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A COMPUTERIZED APPROACH ON BREAST CANCER DETECTION AND CLASSIFICATION

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ABSTRACT

Breast Cancer has become the world largest disease among women. Cancer can be prevented or cured only when it has been detected at the earliest that can save many lives. Digital mammograms are the one and only digital image which can be used with image processing techniques to detect breast cancer at the earliest. The various image processing techniques have been applied to images and the best features are extracted from the image which is further classified into benign and malignant. The classifier is used to find out the different stages in the cancerous patients. The CAD system developed with various image processing technique will assist the radiologist for further investigation of the affected person. The CAD system will easily identify breast malignancy and group all the malignancy which will help the radiologist to proceed with biopsy and chemotherapy so that malignancy is not in the final stage of the affected person. The CAD system has four different stages like preprocessing, segmentation, feature extraction and classification. The classifier used will be a binary classifier stating the class to be benign or malignant. In this paper, all the basic image processing stages have been applied on the digital mammogram and it's further classified to be cancerous or non-cancerous.
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Mass, feature extraction, segmentation, malignant, benign.

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INTRODUCTION

Breast cancer is the common cancer which affects many women. Breast cancer is developed from the breast tissues. The breast cancer can be seen from the lumps in the breast. Breast cancer is divided into four different stages like micro classification, masses, architectural distortion and bilateral asymmetry. Some of the imaging modalities like magnetic resonance image (MRI), Ultrasound and digital mammograms can be used to capture the breast of the suspected person .Breast cancer need not affect only women it can also present in some man also so the screening need to be done for both but the higher percentage of cancer get affected is women so the world is mostly addressing the women health care. When comparing with all the image modalities digital mammogram is inspected to improve the specificity and sensitivity of the breast cancer diagnosis.The cancer which is from the milk ducts lining is called ductal carcinomas and the one which is from the lobules are called lobular carcinomas. The breast cancer which undergoes the diagnosis process will be verified by taking biopsy of the concerning lumps. The classification which is done will be tested and verified.

A main objective of the pre-processing is a development of image data that suppresses unwanted distortions or enhances some important image features for further processing. The image pre-processing methods are categorized according to the size of the pixel neighborhood. The pre-processing images removes low-frequency background noise, normalizing the intensity of the individual particles images, reflection and masking portions of the images. A feature extraction accurately simplifies the volume of resources needed to define a large set of data. It is used in the image processing area that detects and isolates different desired portion or shapes of a digitized image. The features such as shape, texture, color, etc. are used to define the image content. These features can be further divided into pixel-level features, local features and global features. The image features are classified into primitives. The color feature is a majority used visual feature. The main advantages of the color features are robustness, effectiveness, implementation simplicity, computational simplicity and low storage requirements. In content-based image retrieval, the images are automatically indexed by generating a feature vector for describing the image content. The similarity

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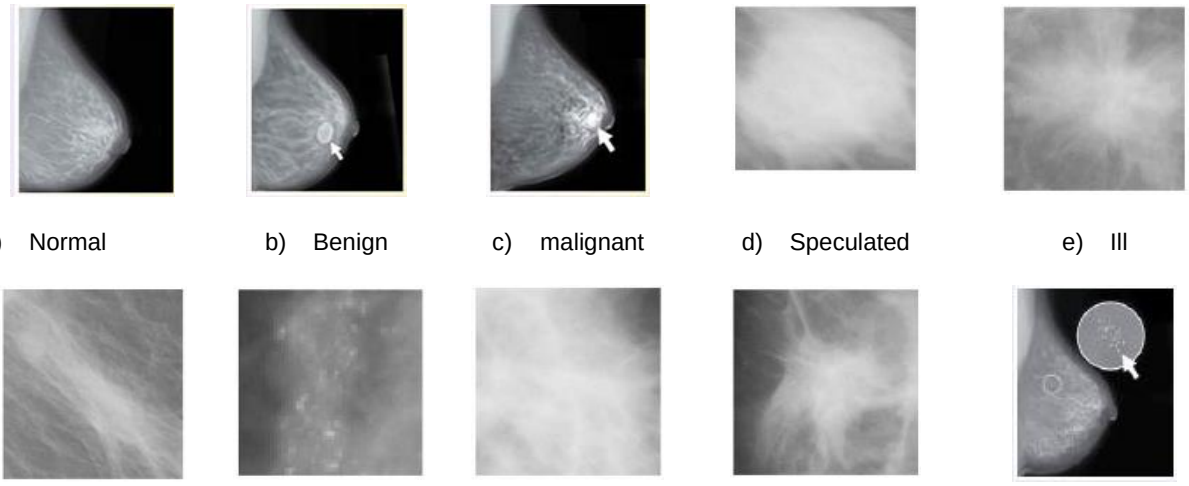
of the feature vectors of the query and database images is evaluated to retrieve the image. The image content feature extraction technology proves the professional applications in industrial automation, biomedicine, social security, biometric authentication and crime prevention.



a) Normal b) Benign c) malignant d) Speculated e) Ill

f) Micro classification g) Arbitrarily shaped region h) Architectural distortion i) Mass k) Calcium

Fig: 1. Types of breast Image

This paper is organized as follows. Section 2 describes recent work in cancer detection Section 3 describe the General Methodology of CAD which explains, pre-processing, Feature Extraction, Image Classification, Image Segmentation and Feature Selection techniques. Section 4 describe the proposed methodology which uses median filter and histogram equalization for preprocessing, GLCM and PSO for Feature extraction and Selection, Selected features are classified as normal or abnormal using SVM followed by result discussion. Conclusion and feature work in Section 5

LITERATURE SURVEY

The median filter is a non-linear filtering technique used for smoothing. It preserve the edges of the image so as to remove speckle noise and salt and pepper noise in the image [1]. This filtering technique is needed to remove the effect of poor contrast due to Glare, noise and effects. This poor contrast is caused by poor lighting conditions during capturing of the image. The pixel value is replaced with a median pixel value for generating a low frequency image [2]. The histogram equalization technique is simple and effective types of well-known image enhancement technique for image contrast enhancement. A conventional histogram equalization is mainly applied to each sub-histogram [3]. In the output image histogram is authorized to enclose within the allocated gray levels range. In the image processing, the histogram of an image obviously mention the pixel intensity values of the histogram. This histogram equalization is mainly used in the prospect of the image enhancement. Compared with the existing techniques this technique has very less amount of calculations with lesser complexity. This technique is not only efficient in image enhancement and also produces rapid computations [4]. The GLCM is a famous statistical method of extracting the second order statistical textural features from the image [5]. This GLCM is adapted with a Gabor filter that has been used in many applications such as image identification and image representation [6] In this technique, a wavelet provides multi-scale representation of the image. These wavelets evaluate the contrast levels of the image according to the various resolution levels. This GLCM have important features such as Co-occurrence and Covariance. Particle Swarm Optimization (PSO) is swarm-intelligence-based, approximate, non-deterministic optimization techniques. This PSO algorithm maintains multiple potential solutions at one time. A population based

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evolutionary algorithm is inspired in the social behavior [7].SVM classifier is mainly used for classification and regression analysis. This classification has been performed well as a computer-aided diagnostic classification mechanism for breast cancer screening in the mammography [8] The SVM is act as a mechanism for designing a SVM classifier to separate the image into normal and abnormal images. After the separation, the abnormal image is taken for further process i.e. segmentation. An ability of the Minkowski functionals is used to detect the changes in the image heterogeneity post-treatment are tested by using this classifier [9].

GENERIC METHODOLOGY OF MAMMOGRAM (CAD) SCHEME

This overview concentrates on outlining the methodologies for breast cancer detection. By and large, the Digital Mammogram CAD frameworks for breast cancer identification include four stages as indicated in **Figure 2**

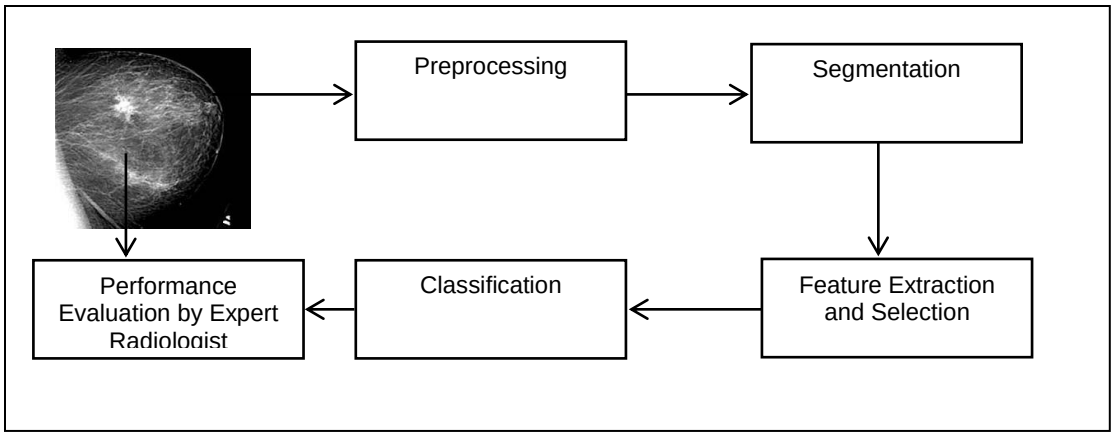

Fig: 2. Typical Methodology of Computer Aided Diagnosis System for Breast Cancer Detection

- *Image Pre-processing* –The purpose of pre-processing is to enhance the visual appearance of the images. Image pre-processing will increase the reliability of an image. Filters are used to remove the background noise which supress the quality of the image. The image which is pre-processed will be cleared from distortion and can be used as an input for the next image processing stage.
- *Image Segmentation* – Segmentation are needed to improve the analysis of an image when there is no correspondence between the pixels of an image type of tissues. This generally separates the image into various segments based on the region of interest (ROI).
- Feature Extraction and Selection – From the segmented image the features are extracted from each image which is trained. Among the features extracted the best few features have been selected and given to the classifiers.
- *Classification* – The extracted features along with his class will be given as the input to the binary classifier which finally says benign or malignant for our tested image.

All the above techniques will also be applied to the test image and the result of the image will be addressed by the classifier by stating cancerous or non-cancerous.

Pre - Processing

The main task of preprocessing an image is to suppress the unwanted distortion from the original image. It is also used to enhance some image features for better clarity in detecting the abnormalities. This section represents some preprocessing techniques applied for mammogram. One of the best techniques for preprocessing is median filter and histogram equalization for image contrast enhancement.

Median Filter

The median filter is one type of smoothing technique and it is also known as nonlinear digital filtering technique. The main idea behind using median filter is to preserve the edges of the images so as o remove speckle noise and

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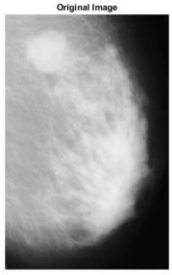
salt and pepper noise in the image [10]. When median filtering technique is used, the edges of the images are preserved and it is not blurred since it is not a linear filter.

$$f\wedge(x,y) = median\{g(s,t)$$

$$where$$

$$(s,t) - belongs\ to\ S_{xy} \qquad [1]$$



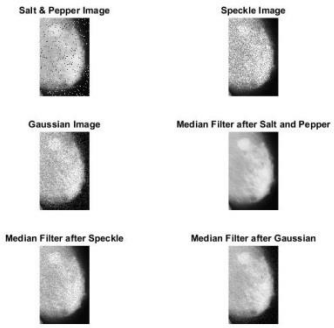


Fig: 3a. Original Image

Fig: 3b. Median Filter

In the median filtering operation, the pixel values in the neighborhood window are ranked according to intensity and the middle value (median) becomes the output value for the pixel.

The advantages of median filtering techniques are

- Easy to understand
- The brightness difference in minimal blurring of regional boundaries is preserved.
- The positions of the boundaries are preserved.

Histogram Equalization Technique

It is a techniquefor adjusting the intensity of an image.It is a simple and effective image enhancement technique for image contrast enhancement. It represents the pixel intensity values of the histogram. Compared with other existing techniques, this technique has very less complexity. It is an efficient image enhancement algorithm and also produces rapid computations. This technique improves the contrast characteristics by mapping the pixels from the histogram. It is used to enhance the de-noised image [11].

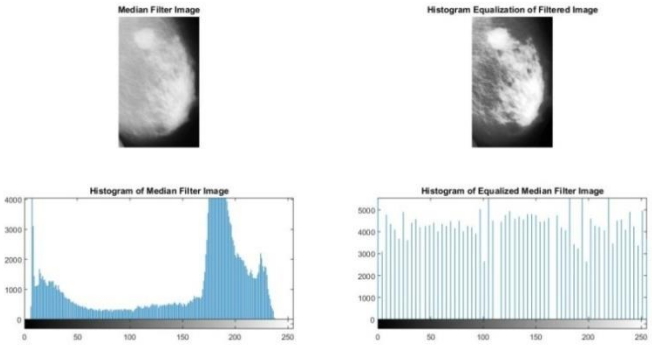


Fig :4.Histogram Equalized Image

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Segmentation

Image Segmentation is a basic and fundamental segment and is a standout amongst the most troublesome patterns in image transforming and example acknowledgment, and decides the nature of the last examination. Division is a part of the picture I into non covering districts.

$$UI_i = I \text{ and } I_i \cap I_j = \emptyset \; i \neq j \quad [2]$$

Computer-aided diagnosis framework will help radiologists in perusing and deciphering sonography. The objective for the division is to find the suspicious regions to support radiologists in conclusions.

Histogram Thresholding

Histogram thresholding is one of the generally utilized methods for monochrome picture division. Histogram thresholding was proposed for fragmenting breast ultrasound pictures. The calculations proposed for dividing masses in US pictures included the accompanying steps: (1) pre-processing utilizing editing and middle separating, (2) duplicating the pre-processed picture with a Gaussian oblige capacity, (3) deciding the potential sore edges through dim quality thresholding [12], and (4) augmenting an utility capacity for potential injury edges. Then again, the middle, width and tallness of the sores expected to be chosen physically or semi-physically.Another thresholding calculation had four stages: First, the regions of interest (ROIs) were pre-processed with a 4×4 middle channel to decrease the dot clamor and to improve the highlights. Second, a 3×3 unshar channel was built utilizing the negative of a two-dimensional Laplacian channel to underline the components with significant sign level and to upgrade the difference in the middle of article and foundation. Third, the ROIs were changed over to a twofold picture by thresholding. The limit was dictated by the histogram of ROIs. On the off chance that a valley of histogram somewhere around 33% and 66% of the pixel populace could be discovered, this force quality was chosen as the edge. In the event that there was no such valley in that range, the force of 50% pixel populace was chosen as the limit esteem. At long last, the chose knob's limit pixels were gotten utilizing morphologic operation.

Feature Extraction and Selection

Highlight extraction and determination are imperative ventures in breast disease identification and order. An ideal list of capabilities ought to have successful and separating highlights, while basically decrease the excess of highlight space to evade "condemnation of dimensionality" issue. The "condemnation of dimensionality" recommends that the testing thickness of the preparation information is so low it couldn't be possible guarantee a significant estimation of a high dimensional characterization capacity with the accessible limited number of preparing information. For some best in class arrangement routines, for example, counterfeit neural system and bolster vector machine, the measurement of highlight vectors not just exceedingly influences the execution of the characterization, additionally decides the preparation time of the calculation. Along these lines, how to concentrate helpful highlights and make a decent determination of the highlights is a pivotal assignment for CAD frameworks.
The highlights of breast US pictures can be separated into four classes: composition, morphologic, model-based and descriptor highlights. We condense and list the common and adequacy demonstrated highlights in Table 4. Unquestionably, one can't utilize every one of them in the meantime. Extraction and determination of compelling highlights is a fundamental step. The general rules for selecting huge highlights principally incorporate four contemplations: segregation, dependability, freedom and optimality. On the other hand, basically consolidating the best performed highlights won't most likely make the frameworks function admirably and successfully. The objective of highlight extraction and choice is to expand the separating execution of the highlight bunch.

Texture Features

A large portion of the surface highlights are computed from the whole picture or ROIs utilizing the dim level qualities. FT1 (auto-covariance coefficient) is an essential and conventional surface highlight which can mirror the internal pixel relationship inside a picture. FT2 (Block difference of inverse probabilities) – FT3 (Block variation of local correlation coefficients) measure the variety of intensities and surface smoothness, individually. The higher estimation of BDIP is, the bigger the change of intensities in a square is, and the bigger Block variation of local correlation coefficients quality shows that the fixings in the piece are harsh. Both the first and second request of FT2 and FT3 can be utilized as the highlights as well. FT4 is characterized as the proportion of the difference, auto-relationship coefficients or power normal inside the sore to that outside the injury. The bigger the proportion is, the bring down the likelihood of the cancer being dangerous is. FT5 is characterized as the summation of contrasts

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among the genuine appropriation of wavelet coefficients in every high-recurrence sub-band and dispersion of the normal Laplacian conveyance. This highlight can mirror the edge smoothness. FT6 is a request measurements based highlight vector removed from wavelet disintegration sub-groups. After 3rd level wavelet decay, the length (length=20) of request insights channel is picked taking into account Monte Carlo reenactment and Akaike's last expectation measure. Twenty mean qualities and 20 difference estimations of request insights parameters for the 12 wavelet coefficient groups were ascertained and framed 480-D highlight vectors. The measurement of the highlight vector was diminished from 480-D to 7-D by utilizing highlight examination. The stepwise highlight choice system or PCA could be a superior decision for lessening the highlight dimensionality. FT7 and FT8 are characterized as:

$$CON = \sum_{ij}(i-j)^2 p(i,j) \quad and \quad COR = \sum \frac{ijp(i,j) - m_x m_y}{\sqrt{s_x^2 s_y^2}} \qquad [3]$$

where *p(i,j)* is the probability that two pixels with gray value *i* and gray value *j* are in a fixed distance apart, and

$$m_x = \sum_i i \sum_j p(i,j), m_y = \sum_j j \sum_i p(i,j) \qquad [4]$$

$$S_x^2 = \sum_i i \sum_j p(i,j) - m_x^2, S_y^2 = \sum_j j \sum_i p(i,j) - m_y^2 \qquad [5]$$

In view of comprehension of the back acoustic conduct or back shadow, distinctive numeric interpretations are proposed to compute FT12. Three ROIs were characterized whose width and profundity were the same as the ROI contains the injury itself. As Figure demonstrates, the post ROI speaks to the back locale of the injury and the privilege ROI and left ROI are nearby tissues at the same profundity of the post ROI. The thin clear limits are utilized to dodge the edge shadows. The skewness picture is sifted with an edge to get the location focuses, i.e., the shadow. The back shadow was characterized as the distinction between the dark scale histograms of the districts inside the sore and back to the injury. For the same normal for breast injuries, we can utilize distinctive approaches to characterize the numeric interpretations. To discover more exact and productive outflows ought to be one without bounds meets expectations. FT13 is the Boltzmann/ Gibbs entropy over the dark scale histogram with respect to the greatest entropy. The higher the entropy is, the more homogeneous the sore is. FT15 – FT16 are surely understood surface highlights which have as of now been all around characterized. On the other hand, they are not often utilized as a part of late US picture portrayal. This may be because of their high processing expense. The meaning of the fractal measurement (FT17) is like the Hausdorff measurement.

Classification

After the highlights have been extricated and chosen, they are info into a classifier to order the pictures into injury/ non-sore or amiable/ harmful classes [13]. Lion's share of the distributions concentrates on ordering threatening and considerate sores (normally called injury arrangement), and a portion of the articles concentrate on arranging injuries and non-injuries (typically called sore identification), and just a couple of them concentrate on both. Sore discovery is essential before injury grouping.

Linear Classifiers

Often utilized direct classifiers for breast malignancy location and grouping are straight discriminant examination and logistic relapse (LOGREG). The primary thought of LDA is to locate the direct blend of the highlights which best separate two or more classes of the information [14]. In the event that there are n classes, and LDA groups the information by the accompanying straight capacities:

$$f_i = \mu_i C^{-1} X_K^T - \frac{1}{2}\mu_i C^{-1} \mu_i^T \; In(P_i), 1 \le i \le n \qquad [6]$$

where

$$c = \frac{1}{N}\sum_{i=1}^{n} n_i C_i, \; P_i = \frac{n_i}{N} \qquad [7]$$

n_i is the quantity of tests in the *ith* class, *N* is the quantity of aggregate examples, *i* is the mean of class *i*, and C_i is the covariance lattice of class *i*. The above parameters can be acquired from the preparation information. At the point when another information x_k is in, it is doled out to class *i* with the most astounding f_i. Logistic relapse is a

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model for foreseeing the likelihood of an occasion happening as an element of different variables. The likelihood of $X=x_1, x_2,...,x_n$ is detailed as:

$$\text{logit}(P) = \log\frac{P}{1-P} = b0 + \sum_{i=1}^{n} b_i x_i \qquad [8]$$

Where $b_0,...,b_n$ are model parameters which could be assessed from the preparation information. At the point when LOGREG is utilized to group two-class issue, for every highlight vector x_i, threshold=0.5 is utilized to choose which class X has a place with. LDA was connected to the information set of 400 cases with four naturally extricated highlights. The normal A_z under ROC bend was 0.87 more than eleven autonomous trials. LOGREG was utilized to focus the likelihood of danger in a database of 58 cases. Three edge based highlights were assessed and the territory under the ROC bend with the best highlight blend of age, edge echogenicity and rakish variety was 0.87±0.05.Here, we can see that the exhibitions of LDA and LOGREG are not high on the grounds that the classifiers are straight, and for nonlinear divisible information, the systems have natural breaking points.

Evaluation

We consider a few oftentimes utilized assessment criteria. A Receiver Operating Characteristic (ROC) curve is most commonly used because of its far reaching and reasonable assessment capacity. AROC bend is a plotting of genuine positive part (TPF) as a component of false positive portion (FPF). The range (A_z) under the ROC bend can be utilized as a paradigm. This demonstrates a case of ROC bend assessment of the execution of CAD frameworks utilizing three diverse information sets [15, 16].

$$overall\ accyracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Specificity = \frac{TN}{TN + FP}$$

$$Sensitivity = \frac{TP}{TP + FN}$$

$$Positive\ perdictive\ value\ (PPV) = \frac{TP}{TP + FP}$$

$$Negative\ predictive\ value\ (NPV) = \frac{TN}{TN + FN}$$

$$MCC = \frac{TP * TN - FP * FN}{\sqrt{(TP + FP)(TP + FN)(TN + FP)(TN + FN)}}$$

$$Where$$
$$TP\ is\ the\ quantity\ of\ genuine\ positives,$$
$$TN\ is\ the\ quantity\ of\ genuine\ negatives$$
$$FP\ is\ the\ quantity\ of\ false\ positives$$
$$FN\ is\ the\ quantity\ of\ false\ negatives.$$

The last recipe is Matthew's connection coefficient (MCC), which has from time to time been utilized for breast disease CAD execution assessment. In any case, MCC is a capable precision assessment foundation of machine learning routines. Particularly, when the quantity of negative examples and positive specimens are clearly unequal, MCC gives a superior assessment than general exactness. As more breast malignancy CAD frameworks utilized machine learning techniques, for example, SVM, ANN and BNN, MCC ought to be utilized as an extra assessment paradigm [17].

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THE PROPOSED METHODOLOGY

Proposed Methodology works on mammogram image which has train set of images processed for extracting features which used for classifying features extracted from test image shown in Figure-5.

Image acquisition and Data set

The methodology presented in this work was tested on the complete mini-MIAS database. It is freely available for scientific purposes. The images of the database originate from a film-screen mammographic imaging process in the United Kingdom National Breast Screening Program. The algorithms where implemented based 90 trained image consist of 40 normal and 50 abnormal.

Preprocessing

We have seen that smoothing (low pass) filters reduce noise. However, the underlying assumption is that the neighboring pixels represent additional samples of the same value as the reference pixel, i.e. they represent the same feature. At edges, this is clearly not true, and blurring of features results. You have used convolution techniques to implement weighting kernels as a neighborhood function, which represented a linear process. There are also nonlinear neighborhood operations that can be performed for the purpose of noise reduction that can do a better job of preserving edges than simple smoothing filters. In the median filtering operation, the pixel values in the neighborhood window are ranked according to intensity, and the middle value (the median) becomes the output value for the pixel under evaluation.Median filtering does not shift boundaries, as can happen with conventional smoothing filters. Since the median is less sensitive than the mean to extreme values (outliers), those extreme values are more effectively removed. Median filtering preserves the edges.

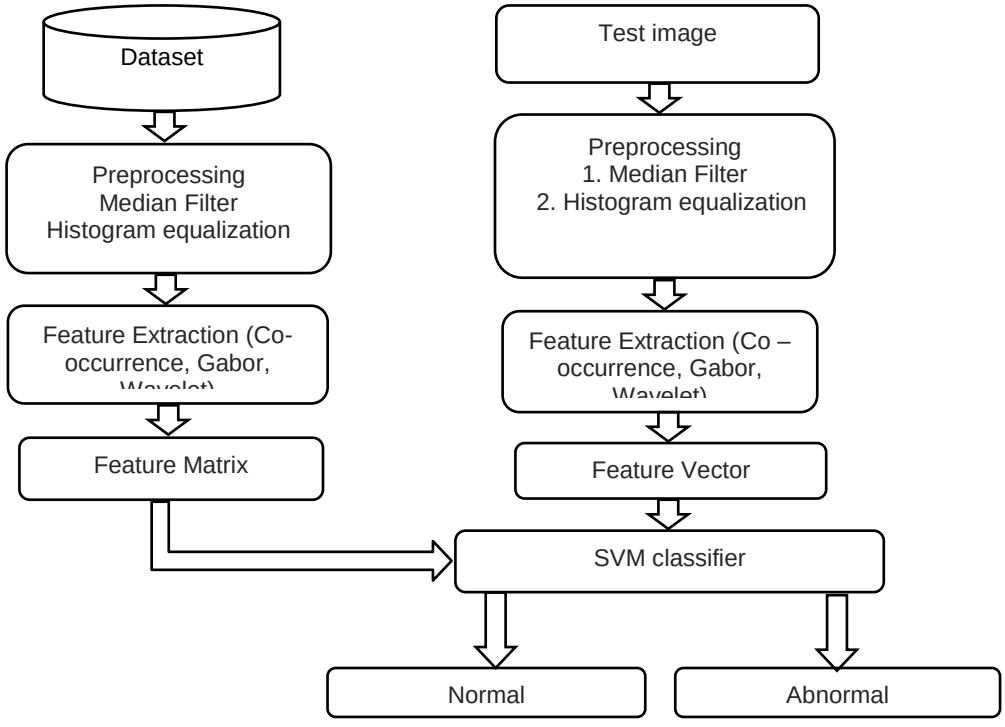

Fig: 5. proposed architecture

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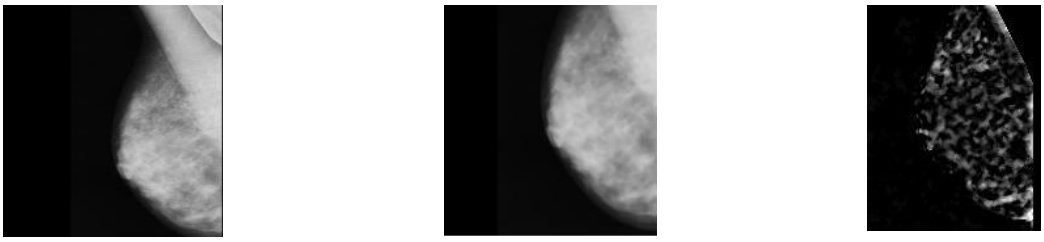

Original Image | Median Filtered Image | Muscle removal

Fig: 6. Preprocessed Image

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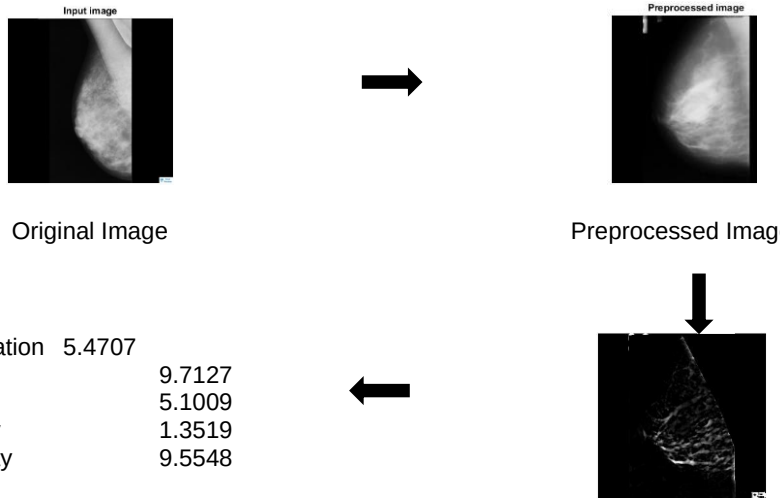
Feature Extraction and Feature Selection

Feature extraction is a process of capturing a visual content of images for originating and recovering. The primitive or low level image features are the extraction of color, texture and shape or domain specific features from the image. The feature selection is mainly used to select the needed features available in the image after the segmentation process is completed. A data in the feature selection contains multiple redundant or irrelevant features

Table: 1. Extracted features of Mammogram image

Image Name	Auto Correlation	Correlation	Energy	Entropy	Homogeneity
mdb123	5.4707	9.7127	5.1009	1.3519	9.5548
mdb153	3.7491	9.6309	6.9143	8.6214	9.6629
mdb304	2.8537	9.4924	6.9211	8.3604	9.6986
mdb319	1.0021	9.6628	1.9198	2.1124	9.3583
mdb322	3.9797	9.6073	5.5252	1.1732	9.601

Classification



Original Image | Preprocessed Image

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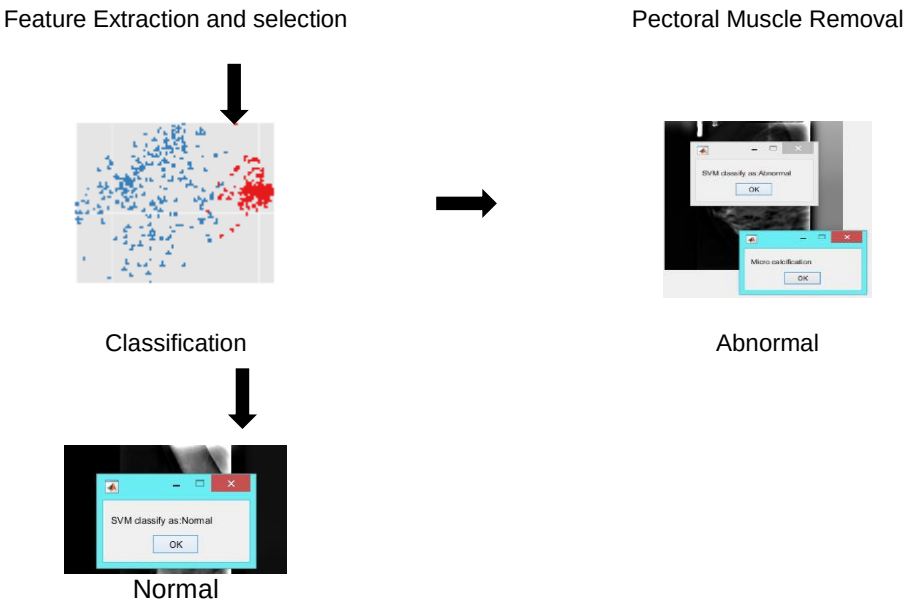

Fig: 7. Result Discussion of Proposed CAD Classification on mammogram image

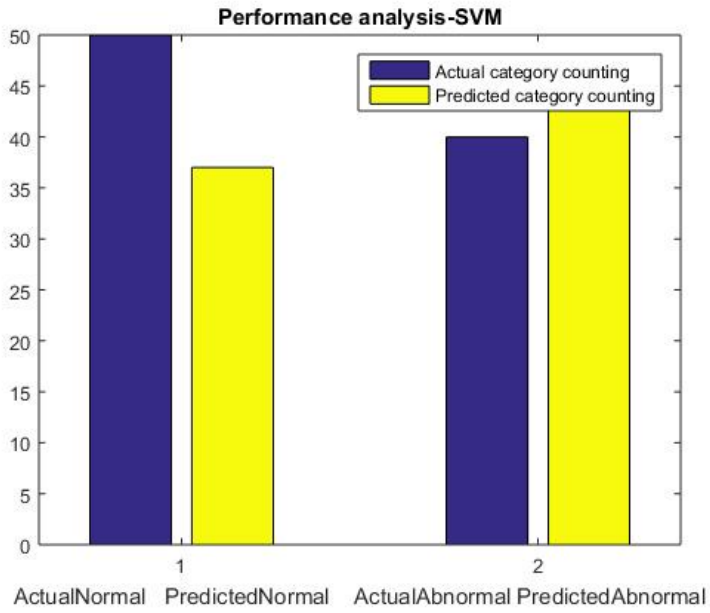

Fig: 8. Performance of SVM Classifier

Finally, extracted features are passed through SVM classifier. SVM is one of the best classifier. SVM is a binary classifier to classify whether the given mammogram image is normal or abnormal.

CONCLUSION

With the advancement in CADthrough mammogram attracts more attention for Brest cancer analysis. Mammogram is one of major research subjects in medical imaging and Cancer diagnosis system. With the survey we proposed a methodology for classifying of Mammogram image. The proposed technique first apply median filter and histogram equalization for noise removal and image enhancement, then employs Gabor filter co-occurrence matrix to extract features from Mammogram and by using the selected features SVM algorithm

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classify as normal and abnormal. Result discussion on proposed method shows the robustness of proposed techniques. According to the experimental result proposed method propose classification accuracy of 93% with 94% sensitivity rate and 92% specificity rate. Proposed method classify input image as normal and abnormal feature work is to apply segmentation algorithm on abnormal image for extracting ROI and selection Features from FOI and classify using Feed Forward Neural Network classification Algorithm.

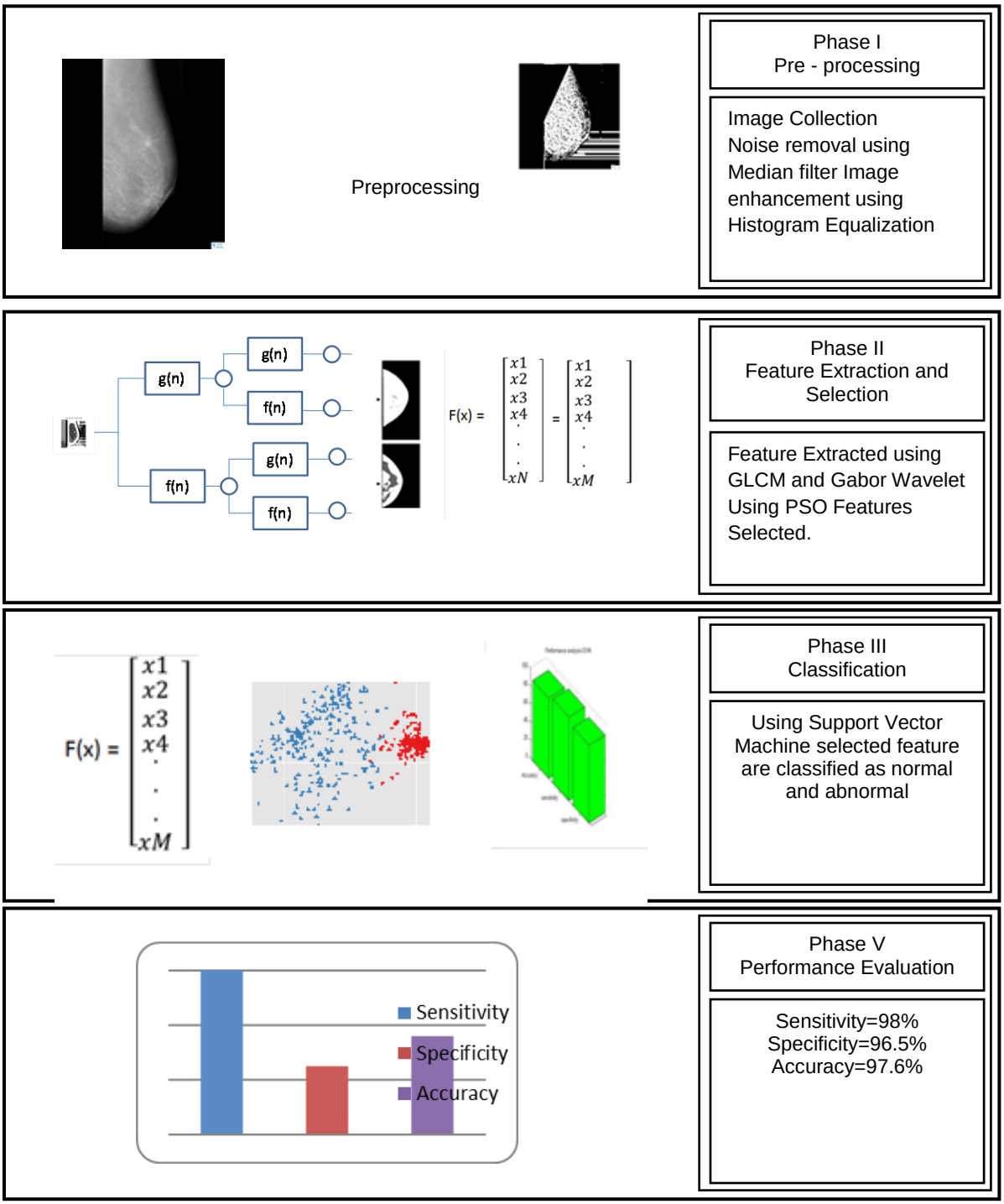

Fig: 9. Proposed Mrthodology of CAD

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CONFLICT OF INTERESTS
Authors declare no conflict of interest.

REFERENCES

[1] Sopharak A, Uyyanonvara,B, Barman S. [2009] Automatic exudate detection from non-dilated diabetic retinopathy retinal images using fuzzy c-means clustering. *Sensors*, *9*(3):2148-2161.

[2] Nivetha P, Manickavasagama MR. [2014] Lung Cancer Detection at Early Stage Using PET/CT Imaging Technique. *International Journal of Innovative Research in Computer and Communication Engineering*, *2*(3).

[3] Yu Z, Bajaj C. [2004] A fast and adaptive method for image contrast enhancement. In *Image Processing, 2004. ICIP'04. 2004 International Conference on* 2: 1001-1004 *IEEE*.

[4] Tuteja M, Kaur B, Gujral S. [2014] Quality Enhancement of Various Diagnosed Medical Images Using Different Signal Processing Methods. *International Journal of Emerging Trends in Science and Technology*, *1*(04).

[5] Mohanaiah P, Sathyanarayana P, GuruKumar L. [2013] Image texture feature extraction using GLCM approach. *International Journal of Scientific and Research Publications*, *3*(5): 1.

[6] Zheng Y. [2010] Breast cancer detection with Gabor features from digital mammograms. *algorithms*, *3*(1): 44-62.

[7] Alba E, García-Nieto J, Jourdan L, Talbi EG. [2007] Gene selection in cancer classification using PSO/SVM and GA/SVM hybrid algorithms. In *2007 IEEE Congress on Evolutionary Computation* , 284-290.

[8] Choi JY, Kim D H, Plataniotis KN, Ro YM. [2014] Computer-aided detection (CAD) of breast masses in mammography: combined detection and ensemble classification. *Physics in medicine and biology*, *59*(14): 3697.

[9] Larkin TJ, Canuto HC, Kettunen MI, Booth TC, Hu DE, Krishnan AS, Brindle KM. [2014]Analysis of image heterogeneity using 2D Minkowski functionals detects tumor responses to treatment. *Magnetic resonance in medicine*, *71*(1): 402-410.

[10] Ergin S, Kilinc O.[2014] A new feature extraction framework based on wavelets for breast cancer diagnosis. *Computers in biology and medicine*, *51:* 171-182.

[11] Srivastava S, Sharma N, Singh SK, Srivastava R. [2013] Design, analysis and classifier evaluation for a CAD tool for breast cancer detection from digital mammograms. *International Journal of Biomedical Engineering and Technology*, *13*(3): 270-300.

[12] Purushotham S, Tripathy B. [2014] A comparative study of RIFCM with other related algorithms from their suitability in analysis of satellite images using other supporting techniques. *Kybernetes*, *43*(1): 53-81.

[13] Mohamed H, Mabrouk MS, Sharawy A. [2014] Computer aided detection system for micro calcifications in digital mammograms. *Computer methods and programs in biomedicine*, 116(3):226-235.

[14] Acharya UR, Ng EY K, Tan JH, Sree SV. [2012] Thermography based breast cancer detection using texture features and support vector machine. *Journal of medical systems*, 36(3): 1503-1510.

[15] Dheeba J, Singh NA, Selvi ST. [2014] Computer-aided detection of breast cancer on mammograms: A swarm intelligence optimized wavelet neural network approach. *Journal of biomedical informatics*, 49: 45-52.

[16] Gøtzsche PC, Jørgensen KJ. [2013] Screening for breast cancer with mammography. *The Cochrane Library*.

[17] Dromain C, Boyer B, Ferre R, Canale S, Delaloge S, Balleyguier C.[2013] Computer-aided diagnosis (CAD) in the detection of breast cancer. *European journal of radiology*, 82(3), 417-423.

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