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REVIEW ON VARIOUS FILTERING TECHNIQUES IN MAMMOGRAM IMAGES

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Abstract: The goal of this study is to determine which pre-processing methods in mammographic images are still viable. Pre-processing improves image quality and prepares it for further processing by removing unwanted noise and undesirable materials from the mammogram's backdrop. Pre-processing a mammography picture can be done in a variety of ways. Their advantages and disadvantages, as well as comparisons, are examined.

Keywords: Breast Cancer, Decomposition, Mammogram, Pre-processing, Segmentation

1. Introduction

Tissues are made up of cells, which are the building components. Tissues aid in the formation of bodily parts as well as the breast. In most cases, cancer begins in the cell. When our bodies require new cells, normal cells expand and divide, resulting in the formation of new cells. Our cells die as they age or get damaged, and new cells grow to replace the old damaged cells. When our bodies do not require new cells, as well as when the old cells do not die or become damaged, new cells are generated. An accumulation of extra cells generates a bump, which is referred to as a tumour. Breast cancer is most typically seen in the breast's ducts and lobules. While lobules produce milk, ducts transport it to the nipple. It occurs both in men and in women. Most women are likely to get breast cancer.

Micro-calcifications, masses, and macro-calcifications are examples of abnormalities. Micro-calcifications are microscopic calcium deposits that appear on a mammogram as white specks. They are usually not caused by malignant cells, but when they occur in specific patterns and cluster together, they could indicate early breast cancer. [3] Macro-calcifications, which look as large white dots on a mammogram and are prevalent in around half of all women over 50, may be non-cancerous. The breast lump is a lump that develops in the breast that can be of various sizes and causes pain. Localized swelling or protuberance is caused by the lump. [1] Almost always, the bumps aren't malignant. Breast lumps can result from benign breast illnesses (benign masses) that do not spread to other parts of the body. They must be removed even if they do not spread since the local tissue may be injured. Malignant mass spreads to other body parts and also destroys the local tissue underlying.[1]

One of the most frequent malignancies in women is breast cancer.Breast cancer is responsible for around a quarter of all cancers found in women, as well as 20% of all cancers that are fatal.The most common cause of mortality in women is breast cancer.Because no cure for breast cancer has been discovered, and early detection can save lives to some extent. The mammogram is a low-dose X-ray scan of the breast that allows doctors to view into the breasts. [2] Mammograms provide the greatest findings to doctors for early detection by detecting micro calcifications or masses. Mammography is the most reliable way of early detection, and the results are extremely accurate. Each breast is screened with a mammography during breast cancer screening. From top to bottom, as well as side to side, each breast is X-rayed.The breast tissue appears white and opaque on the mammography, whereas the fatty tissues seem fatty and translucent. On mammography, both the exposed breast region and the non-breast region are visible (background region).The unexposed non-breast region must be removed for detection, as well as the breast region must be identified for pre-processing.

2. Pre-Processing

Image preprocessing is required to reduce noise and improve image quality, as well as to determine the mammogram's orientation. Before deciding which image processing algorithm to utilise, image preprocessing is required to eliminate the mammogram's backgrounds and noise. Without sacrificing any image information, preprocessing is performed to decrease noise, edge-shadowing, and accurately detect and suppress the pectoral muscle. [11] Mammography enhancement, mammogram orientation, and mammogram segmentation all benefit from preprocessing. Film screen mammography, digital mammography, screening mammography, 3D mammography, conventional mammography, and so on are all examples of mammography. Digital mammography is not recommended since the radiation dose is very low when compared to classic mammographic procedures.

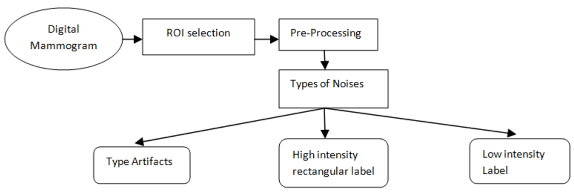

Fig.1 Flowchart of the process in mammography

It's difficult to understand digital mammograms. [11As a result, image quality must be improved and segmentation results must be as precise as feasible.Further processing removes unrelated and superfluous components from the mammogram's backdrop. Generally, filters are employed to remove undesired elements or objects from the image's space and surface. Different forms of sounds are commonly present when processing digital photos.

3. Types of Filters:

To reduce noise and enhance the image for restoration, the following pretreatment filtering procedures are utilised.

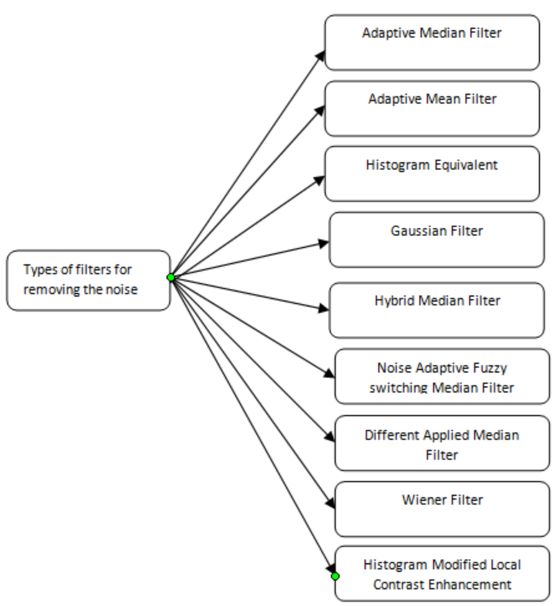

Fig.2 Filters for removing the noise

The primary purpose of filters is to improve image quality. Enhancing an image entails delivering the image's information to human sight. High intensity rectangle label, low intensity label, type artefacts, and other noise forms have been reported in mammograms. [12]

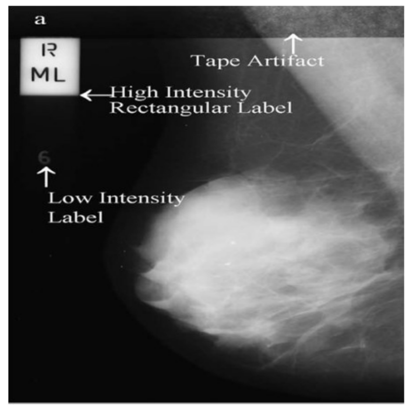

Fig.3 Types of noises in mammogram

3.1 Adaptive Median Filter

Adaptive median filters improve or restore data by decreasing noise without significantly obscuring the image's structure, and they operate well with both low and high noise densities.A non-linear filter used to remove pepper and salty noise is the median filter. [12] The median filter tends to eliminate noise while maintaining the clarity of the image's edges. The filter compares the median to a threshold and decides whether to replace, keep, or recalculate the pixel based on the result. This filter applies to the Sxy rectangle region. Depending on the circumstances, the size of Sxy changes during the filtering process.

The output pixel is the median value of 3*3 neighbours surrounding the relevant pixel in the input image. Zeros will be used to replace the image's edges. [6]. The output of this filter will be a single value that will replace the current pixel value at (x,y), where the S is now centred, with this value. The noise-removal efficacy of the median filter is improved by increasing the window size.

The following notation is used:

Zmin = minimum pixel value in Sxy
Zmax = maximum pixel value in Sxy
Zmed = median pixel value in Sxy

Zxy= pixel value at coordinates (x, y)
Smax = maximum allowed size of Sxy

The adaptive median filter is divided into two levels: Level A and Level B.Level A: A1= Zmed - Zmin A2= Zmed - Zmax If A1 > 0 AND A2 < 0,
Go to level B Else increase the window size
If window size <=Smax repeat level A
The adaptive filter is a self-adjusting digital filter that smoothes non-repulsive noise from two-dimensional data while maintaining visual components.

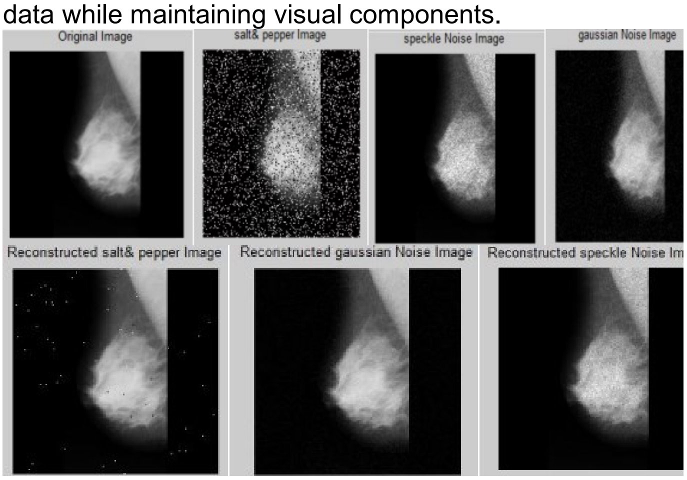

Fig.4 Input and the reconstructed noisy image using Adaptive Median Filter

3.2 Adaptive Mean Filter

The median value in the pixel's surrounding neighbourhood is determined for each pixel in the image.The mean filter denoises Gaussian, speckle, and poisson noise the best, although it has a high blurriness value [7]. This filter minimises the image's opacity impact. The mean and all-pass filtering are balanced in this filter. These types of filters adjust to the image's qualities and remove speckles from various regions of the image. For effective diagnosis and protection from edge and picture qualities, these filters leverage statistical elements of the image, such as mean, variance, and spatial correlation.Speckle noise is eliminated and replaced with a local mean value. Apart from preserving the margins, adaptive mean filters decrease speckles. This filter affects all image pixels regardless of noise content.

The median filter is simple to implement and performs well with low noise densities. It also removes noise when the power spectrum changes over time. The 2D median filter employs a 1D median filter for each row and column of a pixel region, making it more area friendly. When compared to 1D, the filter saves a lot of space but is less precise [12].

Mean Filter = sum up elements and divide the sum by the number of elements.

3.3 Histogram equivalent

Histogram equivalent approach distributes the grey areas in order to generate a homogenous histogram. In this scenario, the integral of the image histogram is used to replace each pixel. Histogram equivalent is an image processing approach that uses an image histogram to set the picture contrast. The intensity of the histogram distribution can be improved with this tweak. As a result, areas with less contrast will be impacted by those with more contrast [9]. This is typically accomplished by the effective growth of the most intense values in the histogram equivalent. In photographs with a light or dark background and foreground, this method is applied. In mammography pictures, the histogram equivalent is utilised to fine-tune the disparity. As a result, image problems are more easily identified.

3.4 Gaussian Filter

One of the peak detection-based filtering approaches is Gaussian filtering. The assumption behind peak detection is that peaks are impulses.The spectral coefficient of interest, as well as any amplitude spectrum coefficients inside the filter frame is corrected by this filter. [8]. This is a linear low pass filter that lowers edge blurring by increasing the importance of pixels near the edge.The degree of smoothing can be adjusted, and the filter is also computationally efficient.

3.5 Hybrid Median Filter (HMF)

The hybrid median filter is a sort of spatially nonlinear windowed filter.It easily eliminates impulsive noise while maintaining the edges [12]. Because it keeps the qualities, this filter is a superior choice. HMF works by repeatedly applying the median technique to any pixel element in the image with a varied window shape and then taking the median of those results. The HMF employs two medians: 1) the horizontal and vertical neighbour pixels' median 2) The diagonal neighbour pixels' median. In the NxN box, The median values of horizontal and vertical R pixels are represented by MR, and the median of diagonal D pixels is represented by MD.

In the NxN box, three median values are considered: MR represents the median of horizontal and vertical R pixels, and MD represents the median of diagonal D pixels.The median of the two median values, as well as the central pixel C, make up the filtered value.:median ([MR, MD, C]). B = HMF(A) uses N = 5 (default value).

3.6 Noise Adaptive Fuzzy Switching Median (NAFSM) Filter

The NAFSM filter is a recursive double-stage filter that primarily works with noise intensities of salt and pepper. [14]. When a noise-free pixel is found, it will be kept and not processed. This filter use fuzzy reasoning approaches to deal with uncertainty introduced by noise in the derived local information.

3.7 Different Applied Median Filter (DAMF)

The DAM filter makes advantage of the values of neighbouring pixels as well as an adjustable window. It can get the value of nearby pixels as soon as possible.

3.8 Wiener Filter

The MSE-optimal stationary linear filter for images that have been broken down by additive noise and are obscure is the Wiener filter.The signal and noise processes must be second-order stationary in order to compute the Wiener filter (in the random process sense).By creating an estimated noise-free image, the Wiener filter decreases the mean squared error.The Wiener filters are intended to reduce image noise while maintaining image sharpness [5]. Wiener filtering is a prominent technique for identifying the noisy signal that will result in a straight estimate of the initial image.Its primary priority is for a solution to be discovered in a short amount of time. It's an example of a non-uniform lowpass filter.

A Gaussian filter's main purpose is to decrease distortion at low and high frequencies.When compared to other filters, Gaussian filters have one of the most significant drawbacks: they take a long time to process. When applied to a stage work input, Gaussian filters have no overshoot and limit the climb and fall times. The error between the input signal and the output signal is calculated using the degradation model f(m, n) and the estimated signal f(m, n) is given by E (M, N) = F (M, N) - F (M, N)

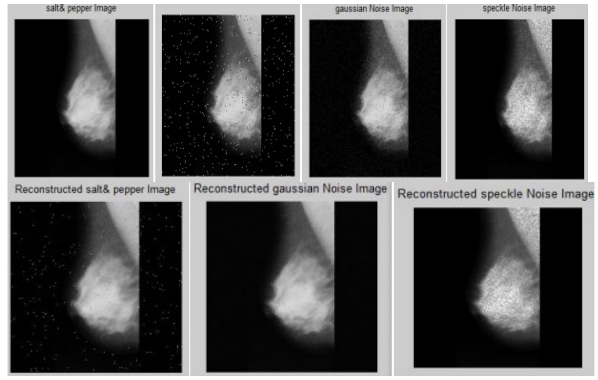

Fig.5 Input and the reconstructed image using Wiener Filter

3.9 Histogram Modified Local contrast Enhancement

The HM-LCE method uses a two-stage processing method that includes histogram alteration as well as a local contrast enhancement methodology. [11]. This contrast enhancement method's capability has been significantly increased to the desired level when compared to other mammography image enhancement methods, and in terms of both subjective and objective quality, this histogram adjusted LCE algorithm improves picture contrast enhancement.

4. Comparisonsof Existing Preprocessing Techniques

S.No	Author's Name	Methods	Advantage
1	NaishilN. Shah, et al in 2014	Edge detector, Morphological Filtering and Region growing	Analyses of morphological filtering grayscale dilation, hole filling, grayscale erosion, and a clear border are all examples of grayscale dilation.
2	K.Vennila, et al in 2014	Dilation followed by erosion, opening, closing and ends with Top hat and Bottom hat transforms	Grayscale dilation can be seen in morphological filtering analyses, hole filling, grayscale degradation, and a distinct boundary, to

			name a few.
3	Farag H, et.al in 2014	Curve fitting algorithm	Detects the upper limiting point of the pectoral muscle against the nipple position.
4	PrakashBethapudi, et al in 2013	Morphological Techniques and Thresholding	Efficacious in locating malignant breast cancer.
5	Farhan AKRAM et.al	CAD system of Mammograms using Active Contour Method	The pectoral muscle region and the remaining breast region are imaged with a decent intensity difference.
6	Rajasekar K.R in 2012	Min max equalization methods, image cropping operations	Removes artifacts, noise, and background noise.
7	Poongothai R, et al in 2012	Raster scanning and Thresholding methods	The image's rectangular shape aids in retrieving the whole pectoral muscles.
8	IndraKhantaMaitra, Sanjay Nag, Samir Kumar Bandyopadhyay in 2012	CLAHE and SRG	Denoising and contrast augmentation do not have to be done separately.
9	SantleCamilusK,et al in 2011	Watershed transformation and merging algorithm	Using one of the pectoral muscle's properties, selects a pectoral muscle region as the initial seed.
10	Aziz Makandae, Bhagirathi Halali in 2016	CAD system	Background artifacts are removed, and the pectoral muscle is reduced.

5. Conclusion

Others interested in this field will find the literature survey to be a useful resource. Pre-processing is the most critical and crucial phase in mammogram analysis since mammography images are of poor quality.It is the most important factor in redressing mammography pictures for further processing and analysis. Image quality can be improved, noise can be removed, the edges of a photograph can be preserved, and the image can be improved and smoothed, and so on.In terms of maintaining crisp edges and being less vulnerable to outliers, the median filter has been found to be superior to mean filters.When compared to the median, adaptive filter, the mean filter can better remove Gaussian noise, and according to the filter analysis, the wiener filter can reduce this noise to a degree.

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