Feature Extraction from Mammograms of Breast Cancer using Automatic Thresholding

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Abstract— Breast cancer detection is still complex and challenging problem. Diagnosis of cancer tissues in mammograms is a time consuming task even for highly skilled radiologists as it contains low signal to noise ratio and a complicated structured background. Therefore, in digital mammogram there is still a need to enhance imaging, where enhancement in medical imaging is the use of computers to make image clearer. Studies show that relying on pure naked-eye observation of experts to detect such diseases can be prohibitively slow and inaccurate in some cases. Providing automatic, fast, and accurate image-processing-and artificial Intelligence-based solutions for that task can be of great realistic significance. This paper discusses about different techniques used to scans the whole mammogram and performs filtering, segmentation, features extraction.

Keywords: Mammography, Segmentation, ROI (Region Of Interest), Micro-Calcification, Masses, Bilateral Asymmetry, Otsu's Thresholding

I. Introduction

Breast cancer is a malignant tumor that grows in or around the breast tissue, mainly in the milk ducts and glands. A tumor usually starts as a lump or calcium deposit that develops as a result of abnormal cell growth. Most breast lumps are benign but can be premalignant (may become cancer). Breast cancer is classified as either primary or metastatic. The initial malignant tumor that develops within the breast tissue is known as primary breast cancer. Sometimes, primary breast cancer can also be found when it is spread to lymph nodes that are close by in the arm pit. Metastatic breast cancer, or Ad-vanced cancer, is formed when cancer cells located in the breast break away and travel to another organ orpart of the body (10).Breast cancer is one of the leading causes of death in women. Studies have indicated that cure rates dramatically increase if the breast lesion can be detected at a size less than 1 centimetre, which is too small for the lesion to be palpable (9).

II. Breast cancer diagnostic methods

Breast image capture and analysis techniques playmajor role in detecting breast cancer. In order to determine if a breast lump is malignant or benign, one or more of the following imaging tests may be performed. Some of the medical diagnostic methods for breast cancerare given below:

A. Mammogram

Mammogram is the basic test to detect breast cancer.During the mammogram test, the Iron Radiation that goesinto the breast shows internal parts of the body and alsothe suspicious region. It shows tissues of breast and veins.After completing the mammogram test, the result will beshown in X-ray film sheet. Nowadays there are 3advanced techniques included in mammography.

- Digital mammography.
- CAD.
- Breast tomosynthesis.

1) Digital Mammography

Digital Mammography is fully upgraded by full field digital mammography (FFDM). Here x-ray film is replaced by solid state detector .The solid state detectors do the X-ray film image converted into electrical signals. Signals are used to capture the breast inner part to produces special digital image. In mammogram test, only one picture can be taken at a time and also only one side of the breast will be captured. Compression of breast causes overlapping of tissues and hides certain details. So mammogram sometimes doesn't show the cancer tumor. Main disadvantage is compression of breast is not comfortable for all women. It may be a painful procedure].

2) Computer Aided Design (CAD)

CAD produces digitally acquired mammogram. Computer software plays major role in this mammogram. It detects abnormal areas of density and mass calcification that may be the presence of cancer. CAD is very helpful to radiologist to detect the cancer .

3) Breast Tomosynthesis

It is a 3 dimensional picture representation of breast using X-rays. It is not considered as standard testing of breast cancer. Main drawback in this testing is that the device is not available in many hospitals. Breast tomosynthesis overcome the above said disadvantage of mammogram. Breast tomosynthesis takes multiple images of breast at many different angles. Breast tomosynthesishave x-ray tube arc. During the test, x-ray tube arc around the breast and takes 11 highly clear 3 dimensional images.

B. Ultrasound

Ultrasound is one of the techniques used to detect breast cancer. Ultrasound is otherwise called as sonographyor ultrasound screening. Ultrasound device consists of computer, electronic transducer, ultrasound gel and video display. Transducer is used to scan the body. Transducer isa hand-held device and it has attached microphone. Ultrasound test is non-invasive test and painless. Ultrasound gel exposes the body to high frequency sound waves. During the ultrasound testing, it does not emit any iron radiation as in mammogram. The ultrasound gel is applied in suspicious breast region. Transducer helps display of the internal structure of breast and movements of internal organ, showing the flow of blood vessels. Ultrasound is less expensive.

C. Doppler Ultrasound

It tests the blood flow through blood vessels and also shows body's major arteries, veins, abdomen, arms and neck. During the breast ultrasound test, the sonographer knows the blood flow in breast. So they use Doppler ultra sound test and also find lack of flow in breast mass. The transducer produce some sounds like frequency soundwaves and sends into the body to test. The waves touch the internal organs and return the echoes from the body. At the same time internal organs are displayed in the computer screen.

D. Magnetic Resonance Imaging

It is full of magnetic field and radio frequency pulses. MRI produces strong magnetic rays into the body. It is little expensive. Computer MRI tests the internal organs, soft tissues, bones and internal structure. Images are shown in computer screen and transmitted into electronic signals then the details are printed or copied in CD in image format. MRI does not produce any iron radiation. MRI test helps to find how large cancer is and suspected muscles are underlying. MRI is capable of capturing the images of both the breasts simultaneously. Any abnormality tumor or lymph nodes in armpit, it can easily detect. MRI finds current stage of cancer and also abnormalities. MRI easily detects dense breast tissue in younger women.

E. Positron Emission Tomography (PET)

PET helps to detect cancer area and body's cells first. PET scan starts with an injection of radiopharmaceutical called Fludeoxyglucose(FDG).During the PET scan gamma rays are emitted by FDG.FDG are recorded by the PET scanner and images are reconstructed and reviewed. This helps to identify the suspected malignancy. If physician can find suspiciousarea, it will accumulate the signals stronger to suspected tissues.

In this paper we discuss different developed computer-aided diagnostic techniques for automatic detection and basic feature extractions from mammogram of breast cancer(24).

III. FEATURES OF BREAST ABNORMALITIES IN MAMMOGRAMS

Usually breast abnormalities are characterized into following classes:

A. Micro calcifications

Calcifications are tiny deposit of calcium which appears as small bright spots on the mammogram. They are described by their type and distribution properties. Radiologists give special attention to calcifications with dimensions of 0.2 to 0.3 mm, with a higher suspicious degree to aligned or clustered micro calcifications.(2, 7)

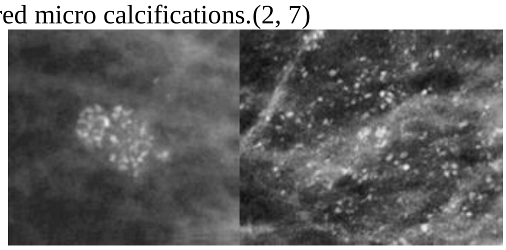


Fig. 1: Figure of Micro Calcifications

B. Masses

A mass is defined as a space which occupy lesion. These are seen at least two dissimilar projection. Masses are identified by their shape and margin property. Masses are the most common asymmetric signs of cancer and appear brighter than the surrounding tissue. Most benign masses possess well-defined sharp orders, while malignant tumours often have ill-defined, micro-lobulated, or speculated borders. (2,7)

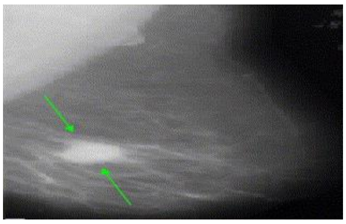


Fig. 2: Figure of Mass

C. Bilateral Asymmetry and Architectural Distortion

1) Bilateral Asymmetry

Bilateral asymmetry is an asymmetry of the breast parenchyma between left and right breast, may indicate breast cancer in its early stage.

2) Architectural distortion

An architectural distortion occurs when normal architecture is distorted with no definite mass visible.An architectural distortion on a mammogram is basically a disruption of the normal 'random'pattern of curvilinear and fine linear radiopaque structures. There is no visible mass, but the distortion often appears as a'stellate' shape or with radiating speculation.(2, 7)

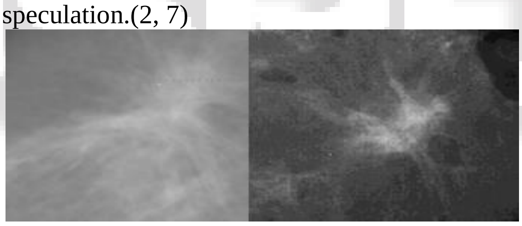


Fig. 3: Figure of Architectural Distortion

IV. TECHNIQUE FOR FEATURES EXTRACTION FROM MAMMOGRAMS

A. OTSU'S METHOD

Otsu's method is one of the most popular methods for its simplicity and efficiency. It is based in thresholding technique. It depends on selecting the optimal threshold value that maximizes the between-class variance of resulting object and background classes. The search for the optimal threshold done sequentially until finding a value that makes variance between two classes or more maximum.

The method searches for the threshold that minimizes the intra-class variance (the variance within the class), defined as a weighted sum of variances of the two classes:

$$\sigma_w^2(t) = \omega_1(t)\sigma_1^2(t) + \omega_2(t)\sigma_2^2(t)$$

Weights ω_i are the probabilities of the two classes separated by a threshold t and σ_i^2 variances of these classes.

The method shows that minimizing the intra-class variance is the same as maximizing inter-class variance

$$\sigma_b^2(t) = \sigma^2 - \sigma_w^2(t) = \omega_1(t)\omega_2(t)\left[\mu_1(t) - \mu_2(t)\right]^2$$

which is expressed in terms of class probabilities ω_i and class means μ_i.

The class probability $\omega_1(t)$ is computed from the histogram as t:

$$\omega_1(t) = \Sigma_0^t p(i)$$

while the class mean $\mu_1(t)$ is:

$$\mu_1(t) = \left[\Sigma_0^t p(i)\, x(i)\right] / \omega_1$$

where $x(i)$ is the value at the center of the ith histogram bin. Similarly, you can compute $\omega_2(t)$ and μ_2 on the right-hand side of the histogram greater than t.

The class probabilities and class means can be computed iteratively. This idea yields an effective algorithm to find the automatic threshold.

B. *Microcalcifications Detection*

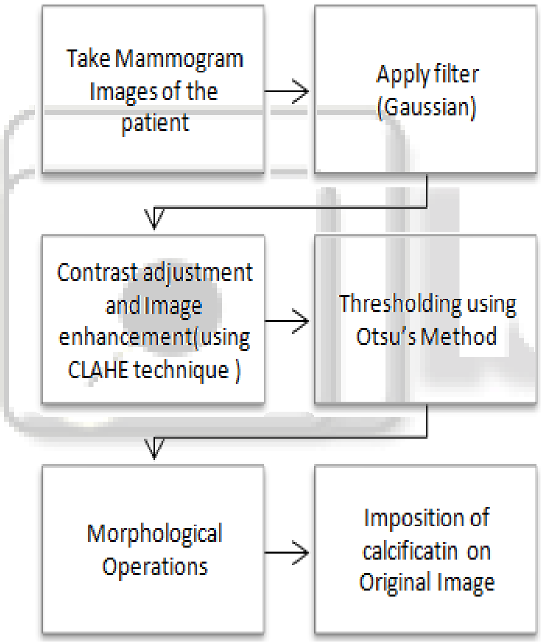
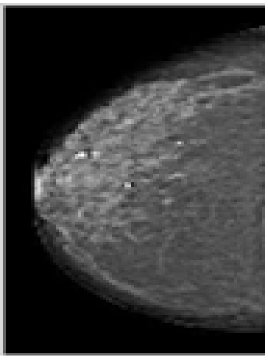
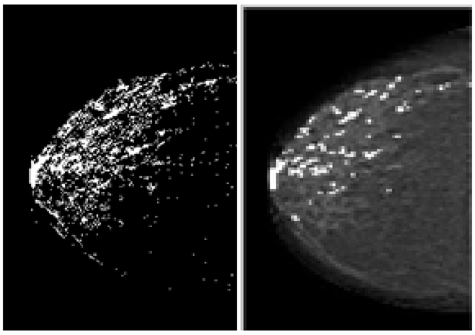


Fig. 4: Flow of Implementation for Detection of Micricalcification

1) *SIMULATION RESULTS*



(1)



(2) (3)

Fig. 5: Results for Mass Detection

Original input image (b) Output after thresholding (3) Final O/P (Microcalcification Superimposed On I/P Image)

C. *Mass Detection*

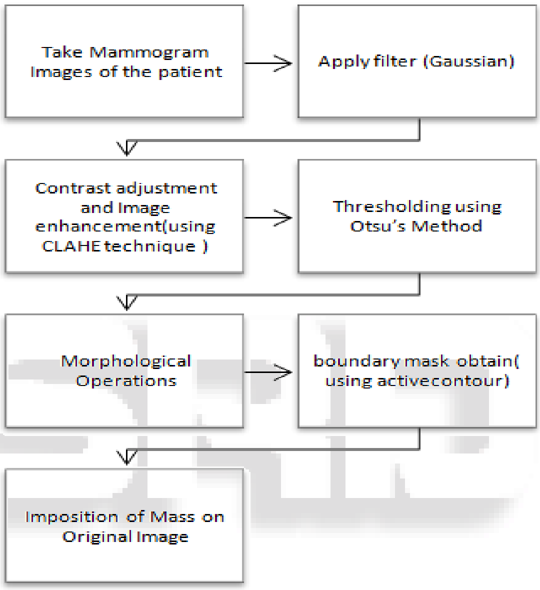
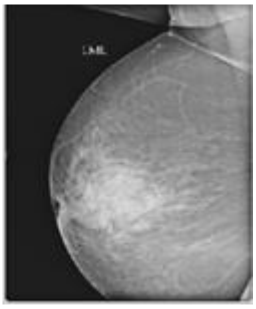
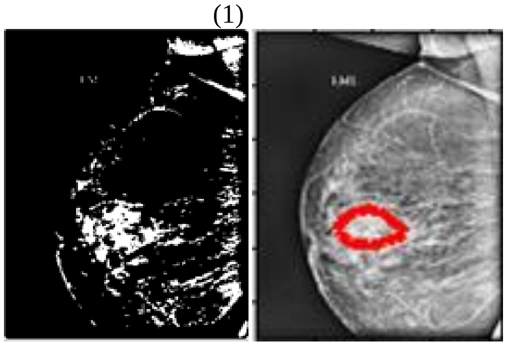


Fig. 6: Flow of Implementation for Detection of Mass

1) *SIMULATION RESULTS*



(1)



(2) (3)

Fig. 7: Results for Mass Detection

(1) Original input image (2) Output after thresholding (3) Output image

D. Detection of Bilateral Asymmetry and Architectural

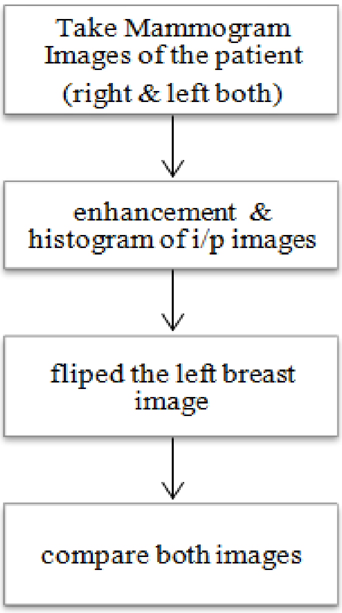
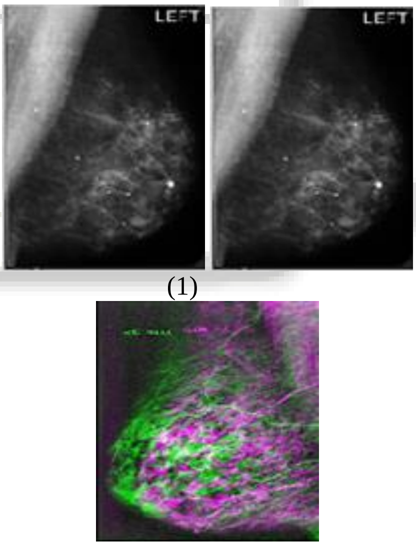


Fig. 8: Flow of Implementation for Detection of Bilateral Asymmetry

1) SIMULATION RESULTS



(1)

(b)

Fig. 9: Results for Bilateral Asymmetry
(1) : Original Left And Right Breast Mamogram
(3) Output image

V. Conclusion

In this review paper different techniques are being used to detect the breast tumor from scanned images of breast are studied. Feature extraction techniques are shown. The methods are simple & provides good and efficient results.

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