A Survey: Analysis on Pre-processing and Segmentation Techniques for Medical Images

R. Beaulah Jeyavathana[1], Dr. R.Balasubramanian[2], A. Anbarasa Pandian[3]

[1]*Assistant Professor, Department of Computer Science and Engineering, Mepco Schlenk Engineering College, Sivakasi*

[2]*Professor, Department of Computer Science and Engineering, Manonmaniam Sundaranar University, Tirunelveli*

[3]*Research Scholar, Department of Computer Science and Engineering, Manonmaniam Sundaranar University, Tirunelveli*

Abstract: **Pre-Processing and Segmentation Techniques are used in the application of medical images. Image segmentation is a tediousprocess due to restrictions on Image acquisitions. The most important goal of medical image segmentation is to perform operations on images to detect patterns and to retrieve information from it. In this paper, first medical image processing is discussed. Then we have been proposed approaches to segment CT and CXR images. The comparative study of various image processing techniques has been given in tabular form. This survey provides details of automated segmentation methods, specifically discussed in the context of CT images. The motive is to discuss the problems encountered in the segmentation of CT images, and the relative merits and limitations of methods currently available for segmentation of medical images.**

***Keywords*: CT, CXR, Segmentation, Pre-processing**

I. INTRODUCTION

Medical imaging plays an important role in medical diagnosis and treatment. Also plays a role in medical applications. Most of the techniques have been developed based on CXR's, CT, MRI or other modalities like (SPEC, PET or ultrasound) [10]. Over the years, medical image processing contributed much in medical applications. i.e., the use of image registration and segmentation. The earliest one is CXR which has been used by doctors for more than a century [26]. In CXR, electromagnetic radiation with short wavelength and high energy has been used. Another technique is CT, which uses X-Ray in imaging body organs and structure internally. By passing X-Ray pulses through the body, it produces a number of parallel slices [43]. Another imaging technique is MRI, which works on magnetic characteristics and provides detailed information about internal organs. It produces a number of parallel slices of organs in three dimensions. But the most important disadvantage of MRI is for manual analytics volume of data is being too large and so it is tedious to collect data. Also noise, intensity and low contrast will be its disadvantages.

Images provided by X-Ray, CT (computed Tomography) serve as the basis for radiation therapy treatments. Most of the doctors prefer CT imaging and it is also being used for assessing parameters of the heart and the presence of stenosis in blood vessels. In medical imaging and medical image processing, there are four key problems.

i) Image Segmentation

ii) Image Registration

iii) Visualization

iv) Simulation

The most important challenging problem in image processing today is "Image Segmentation" [29]. Region of interest is being extracted through an automatic or semiautomatic process. Different Segmentation methods have been used in applications to segment body and tissues.

The different kinds of applications are in surgical planning, simulation of surgeries, tumour detection and segmentation, blood cells, automated classification, mammograms, segmenting heart and cardiac image analysis.

In this paper, we describe various pre-processing and segmentation methods which have been used in image analysis. We have given several advantages and disadvantages for each method.

II. PRE-PROCESSING TECHNIQUES

Due to noisy, inconsistent and incomplete data, pre-processing [39] plays an important role. It is one of the preliminary steps that are required to acquire the high accuracy of steps. CT and MRI images consist of artifacts; patient specific and equipment based artifacts; others are ring, staircase and volume effect artifacts. Before analyzing all these are removed by pre-processing procedures. We have proposed different denoising approaches [34].

i) Gabor Filter

It is a linear filter [38] used for edge detection. The orientation representations of Gabor filter are identical to the human visual system and they are appropriate for texture discrimination and representation.

ii) Adaptive Median Filter

It is used to reduce impulsive noise [20] on an image without any effect to the original image. It is used to cancel

unknown interference contained in a primary signal, with the cancellation being optimized in some sense. The primary signal serves as the desired response of the adaptive filter. The reference signal is employed as the input to the filter.

iii) Morphological Operations

Morphological Techniques investigate an image with a small template called "structuring element". These elements are positioned at all possible locations in the image and it is compared with neighbourhoods of pixels. The two morphological operations are "Erosion and Dilation" [2]. Erosion reduces the size of ROI and it also removed small details from an image. The dilation expands the shapes contained in an input image.

iv) Mean Filter or Average Filter

It is used to replace each pixel value in an image with the average value of its neighbours. It is used to remove pixel values [38] that are unrepresentative of their surroundings.

v) Image Normalization

It is a process that alters the range of pixel intensity values. It is also called Contrast stretching" or "Histogram Stretching" [40].The main motivation behind this is to achieve consistency for a set of data.

vi) Histogram Equalization

As previously discussed, dilation operation expands the shapes contained in an input image. The global contrast of many images is usually increased by this method. By this adjustment, intensities can be better distributed on the histogram [43].

vii) Weighted Median Filter

It is used to remove salt and pepper noise from CT images [23]. It has edge preserving capability and robustness. It has the noise attenuation capability.

viii) Weiner Filter

It is a type of non-linear filter. It is used for the restoration of blurred and noise image [13]. It is used to filter a gray scale image.

Table 1. Comparison of Pre-processing Techniques:

S.No	Preprocessing Technique	Author	Advantages	Disadvantages
1.	Gabor Filter	Vibha S. Vyas and PritiRege,(2015)	1) Uniqueness 2)It is very much specific toa period and scale 3)Fourier analysis is fast using FFT 4)Relevant for quantification of stationary signals	1)FFT requires the size of the image to be about the power of 2. 2)Problem with boundary condition (in other words, after the segmentation region can be very well identified but boundary conditions are not defined) 3) Time domain and frequency domain description of a signal are inversely related.
2.	Adaptive Median Filter	Sumanshrestha(2014)	1) Used to smooth non repulsive noise without any blurring of edges. 2) Retain edge information in case of high density impulse noises.	It does not perform well when impulse noise is greater than 0.2
3.	Morphological Operations	Yoshitaka Kimori (2015)	Enable detection of lesions of various sizes and shapes, including complex shapes.	Morphological operators rely on the notion of infimum and supremum which in turn requires an appropriate ordering of thecolours, i.e. vectors in the selected vectorspace
4.	Mean Filter (or) Average filter	Junn Shan wenju et al,(2010)	Reduce the variance and it is easy to carry out.	1) Averaging operations lead to blurring of an image and it affects features localization. 2) Impulse noise is not completely removed. 3)Affects mean value of all pixels in neighbourhood.
5.	Image Normalization	Dr. A. Sri Krishna(2014)	1) If images are normalized before the endorsement, the size and location of the endorsements would be consistent among different pages in the data set 2) If images are printed, using normalized images would prevent printing problems due to changes in page size and orientation	1)Image normalization can be a time consuming process and can add a significant amount of time to the e-Discovery export process in large cases 2) Using poorly designed normalization software can result in degradation of overall image quality

6.	Histogram Equalization	M.Aarthy, P.Sumathy(2013)	Simple and enhance contrasts of an image.	If there are gray values that are physically far apart from each other in the image, then this method fails
7.	Weighted Median Filter	S.Arastenfar et al.,(2014)	1) Efficient in removing salt and pepper noise. 2) Noise is removed effectively	Rounding corners and mapping texture region to a uniform shade is the most important deficiency.
8.	Weiner Filter	Cervinka et al.,(2015)	1) Minimization of mean square error is an efficient task. 2)Capable to handle both degradation function and noise	A reasonable estimate of degradation function is not efficient

III. SEGMENTATION

It is the process of dividing an image into regions with several properties such as Color, texture, brightness, contrast and gray level [35]. The input to the process is a digital gray scale image. (e.g., CT or MRI). The output of the process is abnormalities. The use of segmentation is to give greater information than which exists in medical images. Various techniques like neural networks, decision tree, and rule based algorithm and Bayesian networks are used to get desired output data in segmentation.

Segmentation Techniques

In this section different methods are proposed to segment the medical image regions. They are Pixel Based Methods, Edge based, Region Based, Model Based, Texture Based, ANN Based, Fuzzy Theory Based and Genetic Algorithm Based methods [27].

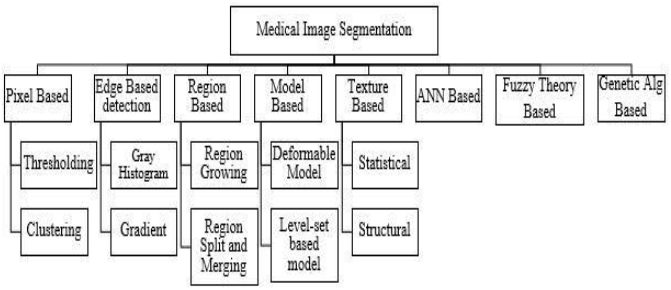

Fig.1.4 Segmentation Method

3.1 Pixel Based Methods

3.1.1 Thresholding

Thresholding is a simple and an innate method of segmentation in which pixels that meet the given criteria are considered as belonging to target, downgrade back to background status. It is one of the simplest and fastest segmentation methods. The histogram of images which can divide the images into different parts has different peaks and valleys [30]. Threshold is a value in the histogram that divides intensities into two parts. The first part is foreground and the second part is the background where the foreground is having pixels with intensities greater than or equal to the threshold and the background is having pixels with intensities less than the threshold.

Therefore,

$$A(x, y) = \begin{cases} \text{Foreground, if } f(x, y) >= Th \\ \text{Background, if } f(x, y) < Th \end{cases}$$

Where f(x, y) is the pixel intensity in (x,y) position and Th is threshold value. Multithresholding is using more than one threshold value to separate more than one object with different gray levels. Thresholding segmentation [1] cannot mind about the spatial information of images which yields to noise and intensity inhomogeneities. Here MRI images can suffer from these problems and they destroy the histogram [10]. In the following, OTSU's thresholding and adaptive thresholding is being discussed where, they both uses an automatic threshold value and local threshold value respectively.

OTSU's Thresholding

When selecting the threshold value visually, there may be some problems and it leads to poor results [16]. For an automatic selection of threshold value OTSU's method is being used. It chooses the threshold to reduce the variance within the class of black and white cluster pixels.

Adaptive Thresholding

In Adaptive Thresholding each pixel is compared to an average of the surrounding pixel. Specifically, an approximate moving average of the last pixels seen is calculated while traversing the image. If the value of the current pixel is lower than the average then it is set to black, otherwise it is set to white. This method works because comparing a pixel to the average of nearby pixels will preserve hard contrast lines and ignores soft gradient changes. The advantage of this method is that only a single pass through the image is required. However, a problem with this method is that it is dependent on the scanning order of the pixel.

3.1.2 Clustering

It is another way of segmenting, which separates regions of objects. Using a similarity measure as a criterion, this method operates as a grouping method to divide smaller regions. Dissimilar parts have been put in different groups. The resulting regions are called as clusters.These methods are widely used in medical imaging based applications, computer vision applications, satellite imaging and remote sensing [5]

K-Means Clustering

It is an unsupervised technique helps in the segmentation of medical images of the brain and other parts of the body.To be used in the implementation, number of mean values is selected as K-for K-clusters. MRI images that show the brain images contain regions that provide bone, soft tissue and fat and we can select the number of clusters [33]. Huge data are partitioned into K-clusters and data points are assigned to clusters, yielding in all clusters having the same number of data points. The Euclidean or Mahalanobis distance is computed for clusters from data point to mean of clusters. If data point is not near to its own cluster it can be shifted to its closest cluster [32], and if the point is closest to its own cluster, this is not moved and remains in its group. This process continues until no clusters remain to be checked.

3.2 Edge Based Detection Methods

Based on discontinuity calculations, edge of a segment of the image is determined. There are two operations to be performed for segmentation. Edge detection and linking. Many methods have been developed for segmentation on mammograms using active contour models. In this method, the RGI based segmentation method was applied to get a contour initially.

Sobel edge detection comes under edge detection. It takes maximal values in absolute value of gradient of the image. It is less sensitive to image noise and it is one of the best edge detection methods. Hence, numerical approximations to the gradient must be used.

3.2.1 Gray Histogram

This technique is based on a threshold value T. It is defined for the division of the image into foreground and background. The complexity of the method lies in the proper selection of the threshold as the range of gray histogram is not uniform due to the presence of noise. Hence two conic Gaussian curves [45] are selected, each curve representing the foreground and the background. The intersection point of the curves defines the threshold T value.

3.2.2 Gradient

Gradient refers to a generalized version of a derivative for image f (x,y), whenever there is an abrupt change in the intensity of the image near its edges. This is a method which convolves gradient operators with the image [46]. The gradient magnitudes with high values are generally those regions which represent abrupt changes between two regions. They are referred as edge pixels, and they form closed boundaries by linking the pixels together.There are many edge detection operators that can be used ingradient based methods such as sobel operator, canny operator, Laplace operator, Laplacian of Gaussian (LOG) operator and many others. The canny operator gives best results among the following but it is complex and takes more time when compared with the sobel operator. Generally the method of edge detection requires a balance between the proper detection of the edges and the level of noise present. The edge detection process depends highly on the proper level of accuracy too. If the accuracy level is very high the detected edges might be fake or extra as detected by the noise adding unreasonable outlines in the image, if the level of accuracy is lower than usual, then many of the important edges might be missed or won't get detected leaving out important objects.

3.3 Region Based Methods

A region [8] is a collection of pixels, among them two by two is neighbours and the boundary is differences between two regions. Most image segmentation methods are based on region and boundary properties. Here we have proposed two popular region based approaches: Region growing and Region split and Merge Method.

3.3.1 Region growing

Two components followed the algorithm by Region-Growing methods [13],

i) Principle of growth
ii) Seed Point Selection

The Principle of growth describes about the pixel value of pixels in neighbour is smaller than the threshold. Seed point selection requires human computer interaction method [15].
A general region algorithm for extracting one object is as given below

Algorithm:

Input (Seed Point)

(1) Region x= [seed]

(2) While x.neighbours { }

(a) For each voxel a in x.neighbours, if
B (a,x)=true,

Then add a to x (b)
End while

Return x

In the above algorithm, x is a region that we are going to extract. In this algorithm, region growing method is being explained by calculating the distance between voxel a and the mean of region B. The disadvantage of region growing is a result depends on the seed point selection. The shape which is being extracted depends on the user.When compared with thresholding; noise sensitivity is less in this method.This method is used in mammograms to extract the lesions from its background.

3.3.2 Region Split and Merge

This method is the most similar method to segment the image based on homogeneity criteria [44]. This method works on the basis of quad trees and the main objective is to These features can also be classified as first-order statistics by applying operators directly on grey pixel values, second-order statistics by calculating the illumination difference for pixels fixed at a distance *d* from each other. Methods based on second-order statistics have been shown to achieve higher discrimination rates than the power spectrum (transform-based) and structural methods. Accordingly, the textures in grey-level images are discriminated spontaneously only if they differ in second order moments.

Same second- order moments, but different third-order moments require deliberate cognitive effort [36]. This may be an indication that also for automatic processing, statistics up to the second order may be most important. The most popular second-order statistical features for texture analysis are derived from the co-occurrence matrix. They were demonstrated to feature a potential for effective texture discrimination in biomedical-images. Probably the most important second-order statistical features for texture analyzing are co-occurrence matrices. The co-occurrence matrix method named GLCM has become one of the most important and widely used statistical derivation approaches in texture analysis.

3.5.2 Structural Based

These represent texture as composed of texture elements (textons). Here texture is defined by means of well-defined primitives called micro texture and a hierarchy of spatial arrangements of those primitives called as macro texture. To describe the texture, one must define the primitives and the placement rules. The advantage of the structural approach is that it provides a good symbolic description of the image; however, this feature is more useful for synthesis than analysis tasks. The abstract descriptions can be ill defined for natural textures because of the variability of both micro and macrostructure and no clear distinction between them. A powerful tool for structural texture analysis is provided by mathematical morphology. It may prove to be useful for bone image analysis, e.g. for the detection of changes in bone microstructure. The method was successfully applied in medicine, especially for detection of changes in bone micro-structure.

3.6 Artificial Neural Networks Based Methods

Neural Network is nothing but artificial demonstration of human brain this attempts to imitate its learning procedure. Artificial Neural Network [31] frequently known as a neural network or merely neural net. Up-to-date, neural nets are broadly utilized to answer the crisis of image segmentation in medical stream. It is dependent on life imitation, particularly learning process of human brains, comprises a huge number of parallel node learning process could be accomplished through moving the node connections and weights of connection [37]. Its major significant benefit is not dependent on the function called as probability density distribution function. It could also verifies segmentation consequences whenever the data divergence from the usual condition. Neural net could also diminish the expert intervention requirements while doing process of image segmentation.

3.7 Fuzzy Theory Based Methods

Fuzzy set theory is used in order to analyze images, and provide accurate information from any image. Fuzzification function can be used to remove noise from image as well [34]. A gray-scale image can be easily transformed into a fuzzy image by using a fuzzification function. Different morphological operations can be combined with fuzzy method to get better results [35]. Fuzzy k-Means and Fuzzy C-means (FCM) are widely used methods in image processing [36].

Different types of membership functions are used, i.e., Membership function for Region pixel distribution, to measure the closeness of the region, and to find the spatial relationship among pixels. Fuzzy rules use membership functions and fuzzy IF-THEN rule structure to perform segmentation of an image.

3.8 Genetic Algorithm Based Methods

Genetic algorithm is a part of evolutionary computing, which is a rapidly growing area of artificial intelligence. It generates solutions to optimization problems using techniques that are inspired by natural evolution, such as inheritance, selection, mutation and crossover. Algorithm starts with a number of solutions or chromosomes also called as population [47]. Then the solutions from one population are taken and are used to form a new population which is better than the old one. The solutions which are selected to form new solutions (offspring) are selected based on their fitness. This procedure is repeated until some condition is satisfied. Unlike traditional search methods, genetic algorithms rely on a population of candidate solutions.

Outline of the Basic Genetic Algorithm:

- **[Start]** Generate random population of *n* chromosomes (suitable solutions for any problem)
- **[Evaluation]** Evaluate fitness f(x) of each chromosome x in the population
- **[New population]** Create a new population by repeating following steps until the new population is complete.
- **[Selection]** Two chromosomes from a population are selected according to their fitness (the better is the fitness, the bigger chance to be selected)
- **[Crossover]** Selected parents are Crossover to form a new offspring (children). If no crossover was performed, then the offspring is an exact copy of parents.

- **[Mutation]** Mutate new offspring at each position in chromosome.
- **[Accepting]** Placing the new offspring in new population
- **[Replacing]** Use new generated population for further steps of the algorithm.
- **[Testing]** If the end condition is satisfied, then stop, and return the best solutions in the current population.

Table 2. Comparison of Segmentation Techniques

S.No	Segmentation Technique	Author	Advantages	Disadvantages
1.	Pixel Based	Lahouaoui LalaoUI et al(2013)	When the region homogeneity criterion is easy to define this algorithm works well	1)Quite expensive in computational time and memory. 2)In the image, there may be under and over segmentation and holes may be present in the region.
2.	Edge Based	Donya D'Souza et al.,	1) It does not require prior knowledge about the content of the image 2) It is computationally fast	It is a cumbersome process if there are too many edges.
3.	Region Based	Siddheswar Ray Rose H et al.,(1988)	Easier to classify and implement	1)Determination of number of clusters is difficult. 2)Spatial information utilization is difficult. 3)Selection of features is difficult to understand.
4.	Deformable Models Approach	G.Tsechpenakis et al.,(Springer 2011)	1)This approach is robust to noise and spurious edges 2)Able to generate surface from images	1)Manual approach is required to place as initial model 2)It is difficult to choose parameters
5.	Texture Based	ZhenghaoShi et al.,(2010)	1)Easy to solve complex problems using training data. 2)Error detection is an easier task	1)Training process is costly and prone to human errors. 2)Analysis of different image types is required
6.	Artificial Neural Network Based	T.F. Wang et.al.[24] Y.L.Huang et.al.[25] T.Kohonen[26	1)Doesn't require writing tedious programs. 2)Could entirely exploit the parallel nature of neural net	1) Extended Training period. 2) Initialization might affect the outcome.
7.	Fuzzy theory Based	S. Naz et al., [2010]	1)Single fuzzy rule applied to stress the importance attached to feature based and spatial information in the image. 2)Structure of the membership functions and associated parameters were automatically derived	1) Sensitive to noise. 2) Computationally expensive. 3) Determination of fuzzy membership is not very easy.
8.	Genetic Algorithm Based	Miss. Komal R. Hole et al.,[2013]	1)Prove to be effective in coming out of local optima but also brings considerable flexibility. 2)Effective in the contrast enhancement and produce image with natural contrast. 3)Provide a simple and almost generic method to solve complex optimization Problems	In complex design, simple GA may converge extremely slowly or it may fail, due to convergence to an unacceptable local optimum.

IV. CONCLUSION

In this paper various pre-processing and segmentation methods are analyzed. It is very well understood that all methods work well for different purposes. The advantages and disadvantages of these methods are discussed in the table. Pre-processing filters like Gabour, Histogram Equalisation have been used to improve the various imaging modalities and it also used in better diagnosis. Segmentation methods which are based on gray level techniques like thresholding i.e. pixel-based and region based methods are the simplest methods but they have very less applications. But by integrating with other techniques, the performance of all techniques has been improved. We can use Fuzzy C-Means algorithms in many situations. Neural network-based algorithms are feasible for texture-based segmentation and classification. Genetic Algorithm based segmentation is being used to find approximate solutions for optimization problems. Fuzzy Based segmentation is widely used in medical imaging. Most of these algorithms need systematic supervision and training. Their performance relies on the method and data used in training. We can see that many features should be satisfied by medical image segmentation algorithms. They are accurate, reliable, and robust in performance and also they should be least dependent on the operator.

REFERENCES

[1]. T. Abak, U. Bariş and B . Sankur, ‘‘the performance of thresholding algorithms for optical character recognition,’’Intl. Conf. Document Anal. Recog. ICDAR’97,pp. 697–700~1997.

[2]. Ahmed, M. N., Yamany, S. M., Mohamed, N., Farag, A. A., & Moriarty, T. (2002). A modified fuzzy c-means algorithm for estimation and segmentation of MRI data. Medical Imaging, IEEE Transactions on, 21(3), 1993.

[3]. Alamgir Nyma,1 Myeongsu Kang,1 Yung-Keun Kwon,1 Cheol-Hong Kim,2 and Jong-Myon Kim, “Hybrid methods for medical image segmentation” Journal of Biomedicine and Biotechnology Volume 2012 (2012)

[4]. Anisha Bhatia, “Salt-And-Pepper Noise Elimination in Medical Image Based On Median Filter Method’, International Journal of Electrical, Electronics and Data Communication, ISSN: 2320-2084, Volume 1, Issue 6, August 2013.

[5]. A. Asuncion and D. J. Newman, UCI Machine Learning Repository Irvine, CA: University of California, School of Information and Computer Science, 2013.

[6]. Bankman, I. (Ed.). (2008). Handbook of medical image processing and analysis. Academic press.

[7]. Bezdek, J. C., Ehrlich, R., & Full, W. (1984). FCM: The fuzzy c-means clustering algorithm. Computers and Geosciences, Analysis of Medical Image Segmentation Techniques 1993.

[8]. Bhattacharya, M., & Das, A. (2007, September). Fuzzy logic based segmentation of micro calcification in breast using digital mammograms considering multiresolution. In Machine Vision and Image Processing Conference, 2007. IMVIP 2007. International (pp. 98{105). IEEE.

[9]. Bo Peng, Lei Zhang, and David Zhang, “A Survey of Graph Theoretical Approaches to Image Segmentation”.

[10]. Brzakovic, D., Luo, X. M., and Brzakovic, P. (1990). An approach to automated detection of tumors in mammograms. Medical Imaging, IEEE Transactions on, 9(3), 233-241.

[11]. Y. Chang, X. Li, “Adaptive Image Region growing”, IEEE Trans. On Image Processing, Vol. 3, No. 6, 1994.

[12]. Cheng, H. D., Shi, X. J., Min, R., Hu, L. M., Cai, X. P. and Du, H. N. (2006). Approaches for automated detection and classification of masses in mammograms. Pattern recognition, 39(4), 646-668.

[13]. Chikako Abe and Tetsuya Shimamura , “Iterative Edge - Preserving Adaptive Wiener Filter for Image Denoising”, International Journal of Computer and Electrical Engineering, Vol. 4, No. 4, August 2012.

[14]. Christian Wachinger, Karl Fritscher, Greg Sharp, and Polina Golland ,”Contour-Driven Atlas-Based Segmentation”IEEE Transactions On Medical Imaging, Vol. 34, No. 12, December 2015.

[15]. Davatzikos C, Bryan RN. “Using a deformable surface model to obtain a shape representation of the cortex”. IEEE Trans MedImaging1996; 15:785–795.

[16]. L. Dongju and Y. Jian, “Otsu method and k -means,” in Hybrid Intelligent Systems, 2009. HIS ’09. Ninth International Conference on, vol. 1, 2009, pp. 344–349.

[17]. Gulsrud, T. O., Engan, K., &Hanstveit, T. (2006, January). Watershed segmentation of detected masses in digital mammograms. In Engineering in Medicine and Biology Society, 2005. IEEE-EMBS 2005. 27th Annual International Conference of the (pp. 3304{3307). IEEE.

[18]. Hamid Hassanpour, NajmehSamadiani, “Using morphological transforms to enhance the contrast of medical images” The Egyptian Journal of Radiology and Nuclear Medicine, Volume 46, Issue 2, June 2015, Pages 481–489.

[19]. Huang, Y. L. and Chen, D. R. (2004). Watershed segmentation for breast tumor in 2-D sonography. Ultrasound medicine and biology, 30(5), 625-632.

[20]. IlatulFerdouse et al., “Simulation and performance analysis of Adaptive filtering algorithms in noise cancellation”, IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 1, January 2011.

[21]. D. Jayadevappa, S. Srinivas Kumar, and D. S. Murty, “A Hybrid Segmentation Model based on Watershed and Gradient Vector Flow for the Detection of Brain Tumor” International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 2, No.3, September 2009.

[22]. JiZhao, Lina Zhang, Minmin Yin, “Medical Image Segmentation Based on Wavelet Analysis and Gradient Vector Flow”, Journal of Software Engineering and Applications, 2014, 7, 1019-1030.

[23]. R.Karthik Manoj, “Removal of Impulse Noise Using Adaptive Weighted Median Filter”, Indian Journal of science and technology”,DOI:10.17485/ijst/2014/v7iS6/62679.

[24]. Kaganami, H. G., &Beiji, Z. (2009, September). Region-based segmentation versus edge detection. In Intelligent Information Hiding and Multimedia Signal Processing, 2009. IIH-MSP'09. Fifth International Conference on (pp.1217 -1221). IEEE.

[25]. W. X. Kang, Q. Q. Yang, R. R. Liang, “The Comparative Research on Image Segmentation Algorithms”, IEEE Conference on ETCS, pp. 703-707, 2009.

[26]. Kim Le, “A Design of A Computer-Aided Diagnostic Tool For Chest X-Ray Analysis”, International Journal of Computer Science & Information Technology (IJCSIT), Vol 3, No 2, April 2011.

[27]. D Krstinic, AK Skelin, I Slapnicar,”Fast two-step histogram-based image segmentation”, on, IET, 2013.

[28]. Kupinski, M. A., &Geiger, M. L. (1998). Automated seeded lesion segmentation on digital mammograms. Medical Imaging, IEEE Transactions on, 17(4), 510-51.

[29]. Li, H. D., Kallergi, M., Clarke, L. P., Jain, V. K. and Clark, R. A. (1995). Markov random for tumor detection in digital mammography. Medical Imaging, IEEE Transactions on, 14(3), 565-576.

[30]. I.Mitsuru, M. Reiko and I. Kuniharu,“A new evaluation method for image noise reduction and usefulness of the spatially adaptive wavelet thresholding method for CT images”, Australasian Physical and Engineering Sciences in Medicine, vol. 35, no. 4, (2012), pp.475-483.

[31]. Moghaddam, M. J., &Soltanian-Zadeh, H. (2011). Medical Image Segmentation Using Artificial Neural Networks.INTECH Open Access Publisher.

[32]. Nameirakpam, Dhanachandra, umanthem Manglem and Yambem JinaChanu, “Image Segmentation using-means Clustering Algorithm and Subtractive Clustering Algorithm” Eleventh International Multi-Conference on Information Processing-2015 (IMCIP-2015).

[33]. S. H. Ong; K. W. C. Foong; P. S. Goh“Medical Image Segmentation Using K-Means Clustering and Improved Watershed Algorithm” Image Analysis and Interpretation, 2006.

[34]. Pal et. al., 1993] A Review on Image Segmentation Techniques, Pattern Recognition Society, Britain, volume 26, No. 9, pp. 1274.

[35]. D. L. Pham and J. L. Prince, “Adaptive fuzzy segmentation of magnetic resonance images,” IEEE Trans. Med. Image., 1999. International Congress Series (Vol.1069, pp. 375{378).

[36]. Pham, D. L., Xu, C., & Prince, J. L. (2000). Current methods in medical image segmentation 1. Annual review of biomedical engineering, 2(1), 315-337.

[37]. S.Raghu and Dr. Lakshmi Rajamani, “ASurvey on Neural Network based Automatic Segmentation of Brain MRI”, International Journal of Research and Applications” 2(7):351-357.

[38]. Rangayyan, R. M. (2004). Biomedical image analysis. CRC press.

[39]. Rupinder Singh, Jarnail Singh, Preetkamal Sharma, Sudhir Sharma., Edge Based Region Growing. IJCTA | July-August 2011.

[40]. Mr. Salem Saleh Al-amri(2010),Linear and Non-linear Contrast Enhancement Image, IJCSNS International Journal of Computer Science and Network Security, VOL.10 No.2, February 2010.

[41]. Shameena, N., &Rahna Jabbar, T. (2011). Fundamentals of Digital Image Processing: A practical approach with examples in Matlab. John Wiley & Sons.

[42]. Song, E., Jiang, L., Jin, R., Zhang, L., Yuan, Y., & Li, Q. (2009). Breast mass segmentation in mammography using plane and dynamic programming. Academic radiology, 16(7), 826-835.

[43]. Dr. A. Sri Krishna, "Contrast Enhancement techniques using histogram equalization methods on color images with poor lighting" International Journal of Computer Science, Engineering and Applications (IJCSEA) Vol.3, No.4, August 2013 DOI: 10.5121/ijcsea.2013.340215

[44]. Suckling, J., Parker, J., Dance, D., Astley, S., Hutt, I., Boggis, C. Savage, J. (1994, July). The mammographic image analysis society digital mammogram database. In Exerpta Medica.

[45]. TamalikaChaira, "Intuitionistic fuzzy color clustering of human cell images on different color models", Journal of Intelligent & Fuzzy Systems: Applications in Engineering and Technology - Hybrid approaches for approximate reasoning archive volume 23, Issue 2,3 March 2012, pages 43-51.

[46]. Valverde, F. L., Guil, N., &Munoz, J. (2004). Segmentation of vessels from mammograms using a deformable model. Computer methods and programs in biomedicine, 73(3), 233-247.

[47]. Miss.Komal R.Hole, Application of Genetic Algorithm for Image Enhancement and Segmentation, International Journal of Advanced Research in Computer Engineering & Technology, Volume 2, Issue 4, April 2013.