Fast Segmentation Methods for Medical Images

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ABSTRACT
Image segmentation is about splitting the whole image into segments. In case of image analysis, image processing one of the crucial steps is segmentation of the image. Segmentation of image concern about dividing the entire image in sub parts that may be similar or dissimilar with respect to features. Output of image segmentation has consequence on analysis of image, further processing of images. Analysis of image comprises depiction of object and object representation, measurement of features. Therefore characterization, area of interest's visualization in the image, description have crucial job in the segmentation of the image. This survey explains some methods of image segmentation. Segmenting an image into meaningful parts is a fundamental operation in image processing. Image segmentation is the process of partitioning a digital image into multiple segments. In this paper, various image segmentation methods are explained like edge detection, region based segmentation, neural network techniques ,energy based and hybrid methods, etc. In this paper review of image segmentation is explained by using different techniques. The efficiency of the segmentation process improved with the help of several algorithms, namely, active contour, level set, fuzzy clustering and K-means clustering. This paper analyses the performance of algorithms for image segmentation in detail. Intensity and texture based image segmentation is the two levels of the level set method. The combination of both intensity and texture based image segmentation provides better results than the traditional methods. The detailed survey of segmentation techniques provides the requirement of the suitable enhancement method that supports both intensity and texture based segmentation for better results.

Keywords
Segmentation, Image analysis, Active contour model, fuzzy C-mean(FCM), Gaussian mixture model(GMM), Level set method.

1. INTRODUCTION
Segmentation is the most important part in image process. Fence off an entire image into several parts which is something more meaningful and easier to further process. These several parts that are rejoined will cover the entire image. Segmentation may also depend on the various features that are contained in the image. It may be either color or texture. Before de-noising an image, it is segmented to recover the original image. The main motto of segmentation is to reduce the information for easy analysis. Segmentation is also useful in image analysis and image compression[1].

Image segmentation is still a very hot area of research in image processing field. It is still a challenging task for researchers and developers to develop a universal technique for image segmentation [2]. Image segmentation is also used to differentiate different objects in the image, since our image is divided into foreground and background, whereas the foreground of the image is related to the region of interest, and background is the rest of the image. Hence ,image segmentation will separate these two parts from one another.

The refinement of boundary is an important requirement in image segmentation. Contour based approaches [7-9] applied on various images in order to handle the topology changes, noise, streaks and faint spots. The active contour segmentation extends into morphological nature for accurate refinement of boundary with more energy consumption. The split Bergman method efficiently minimizes the energy function. Contour based approaches ignores the spatial relationship between the colors of images, thereby segmented. Active contour models are widely used in image segmentation problems, especially for medical images with a lot of noise and intensity inhomogeneity. State-of-the-art active contours[1, 2, 3, 4] are implemented using the level set method [5] in Eulerian framework. The level set method has several advantages such as regular computation on a grid and being easy to handle topological changes. Existing active contour models can be roughly categorized into edge-based models and region-based models. Generally speaking, region-based models are more robust when weak edges exist and less sensitive to initialize, but more computationally expensive than edge-based models. The LBF model minimizes an energy term which encourages smooth intensity variation locally within each region and tolerates abrupt intensity change along the region boundary.

2. CATEGORIZATION OF SEGMENTATION TECHNIQUES
Segmentation can be classified as five different techniques follows [3]:

- Region based methods
- Edge based methods
- Energy based methods
- Clustering based methods
- Hybrid methods

2.1 Region Based Segmentation
In this technique pixels that is related to an object are grouped for segmentation. The area that is detected for segmentation should be closed. Region based segmentation is also termed as similarity based segmentation [1]. Region growing is a procedure [4-5] that group's pixel in whole image into sub regions or larger regions based on predefined criterion [6]. Select a group of seed pixels in original image [7]. Select a set of similarity criterion such as gray level intensity or color and set up a stopping rule. Grow regions by appending to each seed those neighboring pixels that have predefined properties similar to seed pixels.Stop region growing when no more pixels met the criterion for inclusion in that region (i. e Size, likeness between a candidate pixel & pixel grown so far, the shape of the region being grown).

In region splitting and merging rather than choosing seed points, users can divide an image into a set of arbitrary unconnected regions and then merge the regions [4-5] in an attempt to satisfy the conditions of reasonable image segmentation. Region splitting and merging is usually implemented with a theory based on quad tree data. The Watershed Transform is a unique technique for segmenting digital images that use a type of region growing method based on an image gradient. The concept of the watershed transform is based on visualizing an image in three dimensions: two spatial coordinates versus gray levels. In such a topographic interpretation, The principal objective of segmentation algorithms based on these concepts is to find the watershed lines[6]. Fast scanning is like a unseeded region growing algorithm the number of clusters is not decided before getting the image. It is very fast and simple method[7]. The Image is scanned from upper left to lower right corner by this method and it checks whether the pixel can be merged into an existing cluster or not. A threshold value is fixed beforehand. The difference between the pixel value and average intensity value of neighboring cluster smaller than threshold (fixed before) then pixel is merged into the cluster. Although it does not provide a global view of the problem, also causes the gradient problem and very sensitive to noise. It takes lesser time than other segmentation algorithms and provides good shape matching with real world objects. Dynamically growing hierarchical self organizing map[8] is also giving better results in similarity based segmentation of images.

The Mean shift (MS) [9] algorithm clusters an n-dimensional data set by associating each point with a peak of the data set's probability density. For each point, Mean Shift computes its associated peak by first defining a spherical window at the data point of radius r and computing the mean of the points that lie within the window. At each iteration the window will shift to a more densely populated portion of the data set until a peak is reached, where the data are equally distributed in the window. MS was successfully applied by Mayer[10]in clusters, segmentation and filtering of natural resources in 2D images , using a paradigm adaptively to segment the brain MR images.

2.2 Edge Based Segmentation

Segmentation can also be done by using edge detection techniques. In this technique the boundary is identified to segment. Edges are detected to identify the discontinuities in the image. The edges of the region are traced by identifying the pixel value and it is compared with the n neighboring pixels. For this classification they use both fixed and adaptive feature of Support vector machine **(**SVM**)** in this edge based segmentation, there is no need for the detected edges to be closed. There are various edge detectors that are used to segment the image. the edges or pixels between different regions that have rapid transition in intensity are extracted [11] and linked to form closed object boundaries. The result is a binary image [12]. Based on theory, there are two main edge based segmentation methods gray histogram and gradient based method [13].

Sobel operator works on first order derivatives and made the image approximations digitally by differences. The sobel operator computes the gradient by using the discrete differences between rows and columns of a 3*3 neighborhood[14].The sobel edge filter is worked on convolution of the original image with a small, separable, and integer valued filter in both direction horizontal & vertical. Hence it is less costly. But on the other way, for high frequency variations in the images the gradient approximation can not produces good result. Sobel operator makes some inaccurate approximation of gradient.[15]

For the masking purpose the prewitt edge detector uses the differentiation Gx, Gy for digital image approximation. In this filter the parametric units of this function are similar with the sobel edge filter parametric units. The computation of convolution process while implementing it is slightly simpler than the sobel edge detector, but it tends to produce somewhat noisier results [14].

The prewitt operator is worked on the basis of convolution of the original image with a mask which is small, separable, and integer valued filter operated in both direction horizontally and vertically. Hence relatively less costly in terms of convolution computations with compared to others. In prewitt edge filter the points of gradient vector are directed towards the largest possible increasing intensity at every point of image and the length of the gradient vector correlated with the rate of change in that direction. This gives the analyzing result of this edge detector at the point of image where the region of constant image intensity as zero vectors and at a point on an edge is a vector which points across the edge, from darker to brighter values.The prewitt operator masks for horizontal and vertical directions are given below.

Canny edge filter is the detection techniques which give the more accurate and reliable edge than the sobel, prewitt edge operators. The optimality of canny edge filter is good because it uses three criterion for edge detection and after that the complete simple process for implementation, therefore it becomes popular filtration method [16]. The edge filter is very widely used method to the image segmentation problems. The canny edge filter algorithm work as the detection of points while doing this it takes abrupt changes at gray levels [17]. This canny edge filter operates on the local maxima of the gradient of f(x, y). The gradient is calculated by means the differentiation of a gaussian filter. This filter algorithm uses double thresholding for the edge detection. The pixels which has stronger edge than the threshold value high these are named as strong and those pixels which has weaker edge than the low value of threshold are get suppressed and the edge pixels between these two high & low thresholds are named as weak. In this case it uses two thresholds strong and weak for the detection of edges.

The Roberts edge detection performs a simple, quick to compute, 2-D spatial gradient measurement on an image. This method emphasizes regions of high spatial frequency which often correspond to edges[19]. The input to the operator is a grayscale image the same as to the output is the most common usage for this technique. Pixel values in every point in the output represent the estimated complete magnitude of the spatial gradient of the input image at that point.[20]

The Laplacian of Gaussian (LoG) [21]was proposed by Marr(1982). The LoG of an image f(x,y) is a second order derivative defined as,

$$\nabla 2\mathrm{f} = \frac{\partial 2f}{\partial x 2} + \frac{\partial 2f}{\partial y 2}$$

It has two effects, it smoothes the image and it computes the laplacian, whch yields a double edge image. Locating edges then consists of finding the zero crossings between the double edges.

2.3 Feature Based Clustering

Segmentation is also done through clustering. They followed a different procedure, where most of them apply the technique directly to the image but here the image is converted into histogram and then clustering is done on it . Pixels of the color image are clustered for segmentation using an unsupervised technique fuzzy C. This is applied for ordinary images. If it is a noisy image, it results to fragmentation.[5]

A basic clustering algorithm i.e., K-means is used for segmentation in textured images. It clusters the related pixels to segment the image Segmentation is done through feature clustering and there it will be changed according to the color components. segmentation is also purely depending on the characteristics of the image. Features are taken into account for segmentation. Difference in the intensity and color values are used for segmentation. Since k- means clustering uses two stage process. It is beneficial for increment in the segmentation computational efficiency which because it avoid the feature extraction of each pixel in the soybean image of leaves. K- Means clustering algorithm method considered that a vector space is formed them from the data features. K- Means clustering is a non-hierarchical technique and it gives a simple and easy approach for classification of a given dataset. As K-means algorithm is iterative, therefore it is applied only on sub group of original image rather than to full original image and it can be called as unsupervised training areas [22].In real time applications, one of the most difficult task in image analysis & computer vision is to classify the pixel in an image correctly [19], when there is no crisp boundaries between objects in an image thus in order to address this difficulty , fuzzy clustering techniques are used .

Fuzzy clustering technique classify pixel values with great extent of accuracy & it is basically suitable for decision oriented applications like tissue classification & tumor detection etc. fuzzy clustering divides the input pixels into clusters or groups on the basis of some similarity criterion, such that similar pixels belong to same cluster. Similarity criterion used can be distance, connectivity, intensity. The resulting partition improves the understanding of human beings & helps in a more informed decision making.

The advantage of fuzzy system is that they are easy to understand, as the membership function partition the data-space properly[23]. Fuzzy clustering algorithms include FCM (fuzzy C means) algorithm, GK (Gustafson-Kessel), GMD (Gaussian mixture decomposition), FCV (Fuzzy C varieties), AFC, FCS, FCSS, FCQS, FCRS algorithm and etc, among all the FCM is the most accepted method since it can preserve much more information than other approaches [24]. FCM assign pixels to each class by means of membership function.

2.4 Energy Based Segmentation

Using a enrgy based method & solving the PDE equation by a numerical scheme one can segment the image. Image segmentation based on PDEs is mainly carried out by active contour model or snakes. This method was first introduced by Kassetal [22] Kass developed this method to find familiar objects in presence of noise and other ambiguities. The central idea of snake is transforming a segmentation problem into a PDE framework. That is, the evolution of a given curve, surface or image is handled by PDEs and the solution of these PDEs is what we look forward to various methods for image segmentation**.**

Active contours or snakes are computer generated curves [22-23] that move within the image to find object boundaries under the influence of internal and external forces. Snake is placed near the contour of Region of interest (ROI). During an iterative process due to various internal and external forces within the image [23], the Snake is attracted towards the target. These forces control the shape and location of the snake within the image. An energy function is constructed which consist of internal and external forces to measure the appropriateness of the Contour of ROI, Minimize the energy function (integral), which represents active contour's total energy, The internal forces are responsible for smoothness while the external forces guide the contours onwards the contour of ROI Shortcoming of traditional snake is that, it require user interaction, which consists of determining the curve around the detected object [23], the energy function often converge to minimum local energy, so snake should be placed usually near the boundary of ROI [16], original snake algorithm is particularly sensitive to noise. More Sensitive to the choice of its parameters and adaptively adjusts the parameters in an extremely complex process. The computational complexity of the algorithm is high. To solve these problems, number of researchers, have made various improvements to basic model, but the shortcoming of snake are still not overcome fundamentally.

Many of the PDEs used in image processing are based on moving curves and surfaces with curvature based velocities. In this area, the level set method developed by Osher and Sethian[24] was very influential and useful . The basic idea is to represent the curves or surfaces as the zero level set of a higher dimensional hyper surface. This technique not only provides more accurate numerical implementations but also handle topological change very easily. 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. 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.

The Mumford-Shah model uses the global information of the image as the stopping criterion to segment the image [24]. Mumford-shah takes advantage of the entire information of the image to result in the best image segmentation. The basic idea is to look for a particular partition of a given image into two regions [24], one representing the objects to be detected & other background. C-V model is not based on edge function, to stop the evolving curve on desired boundary. (There is no need to smooth initial image, even if it is noisy), the location of boundary are very well detected. It can detect objects whose boundary are not necessarily defined by gradient or very smooth boundaries. Starting with only one initial curve this model can automatically detect interior contours and it does not necessarily start around the objects to be detected.

2.5 Hybrid methods

These methods combine one or more existing segmentation methods. These methods rely on morphological operations performed on the images. For example: Local binary fitting(LBF), Local intensity fitting(LIF)[25].Local Gaussian Intensity fitting(LGIF), Local region based active contour method(LRBAC)[26].Local Binary Fitting model [18] by embedding the local image information. It also works well

on images with intensity in homogeneity. The main idea in this method is to add a kernel function to define the energy functional.

$$E^{LBF} = \lambda 1 \int_{\Omega} \int K\sigma \ (x\text{-}y)/(y)\text{-}f1(X)2 \ dy \ dx + \lambda 2 \int_{\Omega} \int K\sigma$$

$$(x\text{-} \ y)/(y)\text{-}f2(X)2 \ dy \ dx \quad x,y \in \Omega$$

Where λ1 and λ2>0 are fixed parameters, Kσis Gaussian kernel with standard deviation σ, f1 and f2 are two smooth functions that approximate the local image intensities inside and outside the contour. The standard deviation of kernel plays an important role, it can be observed as scale value that controls, region scalability from small neighborhood of the whole image domain. It is always carefully chosen as not too small and not too large to get better results. Here f1(x) and f2(x) are the averages of image intensity inside and outside the contour. This is the reason why this method can handle the problem of intensity in homogeneity well.

Local Image fitting method is a modified form of the above method. This method also takes care of intensity in homogeneity problem, but gets stuck in local minima sometimes. LIF energy attracts the contour towards object boundaries and mainly dominant near object boundaries. This method can be viewed as constraint of difference between fitting and original image[27]. In this model a truncated Gaussian window is taken Kσ(x) with standard deviation σ and size of 4k+1 by 4k+1 where k is greater integer smaller than σ. Although this method is good for intensity inhomogeneity problem, but re initialization was expensive and time consuming. Traditional level set formulation of this method used signed distance function to its interface and during evolution as re initialization is necessary to restore degraded level set function. To regularize the level set function gaussian kernel is used in this method.This method can be implemented without re initialization that is by using the Euclidean length term that regularize the level set function. This will remove the initialization need, but it gets trapped in local minima. On the whole this method is more computationally efficient than LBF.

Local Gaussian intensity fitting: Li et al.[28] proposed a Local Gaussian distribution of energy with level set functions, local means and variances.These means and variances of local intensities are considered as spatially varying functions. These methods take care of images with intensity inhomogeneity problem. And moreover, it can be applied on 3D data as well. This method is a region based active contour method with variational level set formulation, in which a kernel function is used to define the energy to characterize the fitting of local Gaussian distribution to local image data around the neighborhood of a pixel. Then the double integral of this is calculated over the entire image to form internal energy. While calculating the resultant that minimizes the energy functional, the local intensity information is used to find variances and therefore guide them option of contour. And so it handles images with intensity inshomogeneity also.

Local region based active contour method: Lankton et al. [29] proposed a framework for region based segmentation energy to be formulated in a local way. As most of the medical and natural images are heterogeneous in nature that is objected to be segmented cannot be distinguished on the terms of global intensities which can further lead to error prone segmentation. So to counter this problem Lankton et al. proposed a new class of active contours energies which considers local information plus the benefits of region based techniques. LRBAC provide objectives like it can be used to localize any region based energy,it provided a way to localized active contour to interact and it provides a way by which any region based energy can be localized in a local way. This method basically divides the whole image into local smaller regions and in turn creates local energies at each point along the curve. In this method three energies that come into the picture are uniform modeling energy, means separation energy and histogram separation energy. These energies interact simultaneously to segment multiple objects. So this method allows localized active contours to compete in an image while segmenting different objects that may or may not share borders.

Implicit Active contour model with local and global intensity fitting energies method integrates the Local intensity fitting energy with an auxiliary global intensity fitting energy. The LIF energy attracts the contours near the edges of objects or boundaries. GIF incorporates global image information to improve the robustness to initialization of the contours. As compared to previous LIF, LRBAC [30] provides accurate segmentation results regardless of initialization. This method is capable of finding objects with interior holes or blurred edges also. It also handles intensity inhomogeneity efficiently while allowing more flexible initialization and maintains the sub pixel accuracy.Medical Image Segmentation Based on a Hybrid Region-Based Active Contour Modelis a new hybrid method based on Active contour model to segment the images with intensity inhomogeneity. The energy functional in this method comprises of three weighted terms Local, global and regularization term. The total energy is incorporated in a level set formulation with a level set regularization term from which a curve evolution equation is derived for energy minimization. This is based on the region information of the images and use both global and local information to attain the correct result quickly[31].The global information is provided by CV model. The local information is described by applying the framework of the energy in the localizing the energy. The global term in energy functional will take care of images with weak boundaries[32], Local term will take care of images with intensity inhomogeneity and to stop the curve from weaving around areas of noise regularization term is added. The energy function for this model is non-convex and therefore has local minima which makes it sensitive to initialization of contour.

2.6 Comparison

Table 1 [33] shows a comparison between various segmentation techniques by specifying a brief description of every method each with its advantages and disadvantages.

Table 1. Comparison of various segmentation methods

Segmentation Technique	Description	Advantage	Disadvantage
Region Based	based on partitioning image into homogeneous regions	more immune to noise, useful when it is easy to define similarity criteria	expensive method in terms of time and memory
Edge Based	based on discontinuity detection	good for images having better	not suitable for wrong detected or

		contrast between objects	too many edges
Cluster Based	based on division into homogeneous clusters	fuzzy uses partial membership therefore more useful for real problems	determining membership function is not easy
Energy Based	The curve moves to minimize the energy. This method uses a framework in which local minima of energy functional is having the set of alternate solutions.	fastest method, best for time critical applications	Less computational complexity
Hybrid methods	based on the working of combining different methods.	fastest method, best for time critical applications	more computational complexity

3. CONCLUSION

In this paper we classify and discuss main image segmentation algorithms. Image segmentation has a promising future as the universal segmentation algorithm and has become the focus of contemporary research. In this review of image segmentation techniques, various image segmentation techniques are detailed described and compared. These all techniques are suitable for many medical image applications. These techniques can be used for object recognition and detection. In spite of several decades of research up to now to the knowledge of authors, there is no universally accepted method for image segmentation, as the result of image segmentation is affected by lots of factors, such as: homogeneity of images, spatial characteristics of the image continuity, texture, image content. Thus there is no single method which can be considered good for 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.

4. REFERENCES

[1] R.Yogamangalam,,B.Karthikeyan,(2013),"Segmentation Techniques Comparison in Image Processing" , International Journal of Engineering and Technology (IJET).

[2] Muhammad Waseem Khan (2014) " A Survey: Image Segmentation Techniques" International Journal of Future Computer and Communication, Vol. 3.

[3] A.Manikannan,,J.SenthilMurugan(2015.)"A comparative study about region based and model based using segmentation techniques" International Journal of Innovative Research in Computer and Communication Engineering

[4] S.Aksoy,"Image Segmentation", Department of Computer Engineering, Bilkent Univ.

[5] K. G. Gunturk, "EE 7730- Image Analysis I", Louisiana state university.

[6] Niket Amoda, Ramesh K Kulkarni (2013)" Image Segmentation and Detection using Watershed Transform and Region Based Image Retrieval" International Journal of Emerging Trends & Technology in Computer Science.

[7] Y. Chang, X. Li, (1994) "Adaptive Image Region Growing", IEEE Trans. On Image Processing, Vol. 3, No. 6, .

[8] N. Waoo, R. Kashyap and A. Jaiswal (2010),",DNA Nano array analysis using hierarchical quality threshold clustering," The 2nd IEEE International Conference onInformation Management and Engineering (ICIME), Chengdu,, pp. 81-85.doi: 10.1109/ICIME.2010.5477579

[9] Lahouaoui.Lalaou,Tayeb.Mohamadi (2013) "A comparative study of Image Region-Based Segmentation Algorithms" International Journal of Advanced Computer Science and Applications, Vol. 4, No. 6.

[10] A. Mayer et H. Green span(2006)"Segmentation of brain MRI by adaptive mean shift. International Symposium on Biomedical Imaging" Macro to Nano, pages 319–322.

[11] K. K. Singh, A. Singh,"A Study of Image Segmentation Algorithms for Different Types of Images", Segmentation. AMR, 756-759, 3430-3434. http://dx.doi.org/10.4028/www.scientific.net/amr.756-759.3430

[12] Karthikeyan, B.Vaithiyanathan, V.Venkatraman, B.Menaka (2011),' Analysis of image segmentation for radiographic images' in Indian Journal of Science and Technology 5, pp. 3660-3664

[13] Baradez, M.O., McGuckin, C.P., Forraz, N., Pettengell, R., Hoppe, A. (2004) 'Robust and automated unimodal histogram thresholding and potential applications', Pattern Recognitation, 37, (6), pp. 1131–1148

[14] Mushrif, M.M., Ray, A.K. (2008) "Color image segmentation: Rough set theoretic approach', Pattern Recognit. Lett., 29, (4), pp. 483–493

[15] Rafael C. Gonzalez, Richard E. Woods, (2007) "Digital Image Processing", 2nd ed., Beijing: Publishing House of Electronics Industry,.

[16] N. R. Pal, S. K. Pal (, 1993) ,"A Review on Image Segmentation Techniques", Pattern Recognition, Vol. 26, No. 9, pp. 1277- 1294.

[17] W. X. Kang, Q. Q. Yang, R. R. Liang (2009),"The Comparative Research on Image Segmentation Algorithms", IEEE Conference on ETCS, pp. 703-707.

[18] Ravi C.Shinde, Jibu Mathew C and Prof. C.Y. Pati (2015) "Segmentation Technique for Soybean Leaves Disease Detection" International Journal of Advanced Research.

[19] Rafael C. Gonzalez, Richard E. Woods and Steven L. Eddins (2010) "Digital Image Processing Using MATLAB" Tata McGraw Hill Education,

[20] Majumdar, Diptesh, Dipak Kumar Kole, Aruna Chakraborty, and Dwijesh Dutta.(2014) "Review Detection & Diagnosis of Plant Leaf Disease Using Integrated Image Processing Approach". International Journal of Computer Engineering and Applications, Volume VI, Issue-III.

[21] Muthukrishnan.R and M.Radha (2011) " Edge detection techniques for image segmentation" International Journal of Computer Science & Information Technology (IJCSIT) Vol 3, No 6, Dec.

[22] Wang, L., He, L., Mishra, A., & Li, C. (2009). Active contours driven by local Gaussian distribution fitting energy. Signal Processing, 89(12), 2435-2447. http://dx.doi.org/10.1016/j.sigpro.2009.03.014

[23] Juneja, P. & Kashyap, R. (2016). Energy based Methods for Medical Image Segmentation.International Journal Of Computer Applications, 146(6), 22-27. http://dx.doi.org/10.5120/ijca2016910808.

[24] Lankton,S. & Tannenbaum, A. (2008). Localizing Region-Based Active Contours. IEEE Transactions On Image Processing, 17(11), 2029-2039. http://dx.doi.org/10.1109/tip.2008.2004611

[25] Kashyap, R. & Gautam, P. (2016). Modified region based segmentation of medical images. In *2015 International Conference on Communication Networks (ICCN)*. IEEE.

[26] Liu, T., Xu, H., Jin, W., Liu, Z., Zhao, Y., & Tian, W. (2014)." Medical Image Segmentation Based on a Hybrid Region-Based Active Contour Mode" Computational And Mathematical Methods In Medicine

[27] Kashyap, R. & Gautam, P. (2016). Fast Level Set Method for Segmentation of Medical Images. Proceedings Of The International Conference On Informatics And Analytics - ICIA-16. http://dx.doi.org/10.1145/2980258.2980302

[28] H. Zhang, J. E. Fritts, S. A. Goldman (2008).,"Image Segmentation Evaluation: A Survey of unsupervised methods", computer vision and image understanding, pp. 260-280,

[29] P.Daniel Ratna Raju G.Neelima (2012 "Image Segmentation by using Histogram Thresholding" IJCSET ,January.

[30] Senthi lkumaran N and Vaithegi S (2016)"Image segmentation by using thresholding techniques for medical imaging" computer science and engineering:a international journal.

[31] Dilpreet Kaur , Yadwinder Kaur (2014)" Various Image Segmentation Techniques: A Review" , International Journal of Computer Science and Mobile Computing, Vol.3 Issue.5, May-, pg. 809-814