples of both images determined the displacement. The coordinates of the points along the detected breast borders were used to determine the angle of rotation to achieve correspondence. After the right breast border was displaced, the correlation coefficient between the coordinates of the points of the left breast border and the coordinates of the points of the rotated right breast border was calculated for angles ranging between -5° and 5° with one-degree step.

D. Extraction of Suspicious Regions from Background Tissue

After the images were aligned, bilateral subtraction is calculated. The digital matrix of the left breast image was subtracted from the digital matrix of the right breast image. Microcalcification in the right breast image have positive pixel values in the image obtained after subtraction, while microcalcification in the left breast image have negative pixel values in the subtracted image. As a result, two new images were generated: one with positive values and the other with negative values [9,12]. Figure 5 shows the left breast mammogram image, aligned image and rotated right breast image, the negative difference image and the positive difference image.

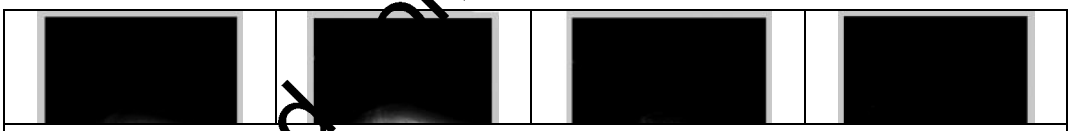

Figure 5. (a) Is left breast and (b) is the aligned and rotated right breast image. Image (c) is the negative difference image and (d) is the positive difference image.

E. Experiments and Results

Wavelet and genetic algorithm has been tested with various types of 322(161 pairs) mammogram images from MIAS database. This proposed approach has been implemented by MATLAB. The co-ordinates of the points in suspicious areas diagnosed by radiologists and by applying this software are very close to each other and are satisfactory. Regarding the nipple position, the results are obtained from the proposed method is 8mm difference with the real position obtained radiologists by consensus. Table IIII shows the comparison of the radiologist's results and computer detection.

Table IIIII: Comparison of the Radiologist's Results and Computer Detection

MIAS data set Ref. No.	Coordinate points and radius of the Suspicious Region						Remarks
	Radiologist			Computer			
	X	Y	R	X	Y	R	
mdb023	538	681	29	528	676	35	Malignant
mdb072	266	517	28	278	525	27	Malignant
mdb149							Normal

mdb213	547	520	45	565	540	40	Benign
mdb231	603	538	44	612	533	45	Benign
mdb249	575	639	64	559	630	59	Malignant
mdb267	793	481	56	790	475	62	Malignant

VII. Conclusion

A prototype for this paper has been developed where this algorithm has the ability to embed more information on mammogram images by using DCT and DWT techniques. A proposed method is designed to automatically detect the breast border using two-dimensional wavelets and nipple in digital mammograms using genetic operators such as reproduction, crossover and mutation. In nipple identification, the border pixels intensity values are considered as population strings, reproduction is applied to these strings to generate parent strings using fitness values, for crossover operator. Crossover and mutation operators are used to generate matted strings, the new population for detection of nipple position. The border and nipple as references, alignment, and bilateral subtraction technique applied both left and right mammogram can be made and obtained suspicious regions extracted from background tissue.

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