

Efficient Segmentation Method for ROI Detection in Mammography Images Using Morphological Operations

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ABSTRACT:- Breast cancer seems to be the world's-largest cause of the death among women. Currently, screening mammography is the best scientific radiological strategy for early diagnosis of breast cancer. However, Segmentation for region of Interest (ROI) is the first and critical step in evaluating digital mammogram images for breast cancer. For this purpose, the preprocessing of mammogram images is very important in the breast cancer diagnosis process as it decreases the number of mammogram images. This paper suggests different strategies for solving noise removal problems and by using a thresholding method, separating the background region from the breast profile section. Finding a precise, robust and effective ROI segmentation technique in digital mammography analysis is still a challenging issue. In this paper we proposed an efficient morphological approach for segmenting interest regions from mammogram images. For research purposes, digital mammograms are taken from the mini MIAS (Mammography Image Analysis Society) database and the findings are collected in MATLAB. These results indicate that the proposed approach is efficient and reliable.

Keywords: Noise removal; pectoral muscle extraction; MATLAB; ROI segmentation

I. INTRODUCTION

In today's world, the various diseases and disorders affect human beings. Cancer is a wide array of diseases characterized by abnormal cells that expand and invade healthy body cells. Cancer starts in the cells that constitute the basic building blocks which form tissue. If this happens, a mass of tissue is created, called a lump or tumour. Breast cancer starts in breast cells as a community of cancer cells that can then invade adjacent tissues or spread to other parts of the body. For the last few years, cervical cancer has become the most common cancer in women around the world, and more deaths have been caused by cervical cancer than any other cancer in India[1]. But breast cancer has been gradually growing over the last 10 years or so and breast cancer is the most common cancer in women in India for the first time now. Mortality from breast cancer is higher than cervical cancer. Breast cancer is the most common cancer and is one of the main causes of death in middle-aged people, since it is very difficult to detect. Since its origin remains unknown, so cannot completely prevent it. Yet early diagnosis of breast cancer helps to lower the mortality rate and better treatment options available to patients. The breast cancer survival rate can be improved if it is diagnosed early in stage [2]. Mammography will get the detection of the earlier point.

Mammograms can't eradicate breast cancer but by finding breast cancer as early as possible they can save a patient's lives. Mammography helps to detect invisible tumours and thereby improve survival rate [3]. Such mammographic images are examined by radiologists to identify abnormalities and determine whether they are benign or malignant, but the radiologist sometimes fails to differentiate between false positive and false negatives. Therefore, a human radiologist is often incapable of correctly detecting anomalies. Nevertheless, the advancement of MATLAB software helps researchers to diagnose breast cancer with great precision and predictive reliability at its earlier stage[4]. The diagram shown below represents the different classes of mammogram image indicating the breast cancer which is present or not. These class of cells are normal, benign and malignant cell classes. Here ,malignant cells indicates the breast cancer but benign cells may or not indicate the cancer.

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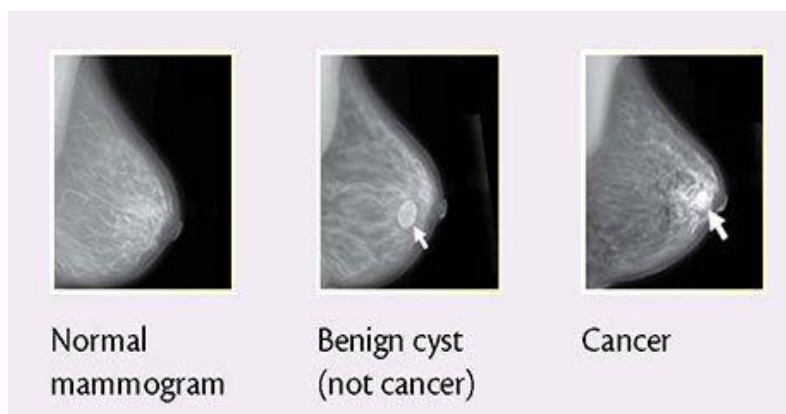


Fig 1: Mammogram Images

Segmentation refers to the method of separating the distinguished image objects from the image background in the sense of image analysis, i.e. partitioning the image into appropriate regions and then choosing the desired area known as Region of Interest (ROI)[5]. Segmentation of images is an essential move which can make the analysis of images easier. ROIs are also collected by specialists in medical imaging applications either manually or automatically using methods of image segmentation before analysing the image for the reason it was captured. [6]The automated identification of regions of interest (ROI) will help to better localize the cancer tissue instead of extracting features directly from the original high-resolution mammography image. The process primarily takes place in three stages:

- Identification of interest regions (ROIs),
- Segmentation of (ROIs),
- Classification.

Extraction of the regions of interest (ROIs) is a capital move in segmenting mammography. Several techniques for detecting regions of interest have been published for this purpose[7], such as:

- Edge Based Techniques
- Region-based Techniques (region growing)
- Split-and-merge
- Clustering

We proposed an efficient method for segmentation of region of interest(ROI) in a mammogram for the early detection of breast cancer diagnosis. The study focused on three stages of breast cancer diagnosis. Image pre-processing is the first stage which include the removal of unwanted noise in the mammogram. The second stage contain the extraction of high density pectoral muscle in a mammogram, so that we can obtain the exact image of breast profile. Final stage of breast cancer detection is segmenting the region of interest in the breast image.

1. Background study

An automatic procedure for segmentation of mammograms is discussed. The proposed algorithm uses the morphological pre- and rising seed region (SRG) algorithm to: (1) eliminate digitization noise, (2) suppress radiopaque artefacts, (3) isolate background area from the breast profile area, and (4) delete pectoral muscle to accentuate the breast profile region[8].

The first phase to classify breast cancer abnormality (malignant from benign), is area of interest (ROI) extraction. To accomplish this, a new approach to breast ROI extraction is proposed to reduce false positives (FP) events. The model proposed is multi-descriptor (texture feature) based. The proposed model was developed based on the knowledge about local pixels and the neural network. It requires two phases, specifically training and testing. A trained model was built during the training stage by extracting the number of batches from both ROI and history. The testing stage involved scanning the image from the background using a fixed size window to detect the ROI[9].

Morphological band pass filter (MBF) is introduced to detect micro calcifications, which is implemented by opening the original image twice with two separate structural elements respectively, and subtracting one opened image using another which can decompose the image into interest information domain image where microcalcifications tend to appear. MBF series are optimized for the detection function, and the binary image containing the region-of-interest (ROI) micro-calcifications will be obtained. Experimental findings show that the proposed method can identify ROI with a true positive of 93.07 per cent and a false positive of 4.34 with these band pass filters[10].

A new classification system for the identification of ROIs in mammography images is proposed. The proposed method first computes the selected image's Wavelet transformation, and then extracts descriptors from HOG and Haralick that compute textural and gradient attributes. Then, a wrapper technique is used to choose the best collection of apps. The suggested method of extraction of features achieves the highest ROI detection accuracy when employed in a random forest classifier. A wrapper-based function selection approach is introduced to reduce the number of dimensions and remove unnecessary features. The proposed approach offers 87.5 percent maximum accuracy[11].

A new algorithm is implemented using statistical properties of mammograms for identification of Mammograms Region Of Interest (ROI). The proposed Algorithm for Successful Statistical Texture Detection (ESTD) is based on the weighted value of each bit in the 8-bit representation of a pixel in an MMG image. The proposed algorithm for the ESTD has had four main steps. (A) De-noising and AOI detection using statistical properties. (B) The data thresholding step for selecting artefacts of high intensity is a further reduction in the number of pixels to be analysed in the following steps. (C) Statistical methods for detecting suspicious objects which are the Cumulative Moments of Dates adopted.(D) Identification of selection parameters for accepting or rejecting suspicious items with a specified interest. The proposed algorithm was tested using 115 mammograms and other references from the MIAS databases. Results of the simulation show that in class detection methods the proposed algorithm achieved a 17 per cent False Positive (FP) reduction on average versus best[12].

The method is proposed [13] for effectively finding the Region of Interest (ROI) from the mammogram picture. First filtration is done to enhance the image. Second, the picture is binned and every bin gets a 3D plot. The number of peaks shall be determined from each 3D plot of the binned image. The combination of blocks with large numbers of peaks is known as ROI. The area of interest was identified by method of binning and 3D graphing. Such region-of-interest identification is achieved by the number of peak counts in each row. The peaks are counted using a method of peak analysis. The block with the highest peak value is then isolated by independent processing of the blocks.

A novel approach is proposed to automatically define and initialize the region of interest in a Breast Ultrasound image. They propose Hybrid Improved Speckle in the pre-processing stage, reducing anisotropic diffusion filter followed by a novel algorithm to extract the region of interest. Pre-processing hybrid filter is constructed by combining Gaussian blur filter and Updated SRAD filter. To remove regions of interest, the Black Hat Transform and Simple Threshold Algorithm are suggested. Modified SRDA is imposed on the Gaussian blur image that reduces the speckle and improves the image to find the ROI. We deploy 2 methods to find the ROI, black has-transform and Easy Threshold. Deploy 2 methods to find the ROI, black has-transform and Easy Threshold. In this work 180 separate pictures of BUS were used out of which 78 were benign and 102 were malignant. The proposed work was applied to these pictures and was 96 per cent accurate[14].

The method is proposed[15] to identify the regions of interest (ROIs) in mammograms using dynamic k-means clustering algorithms. In this approach a method was developed to calculate the initialization number of clusters in mammograms using a data mining algorithm focused on the Local Binary Pattern (LBP) and co-occurrence matrix technique (GLCM). This method consists of three main phases: the image enhancement, the initial number of clusters being generated and the identification of suitable regions of interest. The classic version of the K-means algorithm allows for measurement of the number of clusters (k) used as input parameters.

Image processing techniques were applied to precisely segment the suspicious region-of-interest (ROI) before identification of anomalies. Unsharp masking was applied for mammography enhancement. Removal of the noise was done using median filtering. Discrete wavelet transformation was performed on the filtered image to get precise results before segmentation. The suspect ROI has been fragmented using the Fuzzy-C-means utilizing thresholding strategy. To distinguish mammogram anomalies, tamura parameters, shape-based properties, and instant invariants are extracted from clustered ROI[16].

II. METHODOLOGY

The proposed approach is illustrated by means of the block diagram shown in Fig.1. To classify the ROI in mammograms, pre-processing must be done to remove noise and pectoral muscles. The first module in the block diagram represents normalization and the uniform image given to the second module as input, which uses a modified CLAHE algorithm to eliminate noise. The third segment represents a pectoral muscle description. Grey thresholding is used in the mammogram image to distinguish pectoral muscles. It is extracted by combining grey level thresholding processes with morphological approach in MATLAB after the pectoral muscles have been developed. ROI segmentation is the last phase which is used to detect the breast cancer present in a mammogram image.

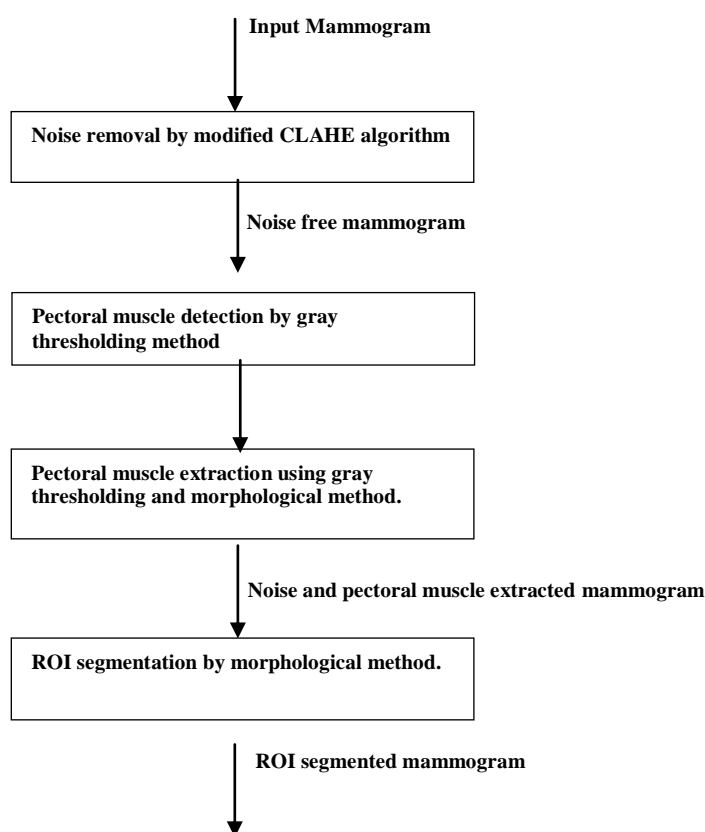


Fig 1: Block diagram for Proposed Method

3.1 Image Pre-Processing: Noise Removal

Background objects with high intensity values make the identification of breast borders a challenging task in many MMGs, especially those scanned where the original film has some artefacts. The computer image processing methods should then be applied to the image for Separate the current breast profile and remove the digitization noise to improve image quality[17].

3.1.1 Proposed algorithm for noise removal using Modified CLAHE algorithm by computing Area.

Step 1: Start.

Step 2: Use a median filter to filter the noise.

Step 3: Apply CLAHE to the image and enter additional name-value pairs.

Step4: Calculate the area of each component in the image.

Step6: select a region of interest in the image

Step5: remove a small area of objects in the image (removal noise).

3.2 Image Pre-Processing: Artifact Suppression And Extraction Of Pectoral Muscle

The MIAS image dataset is included in this study. Raw mammogram image contains wedges & marks. These can produce unnecessary disruptions during the process of mass detection. Therefore it should be extracted during pre-processing. To extract these objects are used in the proposed system of thresholding & morphological opening, closing, dilation & erosion. Using thresholding & morphological operations, radiopaque objects such as wedges & labels are removed in the mammograms images. Larger area should be derived from the analysis, neglecting the smaller areas. Smaller artefact regions can be quickly extracted from the mammogram due to the mechanism above. Morphological erosion & dilation with structuring elements is introduced. Using imfill function in MATLAB the holes generated in the binary image are finally filled. The resulting image is separate image of artefacts.

Like the label and artifact, the mammogram image includes the pectoral muscle which also causes unwanted disruptions during the process of mass identification. The pectoral term is chest connected. It is the largest muscle that occupies much of the upper front body. The pectoral region will always appear across the upper posterior margin of the picture as a high density, triangular region. For certain instances, the upper part of

the boundary is a sharp edge of pressure, while the lower portion is more likely to be an edge of thickness, as it is overlapped by fibro-glandular tissue. As it will also be captured during the mammogram capturing process pectoral muscle it would significantly affect the image processing performance. Hence, it is also removed in ROI detection before the segmentation stage.

Using Thresholding and morphological operations, radiopaque objects such as wedges, labels and breast profile separation in mammograms images are removed. The correct selection of the Thresholding value should be necessary otherwise the maximum fraction of the image would be threshold. Thus a connected component labelling method is used to overcome this problem[18].

3.2.1 Proposed Algorithm for Pectoral muscle extraction by thresholding.

Step 1: Calculate the threshold with Graythresh. The threshold shall be normalized to [0, 1].

Step2: Convert the image to a binary image based on the threshold Step 3: detect and display the pectoral muscle.

Step 4: modify extra components to be present in image

1. Create a disk-shaped structuring element with a radius of 1.

2. Subtract the images with the imsubtract function.

3. Applies the resulting image to a particular morphological procedure.

4. Using imfill feature to fill image regions and holes.

Step5: convert the binary image to the original image.

Step 6: view the cropped image.

3.3 Region Of Interest (ROI) Segmentation

Segmentation is the process of separating the benign and malignant masses from the background portions by partitioning the digital mammograms into nonoverlapping segments. Morphology is a systematic collection of image processing functions that manipulate shape dependent images. pixels in the frame is modified in a morphological procedure, depending on the value of several other pixels in its region. It may create a morphological operation that is responsive to different shapes in the input image by choosing the size and shape of the neighbourhood.

3.3.1 Proposed Algorithm for ROI segmentation

Step1: read the image and display it.

Step2: Find gradient magnitude and direction of image.

step 3: Create a disk-shaped structuring element with radius.

Step 4: Remove snowflakes having a radius by opening it with the disk-shaped structuring element.

Step 5: Erode the image with the structuring element.

Step 6: Perform morphological opening on the mask image, using the marker image to identify high-intensity objects in the mask. Display the result.

Step 7: Perform a morphological close operation on the image.

Step 8: Dilate the image with a vertical line structuring element and compare the results.

Step 9: performs morphological reconstruction of the image under the image.

Step 10: returns the binary image that identifies the regional maxima in grayscale image

(Regional maxima are connected components of pixels with a constant intensity value, surrounded by pixels with a lower value).

Step 11: convert the binary image into the original image.

II. RESULTS AND DISCUSSIONS

The proposed method uses mammogram images captured from the Mammographic Image Analysis Society (MIAS), that will be a public mammogram database, for research, 100 images are randomly selected from the standard and abnormal collection of images¹⁹ and the proposed method is tested on those images. The collection consists of 322 pictures from 161 patients.

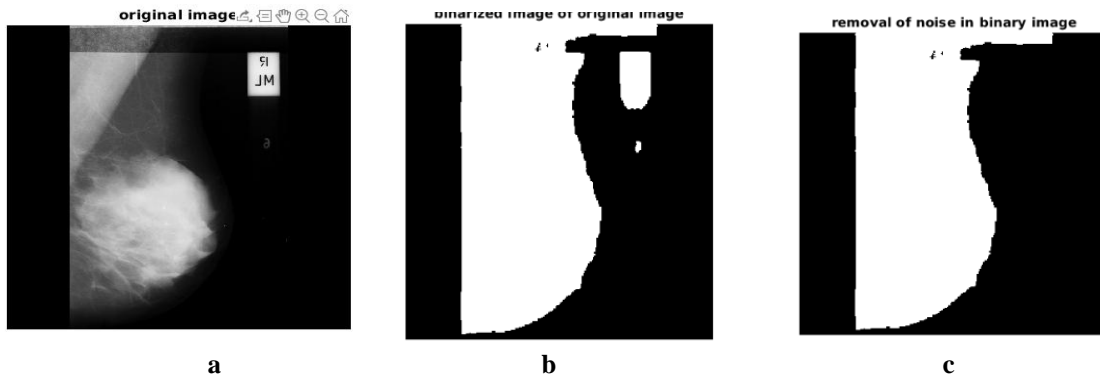


Fig 3: a)original image b) binarized form of original image c)binary image without noise

Above figure 3 shows the image pre-processing stage of noise removal process. This mammogram is the benign class in which breast cancer is present. Here fig (a) shows the original benign class mammogram image with noise is present and fig 3 (b) indicates the binarized form of original image with noise. Fig 3 (b) shows the removal of unwanted noise in a original binarized image.

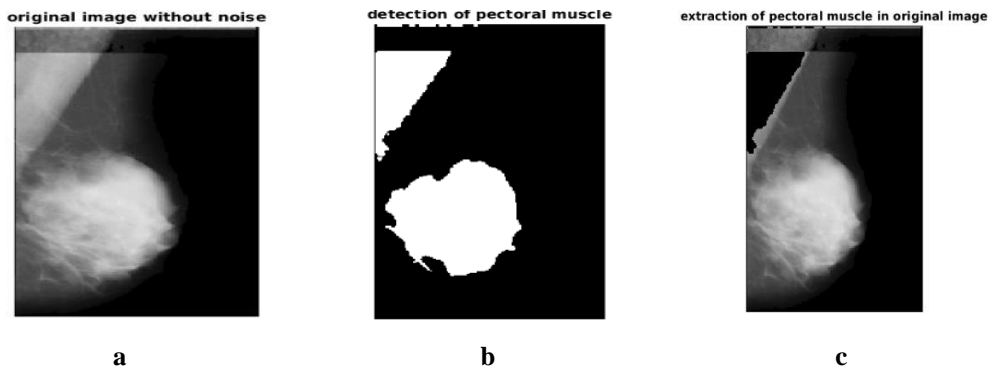


Fig 4: a) original image without noise b) detection of pectoral muscle in an image c) pectoral muscle extracted image

The image with the operation stage of extraction of pectoral muscle is shown above. Here fig 4 (a) represents the output image which is out from the first stage of noise removal process. In fig 4 (b) these image is given to the 2nd stage of image pre-processing stage.in this stage ,high density pectoral muscles are detected . Detected pectoral muscles are extracted in the fig 4 (c) using the gray thresholding and morphological operations in MATLAB.

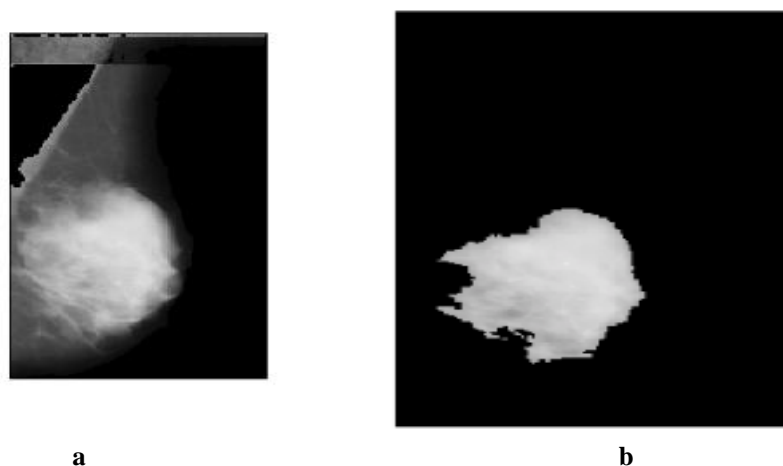


Fig 5 : a) pectoral muscle extracted mammogram b) ROI segmented Image(detected abnormality in a mammogram)

The image is shown above with ROI segmentation operation. Here figure 5(a) represents the output image from the second stage of the pre-processing step. In this stage, high density pectoral muscles are extracted which is provided to the ROI segmentation stage input. Segmentation of region of interest is done by morphological operations in a MATLAB. Fig 5 (b) shows the abnormalities present in a mammogram.

II. CONCLUSION

Mammography is one of the best techniques for detecting breast cancer, but in some cases, with their expertise, radiologists cannot identify tumors. These computer-aided methods as provided in this paper could support medical personnel and support recognize the asymmetry. In this paper, we propose a method for image preprocessing of mammogram and an accurate method for segmenting the ROI present in the mammogram image which is the identification breast cancer. Modified CLAHE algorithm is proposed to remove the unwanted noise in a mammogram. Accordingly, gray thresholding and some morphological operations are applied to remove the high-density pectoral muscle in a mammogram. Finally, Breast asymmetry is segmented by the active morphological strategies in the MATLAB. Our future work is to extract the different characteristics that are presented in mammogram ROI and classify mammogram form.

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