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REVIEW ON VARIOUS TECHNIQUES OF MAMMOGRAM IMAGE SEGMENTATION

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Abstract- **Image segmentation is the most challenging problem in image processing despite decades of research. Breast cancer is one of the major causes of death among women thus; to detect the breast cancer in digital mammogram, firstly we have to segment it properly. Segmentation refers to the process of dividing an image into multiple segments. The aim of segmentation is to change the way of representation of an image in such a form that is more meaningful and easier to analyze. It is used to locate objects and boundaries in the images. In this paper we have reviewed various mammogram image segmentation techniques like watershed, level set, fuzzy c-means & wavelet based methods.**

Keywords- Mammographic Images; Segmentation; Watershed; Wavelet based Method; Level Set Method.

I. INTRODUCTION

Image segmentation consists of object recognition and delineation. For evaluating segmentation methods, three factors - precision, accuracy and efficiency – need to be considered for both recognition and delineation. The many of research works conducted in the area of breast cancer detection and classification much university, commercial institution and research centers are focused on this issue because of the fact that breast cancer is becoming the most common form of cancer disease of today's female population [1]. Breast cancer is one of the major causes of death among women.

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One in eight deaths worldwide is due to cancer. Cancer is the second leading cause of death in developed countries. Cancer disease begins in the cells of the human body, which is generated by abnormal division of those cells**.** There are two types of cancer, benign tumors are not cancerous and malignant tumors are cancerous [3].Breast cancer screening is vital to detecting breast cancer [2]. The most common screening methods are mammography and sonography. Compared to mammography, breast ultrasound examinations have several advantages: Breast ultrasound examinations can obtain any section image of breast, and observe the breast tissues in real-time and dynamically. Ultrasound imaging can depict small, early-stage malignancies of dense breasts, which is difficult for mammography to achieve [4]. The World Health Organization's International Agency for Research on Cancer in Lyon, France, estimates that more than 150 000 women worldwide die of breast cancer each year. There is clear evidence which shows that early diagnosis and treatment of breast cancer can significantly increase the chance of survival for patients. The earlier the cancer is detected, the better the chance that a proper treatment can be prescribed [5]. The various stages of breast cancer detection are shown in fig. 1.

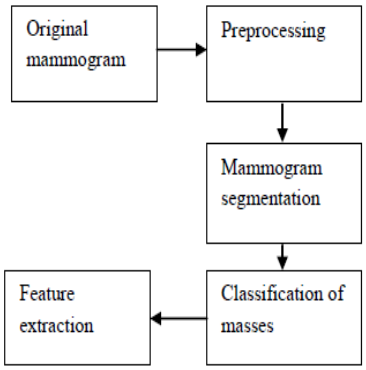

Fig. 1 Stages of cancer detection [11]

Mammography imaging is most efficient imaging techniques. Mammography is highly accurate but like most medical tests, it is not perfect on average mammography will detect above 80% - 90% of the breast cancer in women without symptoms. To accurate segmentation of breast images segmentation of the mammography images is very important and crucial for the exact diagnosis by computer aided clinical tools lot of Varity of image segmentation algorithms have been developed for mammography images [1].

II. VARIOUS TECHNIQUES OF IMAGE SEGMENTATION

1. WATERSHED ALGORITHM

It is based on the morphological concepts and was originally proposed by Digabel and Lantuejoul [6]. Watersheds are one of the classics in the field of topography and have long been used as a useful tool in image segmentation.

It is considered as a important tool for image segmentation. It plays an important role in machine vision, video image segmentation and image analysis. Basic idea of watershed algorithm is to view the gradient of gray scale image as a topographic surface, wherein the rain falling on the watershed line would be collected equally in catchments basins. The line that separates two catchment's basins is referred as watershed line as shown in fig 1. Segmentation efficiency of the watershed transform is improved significantly, if foreground objects and background regions are marked already [7].

In order to compute the gradient magnitude image, linear filtering operations such as average filtering and simple arithmetic calculations are used. However, if watershed algorithm is directly applied on gradient magnitude image, there always occurs an over segmentation mainly due to the presence of large number of minima's in that image. Therefore, markers of desired size are computed before applying watershed transform on gradient magnitude image. The catchment basins possessing minimal value are not marked properly in the presence of noise [7]. Hence, before applying the watershed algorithm, pre-processing step is employed to remove the noise and

other kind of non-uniformity from the test image in order to mark only the desired catchment basins. These marked catchment basins produce the modified gradient image. Watershed transform is then applied on modified gradient image to yield the final watershed ridge lines. The resultant image is finally superimposed on the original image to display the overall segmentation result.

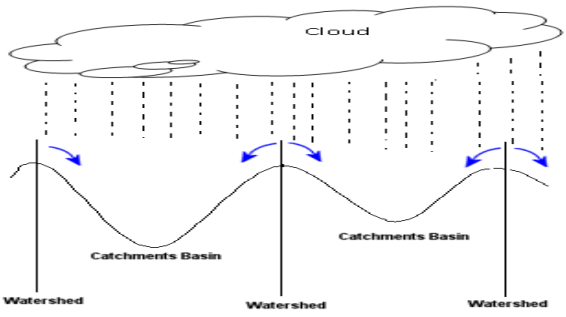

Fig.2: Watershed lines with catchments basins

The strength of watershed segmentation is that it produces a unique solution for a particular image, and it can be easily adapted to any kind of digital grid and extended to n-dimensional images and graphs. Furthermore, in mammograms, a mass tumor region is brighter and has more uniform intensity than its surroundings, which makes a good candidate for watershed segmentation. However, direct watershed segmentation on mammograms often generates unreliable results; the noise in the image results in over segmentation. Another disadvantage of watershed segmentation, again related to the image noise and the image's discrete nature, is that the final boundaries of the segmented region are lack of

smoothness. So it is not an efficient idea to treat the watershed segmentation as the final segmentation [8].

For segmentation with Marker-controlled watershed follow this basic procedure:
1. Compute foreground markers. These are connected blobs of pixels within each of the objects.
2. Compute background markers. These are pixels that are not part of any object.
3. Modify the segmentation function so that it only has minima at the foreground and background marker locations.
4. Compute the watershed transform of the modified segmentation function [2].

2. FUZZY C-MEANS (FCM) ALGORITHM

Clustering is a process of portioning or grouping a given set of unlabeled patterns into a number of clusters such that similar patterns are assigned to one cluster [9].

FCM is the unsupervised pixel classification technique that aims at dividing image pixels into optimal number of clusters. It was first proposed by Dunn et al. In general, pixels in a cluster have high degree of similarity than those in different clusters. However, each pixels of image possesses certain degree of similarity with the pixels of every cluster. Fuzzy c-means (FCM) clustering [10] is an unsupervised technique that has been successfully applied to feature analysis, clustering, and classifier designs in fields such as astronomy, geology, medical imaging, target recognition, and image segmentation.

This degree of belonginess is represented by a fuzzy membership function. The FCM algorithm assigns each pixel to more than one cluster with different membership degrees. Let X = (x1, x2,...,xN) represents an image with N pixels to be divided into c clusters, where xi denotes a multispectral data, then the clusters are formed by the iterative optimization of the following objective function [7].

$$J_p = \sum_{j=1}^{N} \sum_{i=1}^{c} u_{ij}^{p} \left\| x_j - v_i \right\|^2$$

where, uij is the fuzzy membership degree of pixel xj in the cluster i, vi is the cluster center of ith cluster, and p is a constant that controls the fuzziness of the resulting partitions. No theoretical basis exists for the selection of optimal value of p; usually its value is chosen to be 2. The FCM objective function is minimized when pixels in the proximity of cluster centroids are assigned high membership values, and low membership values are assigned to pixels far from the centroid of corresponding clusters. The membership grade matrix U is created for all pixels and clusters. The FCM algorithm can be described as follows:

1. Initialize the membership matrix

$$U = [u_{ij}]\ 1 \le i \le c, 1 \le j \le N$$

in the range [0,1] such that the element of uij of U satisfies the criteria

$$\sum_{i=1}^{c} u_{ij} = 1, j = 1, 2, \ldots, N$$

2. Compute the center vi of their respective fuzzy clusters using

$$v_i = \frac{\sum_{j=1}^{N} u_{ij}^{p} x_j}{\sum_{j=1}^{N} u_{ij}^{p}}$$

3. Update the membership functions using

$$u_{ij} = \frac{1}{\sum_{L=1}^{c} \left(\frac{\left\| x_j - v_i \right\|}{\left\| x_j - v_L \right\|} \right)^{2/(p-1)}}$$

4. Repeat step 2 and 3 until the iteration convergence criterion is satisfied,

$$\max_{ij} \left\{ \left| u_{ij}^{q+1} - u_{ij}^{q} \right| \right\} < \varepsilon,$$

where, ε is an iteration terminating threshold with a value between 0 and 1, and q is the iteration steps.

3. THE LEVEL SET METHOD

The level set method, originally used as numerical technique for tracking interfaces and shapes, has been used in well wide fields including the medical image processing [8]. It offers a powerful approach for the image segmentation since it can handles any of the cavities, concavities, splitting/merging, and convolution. However, despite of all the advantages which this method can provide, it requires the prior choice of the most important parameters such as the

initial location of seed point, the appropriate propagation speed function and the degree of smoothness.
This method, contours or surfaces are represented as the zero level set of a higher dimensional function, usually called a level set function. With the level set representation, the image segmentation problem can be formulated and solved in a principled way based on well-established mathematical theories, including calculus of variations and partial differential equations (PDE) [8].

Advantages:
It has several advantages; its stability and irrelevancy with topology, displays a great advantage to solve the problems of corner point producing, curve breaking and combining etc.
An advantage of the level set method is that numerical computations involving curves and surfaces can be performed on a fixed Cartesian grid without having to parameterize these objects. Moreover, the level set method is able to represent contours/surfaces with complex topology and change their topology in a natural way.

Disadvantages:
Since the edge-stopping function depends on the image gradient, only objects with edges defined by gradients can be segmented. Another disadvantage is that in practice, the edge-stopping function is never exactly zero at the edges, and so the curve may eventually pass through object boundaries [1].

4. WAVELET METHOD

The wavelet based adaptive windowing method is used for the segmentation of bright targets in an image. In these method two types of segmentation is used for mammogram to detect tumor. Coarse segmentation is implemented by using wavelet based histogram thresholding, where the threshold value is chosen by performing in wavelet based analysis of PDF of wavelet transformed images at different channels and second one is fine segmentation which is obtained by choosing threshold by using windowing method. The wavelet based adaptive windowing method is effective to segment the tumor in mammograms and it can also be used in other segmentation applications. This method of segmentation yield significantly superior image quality when it's compared to the global threshold method and window based adaptive thresholding method [1] but the computation time is more as compared to other methods.

III. RESULT

The comparison based on the study is given in the table. The comparative analysis includes various advantages &disadvantages of various image segmentation methods.

Sr. No.	Methods	Advantages	Disadvantages
1.	Watershed Method	produces a unique solution for a particular image, Fast and produce complete division of image in separated region	final boundaries of the segmented region are lack of smoothness It often generates unreliable results; the noise in the image results in over segmentation.
2.	Level Set method	displays a great advantage to solve the problems of corner point producing, curve breaking and combining etc	Computational complexity is high
3.	Wavelet based Method	effective to segment the tumor in mammograms	Computation time is more
4.	Fuzzy c-means Method	Effective for high resolution images	Depends on initial cluster center

IV. CONCLUSION & FUTURE SCOPE

Image segmentation is the challenging and active research area in the field of medical image processing. Mammogram Image segmentation is a

challenging task and there is a need and huge scope for future research to improve the accuracy, precision and speed of segmentation methods. Thus there is no single method which can be considered good for neither all type of images, nor all methods equally good for a particular type of image. Due to all above factors, image segmentation remains a challenging problem in image processing and computer vision and is still a pending problem in the world. Further works may be conducted to develop efficient segmentation methods.

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