



# A review of characteristic study of micro calcification using son mammogram images

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## Abstract

In recent years, the mortality rate in women increases a lot due to occurrence of breast cancer. The challenging task in medical field is to find breast cancer at an early stage. Because the detection of breast cancer at its early stage makes the treatments easy and increases the survival rate of victim. In this review paper, a detailed explanation is given about the characteristics of micro calcification (ie its shape and distribu-tion) and detailed literature survey is done that shows the techniques used previously to detect the Micro calcification from different diag-nostic sources. Moreover, this review paper proposes a new algorithm, to detect micro calcification and to find its classification (benign or malignant) from sono mammogram images at an early stage. First filtering will be taken place in order to enhance the image. Second the image is to be binned and the affected area is to be separated (ROI) by edge detection. Then the size, shape, distribution and density of the ROI will be determined. From the characteristics of ROI, a mathematical model will be developed and signatures to be found to confirm the occurrence of micro calcification and to find its classifications.

**Keywords:** Binning; Feature Extraction; Order-Statistic Filter; Signatures Calculation

## 1. Introduction

Cancer causes when the cells divide in an abnormal and in a un-controlled way. And they eventually spread to other parts of the body. There are above 200 different types of cancers are reported. The cancers develop due to the cell changes, genes, cell division, unwanted cell development etc. Cancer begins when gene changes in one or more cells and starts growing and multiplying, this growth is called tumor1. Cancer cells are divided into two based on their spreading. One is in situ that will not spread to other parts as shown in Figure 1. Another is invasive which spreads to other parts as shown in Figure 2.

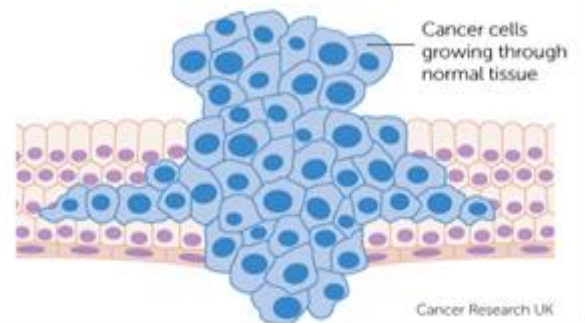


Fig. 2: Invasive Growth of Cancer Cell1.

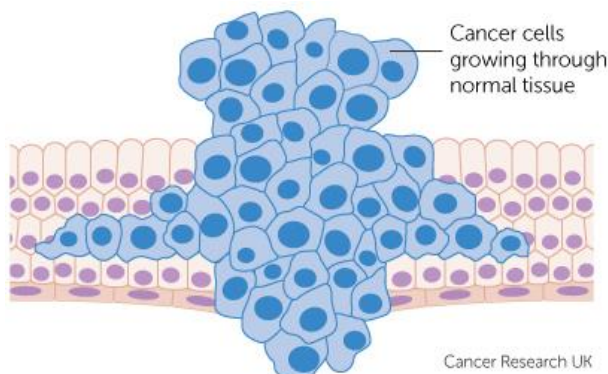


Fig. 1: In Situ Cancer with Normal Cell.

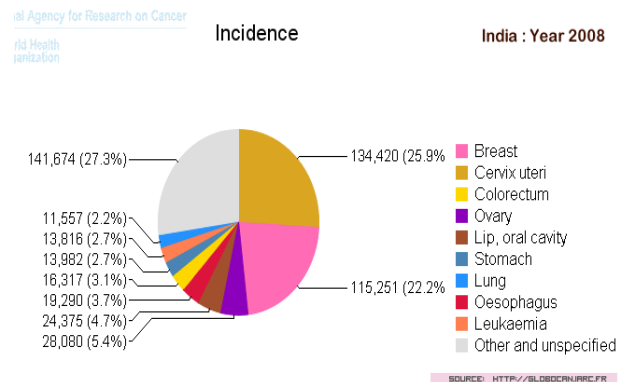


Fig. 3: Cervix Cancer Leading in 2008 Survey3.

Among them the breast cancer is most common type of cancer diagnosed in women. In economically developing countries, the breast cancer is the one which causes more mortality in women. Breast cancer will start in the cells of the breast. Then they invade the neighboring tissues or metastasize to other areas of the body. In 2008, about 1.38 million new cases of cancer have been diagnosed<sup>3</sup>. And out of which 23% are breast cancer as shown in Figure 3. For a decade before cervical cancer was a deadly disease but for the past few years this was changed and the breast cancer leads the cervical cancer in a fasted manner. This was shown in 2012 report as in Figure 43. In 2015, about 2, 31,840 cases of invasive breast cancer have been reported and 60,290 cases of insitu breast cancer are diagnosed. The risk factors for the cause of breast cancer are family history of breast cancer, early menstruation before age of 12, very late menopause after the age of 55, alcohol habit, use of combined menopausal hormone like estrogen and progestin, cigarette smoking, irradiation of breast region at the early age, postmenopausal obesity etc 1.

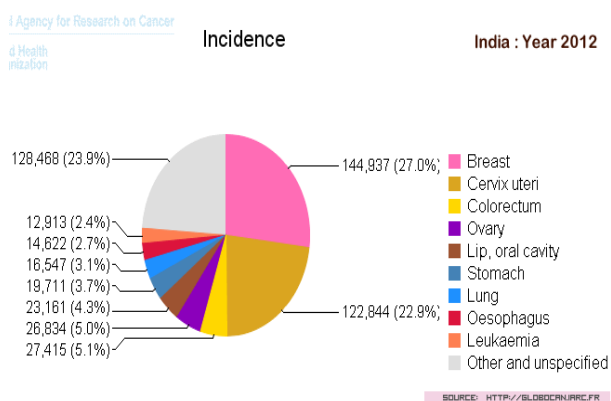


Fig. 4: Breast Cancer Leading in 2012 Survey<sup>3</sup>.

#### Types of Breast Cancer:

**Insitu:** [means “in place”]: Ductal carcinoma insitu [DCIS] is a condition in which the abnormal cells replaces the normal cells of the breast ducts and expand to the ducts and lobules. DCIS are considered to a non-invasive form of breast cancer this is because the abnormal cells will not grow beyond the layer of the cells of the origin.

**Lobular carcinoma insitu [LCIS],** or also called as lobular neoplasia, refers to the cells which look like cancer cells growing within the lobules of the breast. LCIS is much less common than the DCIS.

#### Invasive: [Spreading]

Breast cancers are mostly invasive, or infiltrating. These invasive cancers will break through the walls of the glands or ducts where they have been originated and growing.

**Invasive Ductal carcinoma [IDC]** has hard tumor texture with irregular shape or star-shape. There cell features also varies often.

**Invasive Lobular carcinoma [ILC]** having normal, slightly firm or hard tumor texture. A cell often appears in single file order.

#### Diagonising Techniques:

**Mammogram:** A mammogram uses a machine to diagnose only the breast tissue. It takes the x-rays at lower doses than usual x-rays. Due to this the x-rays don't go through the tissues of the breast easily. So this gives a better image of the affected area. In breast tomo synthesis or 3D mammogram the computer will put the images together into a 3-dimensional image.

**Breast ultrasound:[sonography]:** It is imaging a technique that sends high frequencies of sound waves and converts the echoes as image. A gel is applied on the skin and the transducer is moved across the skin. Then the echoes are converted into black and white image. There is no radiation as in mammogram. It is better than mammogram to see the changes of breast. It also helps to differentiate between the solid masses and the fluid filled cysts. The sono mammogram can be classified into mass and micro calc-

fication. Mass and micro calcification are further classified into benign or malignant based on the characteristics and vulnerability. In addition to mammogram and sonogram, the breast image may be obtained by Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) techniques 2.

#### Mass and Micro calcification:

**Mass:** Mass or tumor, may or may not have any calcification. Masses are group of cells which is denser than the surrounding cell. Masses can be any things which include cysts [fluid filled] and non-cancerous solid tumors.

**Micro calcification:** They are tiny calcium deposits inside the breast tissues. It looks like small white spots in the image as shown in Figure 5. When more micro calcification is seen in an area they are called as cluster which may indicate small cancer.

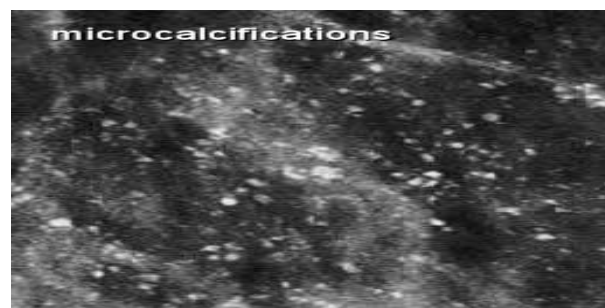


Fig. 5: Micro Calcification Image.

This micro calcification is most common sign of ductal carcinoma of in situ type. It is reported above 90% of the ductal carcinoma insitu are associated with this micro calcification. Micro calcification is associated with benign fibrocystic change or any change of degeneration of breast such as old injuries, aging, Inflammation. Tumors can be benign or malignant.

**Benign tumor:** They are slow in their growth. Benign don't spread to any other parts of the body. It is non-invasive in nature. Usually oval or ellipsoid in shape.

**Malignant tumor:** Malignant are fast growing. It is invasive in nature with infiltrate metastasize. There masses are hard, painless. Irregular borders [3].

#### Shapes of Micro calcification:

It consist of round, linear, coarse, granular [fine], clustered.

**Eggshell:** These are thin, round, rim-like calcifications often seen in the walls of cysts or in fat necrosis. This is shown in Figure 6.

**Coarse and popcorn-like calcifications:** These are calcifications seen within degenerating fibro adenomas, as shown in Figure 7

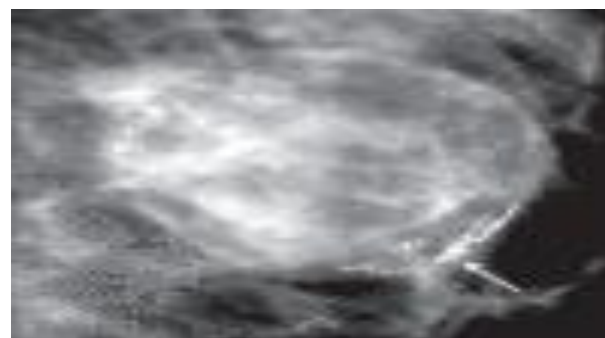


Fig. 6: Egg Shell or Rim like Calcification.

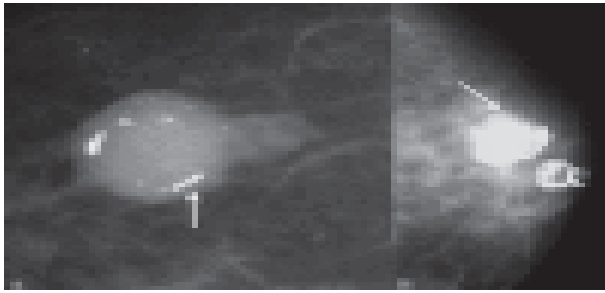


Fig. 7: Coarse and Popcorn-Like Calcification.

#### Distribution of Microcalcification:

Diffuse or scattered: multiple similar appearing clusters of calcifications throughout the whole breast.

Regional: scattered in a larger volume ( $> 2$  cc) of breast tissue

Clustered : at least 5 calcifications occupy a small volume of tissue

Linear: calcifications arrayed in a line, which suggests deposits in a duct.

Segmental: calcium deposits in ducts and branches of a segment or lobe.

The distribution of micro calcifications are shown below in the Figure 8.

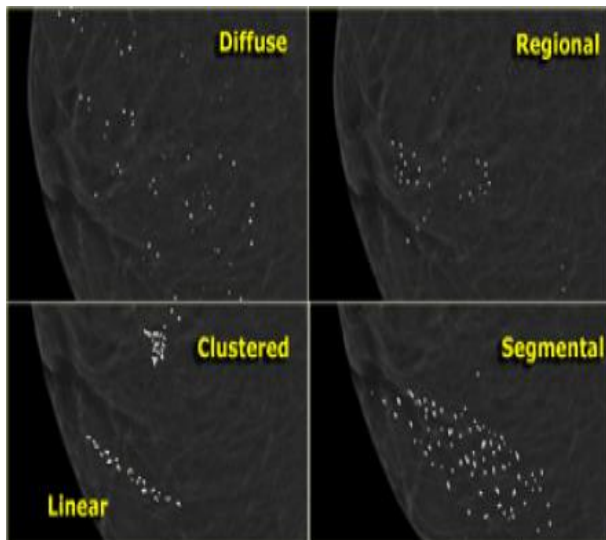


Fig. 8: Distribution of Micro Calcification.

The works that has been done previously which is related to our proposed work has been listed as follows.

The detection of micro calcification cluster has been done with [2] methods. They are multi-branch standard deviation analysis and with the texture-based analysis in breast tissue. Here they have take image with size of  $2510 \times 2000$  pixel and 10 bits for each pixel. The result of this work is 70.8% accurate. In addition, they have detected the individual micro calcification by surrounding region dependence method [4].

A comparative study of surrounding region based on texture analyzes method to detect the micro calcification in breast image. They have also followed another method like conventional texture analysis method, spacial gray level dependence method, and gray level dependence method. The regions of interest are extracted from the textual feature method. Then the region of interest is divided as positive region of interest and negative region of interest. Positive region of interest contain micro calcification and the negative region of interest contain normal tissues<sup>5</sup>.

The micro calcification analyses with two categories and the best one is chosen by the multi variation cluster analysis of genetic algorithm [GA]. The first category was the second order histogram statistic features which representing the global texture and wavelet decomposition features of the micro calcification. The second category represent the first order gray-level histogram-based sta-

tistics which is to segment the micro calcification size, number, distance features of the segmented cluster<sup>6</sup>.

The ultra-structural elemental micro analysis performed on breast micro calcification confirmed the present of already-known types of calcification, CO and HA. The micro calcification contain calcium oxalate [CO] OF 81.1% and mg substituted hydroxyapatite, [DAB] diaminobenzidine<sup>7</sup>.

A standard protocol is developed to acquire the breast thermal image includes the design, construction and installation of mechanical apparatus. They have computed the breast temperature for normal and micro calcification. Standardized breast image thermal used in automated image processing<sup>8</sup>.

The filter design requires a largely depends on prior knowledge with the types of noise in the image. Filters are average, order statistics, Gaussian and wiener to reduce the noisy artifacts with smoothing. The sharpening filters will make the image as non-smooth and they also enhance the high frequencies. So a combination of these two filters is hebbian filter. They developed an algorithm which will achieve the efficient learning from the neighbor pixels<sup>9</sup>.

A thermo gram to create hot spot images. It is an accurate classified into malignant or non-malignant or benign or normal. Features using the normalized bispectrum perform better for the benign/normal classification. These classifications between benign or normal cases, with 83% accuracy compared to 66% for the original. Boundaries are extracted using canny edge detection and elimination of inner edges. Breast images are the segmented using fuzzy c-means clustering and the hottest regions are selected for feature extraction<sup>10</sup>

In the multi-branch standard deviation analysis they have find a correlation between the neighboring pixels and the local maxima. They used Daubechie D4 wavelet transform to encode the polynomial of two coefficients. Support vector machine used to obtain maximum margin with optimal boundaries. There are two types of margin. They are hard margin and soft margin. In this the support vector machine is good to obtain the soft margin. The study was about the detection of statistical based on maximum, mean, variance, coefficient of variation and the standard deviation [11]

The mid-fourier transform infrared [FTTR] spectroscopy. The content of carbonate of micro calcification was decrease when progressing from benign to malignant. The correlation between micro calcification chemical is  $P < 0.001$ . The micro calcification contains two types of chemical they are calcium oxalate and carbonate calcium hydroxyapatite. The mean value of invasive, insitu, and benign of the calcification are 0.8278, 0.3717, 0.111412.

To enhance the image of low range without any undesired artifacts, a digital noval binning algorithm is used. A multiple pixel values in the digital pixel binning can be accumulating without the losing of spacial resolution. The intensity value is auto exposure in the digital pixel binning. Noise-adaptive pixel binning can suppress the noise which was failed to do by context adaptive pixel binning [13]

## 2. Materials and methods

This paper proposes a new automated algorithm to detect micro calcification and its classification from sono mammogram images. The flow for the proposed work is shown in the Figure 9.

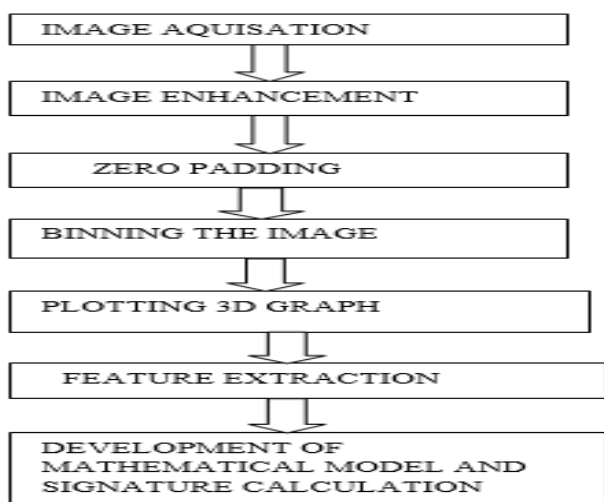


Fig. 9: Flow Chart for the Proposed Work.

Image Acquisition: The raw images were acquired from the clinical center from the radiologist with the report of the doctor. These images are processed in many steps to find the disorder or tumor area. Micro calcification is basically a deposit of calcium. So in the image, the lesion region will be viewed with varying intensity than other region.

Image Enhancement: The filtering or enhancing is the process which is used to extract information from the images. In this image noise reduction techniques contain many filters to reduce the noise of the image. The order statics minimum filter is used. These filters are suitable for medical image because they preserve the

edges and the very fine details of the image then the conventional filters.

If the order statistics vector is applied to a finite impulse filter, the that becomes order statistics[OS] filter. The minimum filter selects the smallest value within the pixel values. So first we have to find the minimum value of the pixel in the image. It can be represented as

$$F(x,y)=\min\{g(s,t)\}$$

Binning of Image: The filtered image is divided into an n number of blocks with x number of rows and y number of column in each block. To obtain this the images are converted to matrix with the command of mat and cell. Then display every block in the same figure. Before that if the image is in rgb image means then it has to be converted into gray-scale image.

Plotting 3D Graph: Graphs are unified representation for image analysis and processing. Graph based methods is used to segment, filter and to classify and cluster the image. The 3D graph is a pair of  $G=(x,y,z)$ , in which x stands for rows of the block, y stands for column of the block, z stands for intensity of the cell. This graph will fill in mesh with the facets. Surf1 graph can produce realistic appearance of surface in 3D.

Feature Extraction: The region of interest can be obtained by many methods. Out of these we use edge detection by sobel method. The edges are usually occurring on the boundary of two regions. Processing of edges in an image to be used as a fundamental asset in image analysis. By the edge detection the objects boundaries, segments can be recognized.

Table 1: Comparison of Proposed Method and Previous Methods

Sl.No	Steps in proposed Algorithm	Technique used in proposed algorithm	Techniques used in Literature Survey	Inferences in Literature Survey
1	Image enhancement	Order static filter	1) Adaptive median filter	1) Speckle noise reduced.
			2) Local adaptive operators integrated in the wavelet domain	2) Increase contrast
			3) Wavelet decomposition and reconstruction	3) Gray scale is increased
			4) Contrast measure	4) Matches the human vision system better
			5) Wavelet domain	5) Image enhancement after compressing the JPEG 2000
2	Image segmentation	Block processing[binning, graph]	1) Histogram and thresholding and region growth.	1) Preliminary lesion boundary.
			2) Fussy models	2) Automatic and semi-automatic detection.
			3) Decomposed in to sub band and reconstruction	3) Classification of micro calcification
			4) Conversion of binary images at multiple threshold levels.	4) Segmentation of distinct structure.
			5) Ranking system based on features.	5) Increase signal to noise ratio
3	Feature extraction	No of high peaks	1) Seed point selection.	1) Region of interest.
			2) Crisp-K-nearest neighbor	2) Intensity as discriminating feature.
			3) Filter bank implementation without down sampling.	3) Detection of optimized details in sub bands
			4) Pre whitening matched filter.	4) Detection of micro calcification.
4	Mathematical model and signature	Gaussian model based on intensity	1) PBM Linear elasticity theory.	1) Model of breast deformation.
			2) Multi resolution signal	2) Capture the statistic structures of smooth and singular region.
			3) Hidden markov tree	3) Texture and edge region are captured.
			4) Featuring linear time computation and processing algorithm	4) Reduce Bayesian inference.

### 3. Conclusion

As per the proposed flow chart, first the image is to be enhanced by using an order statistic filter, and then the filtered image is to be binned. Then the 3D graph for each bin is to be plotted by considering row ,column and intensity of each pixel in the bin as axis parameter( x,y and z axis). To find Region of interest (RoI) the

number of peaks in each 3D graph will be calculated. The block or combination of blocks which is having maximum peaks is to be considered as RoI.

This paper proposed a new automated algorithm to detect the exact location of micro calcification (RoI) in sono mammogram images. From extracted RoI, the characteristics of microcalcification are to be found and using the characteristics the occurrence of early breast cancer will be identified. By developing a mathematical model of RoI, the signatures of micro calcification will be

found. By comparing the characteristics and signatures, it will be easy to find the classification of micro calcification. Since the flow of proposed algorithm involves both the calculation of characteristics of micro calcification and signature calculation definitely will give better result than previous techniques.

## References

- [1] Webpage Moose and Doc (<http://breast-cancer.ca/>)
- [2] Webpage American Cancer society (<https://www.acr.org>)
- [3] Webpage [HTTP://GLOBOCAN.IARC.FR](http://GLOBOCAN.IARC.FR)
- [4] Webpage DDSM <http://marathon.csee.usf.edu/Mammography/Database.html>)
- [5] Arai K, Abdullah IN, Okumura H, Kawakami R. Improvement of automated detection method for clustered microcalcification based on wavelet transformation and support vector machine. *World*. 2013 Apr; 1384:458.
- [6] Kim JK, Park HW. Statistical textural features for detection of microcalcifications in digitized mammograms. *IEEE transactions on medical imaging*. 1999 Mar 18 (3):231-8.
- [7] Dhawan AP, Chitre Y, Kaiser-Bonasso C. Analysis of mammographic microcalcifications using gray-level image structure features. *IEEE Transactions on Medical Imaging*. 1996 Jun; 15(3):246-59.
- [8] Scimeca M, Giannini E, Antonacci C, Pistolesi CA, Spagnoli LG, Bonanno E. Microcalcifications in breast cancer: an active phenomenon mediated by epithelial cells with mesenchymal characteristics. *BMC cancer*. 2014 Apr 23 14 (1): one.
- [9] Bezerra LA, Oliveira MM, Rolim TL, Conci A, Santos FG, Lyra PR, Lima RC. Estimation of breast tumor thermal properties using infrared images. *Signal Processing*. 2013 Oct 31 93 (10):2851-63.
- [10] Mondal PP, Rajan K, Ahmad I. Filter for biomedical imaging and image processing. *JOSA A*. 2006 Jul 1; 23 (7):1678-86.
- [11] EtehadTavakol M, Chandran V, Ng EY, Kafieh R. Breast cancer detection from thermal images using bispectral invariant features. *International Journal of Thermal Sciences*. 2013 Jul 31; 69:21-36.
- [12] Arai K, Abdullah IN, Okumura H, Kawakami R. Improvement of automated detection method for clustered microcalcification based on wavelet transformation and support vector machine. *World*. 2013 Apr; 1384:458.
- [13] Baker R, Rogers KD, Shepherd N, Stone N. New relationships between breast microcalcifications and cancer. *British journal of cancer*. 2010 Sep 28 103 (7):1034-9.
- [14] Yoo Y, Im J, Paik J. Low-Light Image Enhancement Using Adaptive Digital Pixel Binning. *Sensors*. 2015 Jun 25 15 (7):14917-31.
- [15] Quintanilla-Dominguez J, Ojeda-Magaña B, Cortina-Januchs MG, Ruelas R, Vega-Corona A, Andina D. Image segmentation by fuzzy and possibilistic clustering algorithms for the identification of microcalcifications. *Scientia Iranica*. 2011 Jun 30; 18(3):580-9.
- [16] Malek AA, Rahman WE, Ibrahim A, Mahmud R, Yasiran SS, Jumaat AK. Region and boundary segmentation of microcalcifications using seed-based region growing and mathematical morphology. *Procedia-Social and Behavioral Sciences*. 2010 Dec 31; 8:634-nine.
- [17] Eapena MM, Ancelita MS, Geetha G. Segmentation of Tumors from Ultrasound Images with PAORGB. *Procedia Computer Science*. 2015 Dec 31; 50:663-eight.
- [18] Govardhan TV. Classical and Novel Diagnosis Techniques for Early Breast Cancer Detection—A Comparative Approach. *International Journal of Engineering Mathematics and Computer Sciences*. 2015 Nov 11 3 (11):12-6.
- [19] Ponraj DN, Jenifer ME, Poongodi P, Manoharan JS. A survey on the preprocessing techniques of mammogram for the detection of breast cancer. *Journal of Emerging Trends in Computing and Information Sciences*. 2011 Dec 2 (12):656-64.
- [20] Verma B. A neural network based technique to locate and classify microcalcifications in digital mammograms. In *Neural Networks Proceedings, 1998. IEEE World Congress on Computational Intelligence. The 1998 IEEE International Joint Conference on 1998 May 4 (Vol. 3, pp. 1790-1793)*. IEEE.
- [21] Shan J. A fully automatic segmentation method for breast ultrasound images (Doctoral dissertation, Utah State University).
- [22] Shan J, Cheng HD, Wang Y. A completely automatic segmentation method for breast ultrasound images using region growing. In *Proceedings of the ninth International Conference on Computer Vision, Pattern Recognition, and Image Processing 2008 Dec 5*.
- [23] Inbarani HH. A novel neighborhood rough set based classification approach for medical diagnosis. *Procedia Computer Science*. 2015 Dec 31; 47:351 [9].
- [24] Rose RJ, Allwin S. Computerized cancer detection and classification using ultrasound images: a survey. *Int. J. Eng. Res. Dev*. 2013 Jan; 5:36-47.
- [25] Shareef SR. Breast cancer detection based on watershed transformation. *IJCSI International Journal of Computer Science Issues*. 2014 Jan; 11 (1):237-45.
- [26] Cahoon TC, Sutton MA, Bezdek JC. Breast cancer detection using image-processing techniques. In *Fuzzy Systems, 2000. FUZZ IEEE 2000. The Ninth IEEE International Conference on 2000 (Vol. 2, pp. 973-976)*. IEEE.
- [27] Salvado J, Roque B. Detection of calcifications in digital mammograms using wavelet analysis and contrast enhancement. In *IEEE International Workshop on Intelligent Signal Processing, 2005. 2005 Sep 1 (pp. 200-205)*. IEEE.
- [28] Dominguez AR, Nandi AK. Enhanced multi-level thresholding segmentation and rank based region selection for detection of masses in mammograms. In *2007 IEEE International Conference on Acoustics, Speech and Signal Processing-ICASSP'07 2007 Apr 15 (Vol. 1, pp. I-449)*. IEEE.
- [29] Strickland RN, Hahn HI. Wavelet transforms for detecting microcalcifications in mammograms. *IEEE Transactions on Medical Imaging*. 1996 Apr 15 (2):218-29.
- [30] Hahn HI. Wavelet transforms for detecting microcalcifications in mammography.
- [31] Strickland RN, Hahn HI. Wavelet transform matched filters for the detection and classification of microcalcifications in mammography. In *Image Processing, 1995. Proceedings. International Conference on 1995 Oct 23 (Vol. 1, pp. 422-425)*. IEEE.
- [32] Tang J, Sun Q, Agyepong K. An image enhancement algorithm based on a contrast measure in the wavelet domain for screening mammograms. In *2007 IEEE International Conference on Image Processing 2007 Sep 16 (Vol. 5, pp. V-29)*. IEEE.