A Study of Image Segmentation Techniques on CT lung Images

Ms.K.Kothavari and Ms.S.N.Deepa

Abstract-- Segmentation is used to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as colour, intensity, or texture, in this paper various (existing)segmentation algorithm has been studied a and implemented using mat lab.

Keywords: Image segmentation,thresholding, K-means clustering, Fuzzy c-means Clustering;

I. INTRODUCTION

If an image has been preprocessed appropriately to remove noise and artifacts, segmentation is often the key step in interpreting the image. Image segmentation is a process in which regions or features sharing similar characteristics are identified and grouped together. Image segmentation may use statistical classification,
thresholding, edge detection, region detection, or any combination of these techniques. The output of the segmentation step is usually a set of classified elements, Most segmentation techniques are either region-based or edge based.
Region-based techniques rely on common patterns in intensity values within a cluster of neighboring pixels. The cluster is referred to as the region, and the goal of the segmentation algorithm is to group regions according to their anatomical or functional roles. This paper gives the overview of various segmentation techniques and some of the existing segmentation algorithm has been implemented using Matlab

Ms.K.Kothavari is working as Associate Professor, Department of Electronics&Communication Engineering, *Dr.NGP Institute of Technology, Coimbatore641048,TamilNadu, India* and Ms.S.N.Deepa is working as [2]*AssociateProfessor & Head, Department of EEE, Anna university of technology ,Coimbatore, Coimbatore,tamilnadu,India, Emails:* kothaskvn@gmail.com, deepapsg@gmail.com

II SEGMENTATION TECHNIQUES

.

i)Edge-Based Segmentation: Edge detection is the most common approach for detecting meaningful discontinuities An edge is a set of connected pixels that lie on the boundary between two regions, An edge is a "local" concept whereas a region boundary is a more global idea. A reasonable definition of "edge" requires the ability to measure gray level (intensity) transitions in a meaningful way, An *edge based segmentation* approach can be used to avoid a bias in the size of the segmented object without using a complex thresholding scheme. Edge-based segmentation is based on the fact that the position of an edge is given by an extreme of the first-order derivative or a zero crossing in the second-order derivative. the output of edge detection is shown in figure 1

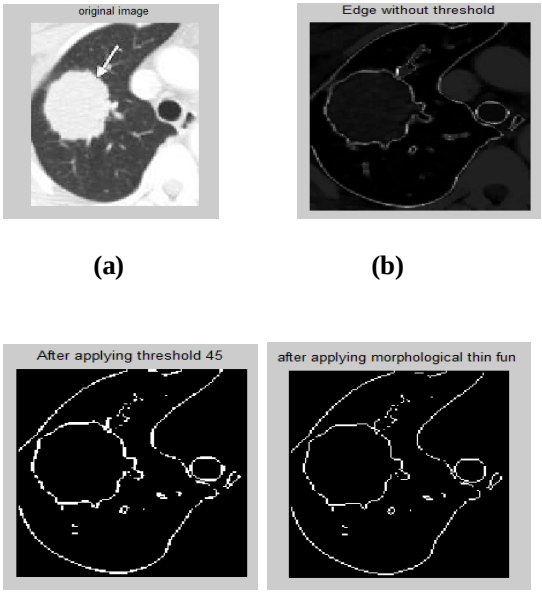


Figure 1: Edgedetection(a)Originalimage (b)Edge without threshold (c)After applying threshold 45(d)after applying Morphological thin fun

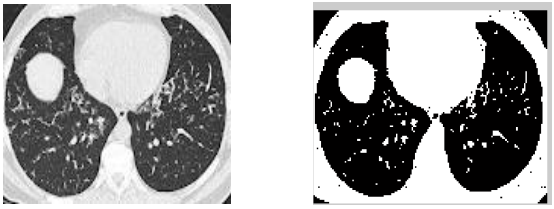
ii**)Thresholding Method**

Thresholding is the simplest way to perform segmentation,and it is used extensively in many image processing applications.Thresholding is based on the notion that regions corresponding to different regions can be classified by using a range function applied to the intensity values of image pixels. The assumption is that different regions in an image will have a distinct frequency distribution and can be discriminated on the basis of the

mean and standard deviation of each distribution.For example, given the histogram of a two-dimensional medical image I(x,y) , we can define a simple threshold rule to classify bony and fat tissues or a compound threshold rule to classify muscle

If, I(x,y) > T1 => Bony,If, I(x,y) < T0 => Fat

If, T0 < I(x,y) < T1 => Muscle **,**The input and output images of Thresholding algorithm are shown in figure 2

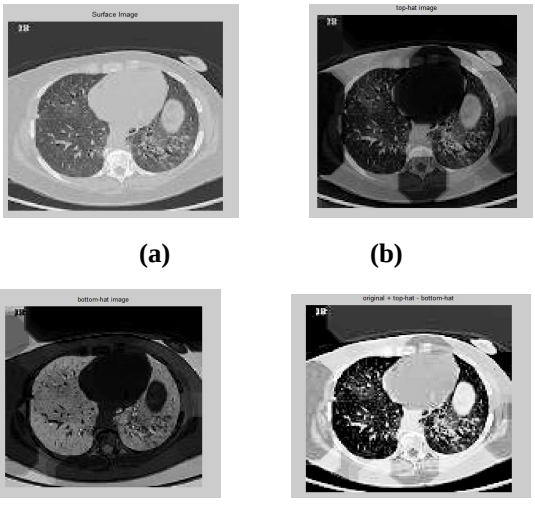


(a) **(b)**

Figure 3: Segmentation usingThresholding (a)Original Image(b)Segmented Image

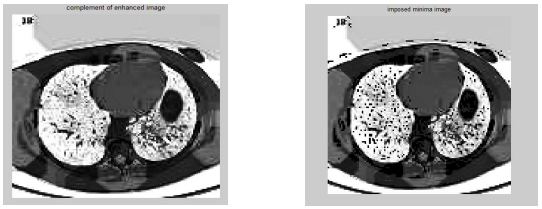
iii)Watershed Algorithm

The watershed algorithm is more representative in the application of mathematical morphology theory for image segmentation. Watershed algorithm is a region based segmentation techniques image that uses image morphology [7]. Watershed algorithm is an iterative adaptive threshold algorithm. The idea of watershed algorithm is from geography,it see gradient magnitude image as a topographic map, the gradient magnitude in correspond with altitude, the different gradient in correspond with the peak and basin in valley in the image. It sees every object of image (including background) as a separate part and requested there must have one tag at least in the each object (or seed points). Marker is knowledge about the object based on application-oriented; it is selected by the operator manually or by automatic process.The objects can use watershed algorithm to transform and develop regional growth after maker.The input and output images of watershed algorithm are shown in figure 3



(a) **(b)**

(c) **(d)**



(e) **(f)**

Figure 3: Whatershed Algorithm(a)Original image (b)Top-hat image(c)Bottom-hat image(d)Original+Top-hat-Bottom-hat(e)Complement of enhanced image(f)imposed minima image

iv)Clustering Algorithms

Segmentation process is also known as cluster analysis and is a widely studied area in statistics. The goal of clustering is to group data into clusters such that the similarities among data members within the same cluster are maximal while similarities among data members from different clusters are minimal. Segmentation is also considered as a clustering problem when it is thought that pixels assign to clusters by means of similarities of some image attributes such as color, texture, histogram, intensity, form factor and etc. In this context, clustering algorithms are used for image segmentation in literature. Clustering algorithms are generally classified as hierarchical and partitioning clustering [7]. While partitioning methods assign data to predefined clusters directly, hierarchical methods assign data to hierarchical datasets which are penetrated with each other. In hierarchical clustering, clustering process can perform by beginning from single sets to a universal set that includes all data or vice versa. The first case is called agglomerative and the second one is called divisive hierarchical clustering. In contrast to hierarchical methods, while the clusters that are appropriate to some criteria given by users are creating, the number of clusters to be obtained has to be certain. Partitional algorithms are faster than hierarchical algorithms. Because a similarity-distance matrix is not necessary to use. Therefore they are more suitable than hierarchical methods in clustering of large databases. In this study, the usage of clustering algorithms with the aim of image segmentation is considered and gray-level values of pixels are used as measure of quality for clustering. Thus regions of interest in the image can be extracted.

Respectively K-means, FCM, PSO-based clustering and ABC-based clustering algorithms are introduced here.

***The K-means Algorithm (*Hard Clustering)**

The K-means algorithm is an iterative technique that is used to partition an image into *K* clusters. The basic algorithm is:

1. Pick *K* cluster centers, either randomly or based on some heuristic
2. Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster center
3. Re-compute the cluster centers by averaging all of the pixels in the cluster

4. Repeat steps 2 and 3 until convergence is attained (e.g. no pixels change clusters)

In this case, distance is the squared or absolute difference between a pixel and a cluster center. The difference is typically based on pixel colour, intensity, texture, and location, or a weighted combination of these factors. *K* can be selected manually, randomly, or by a heuristic. This algorithm is guaranteed to converge, but it may not return the optimal solution. The quality of the solution depends on the initial set of clusters and the value of *K*.

Hard clustering assumes sharp boundaries between clusters [11]; apixel belongs to one and only one cluster. A popular and well knownhard clustering algorithm is K-means clustering algorithm K-means algorithm is the most well-known and widely-used unsupervised clustering technique in partitional clustering algorithms. Purpose of this algorithm is to minimize the distances of all the elements to their cluster centers [3, 11].
Most of the algorithms in this field are developed by inspiring or improving k-means. The algorithm upgrades the clusters iteratively and runs in a loop until it reaches to optimal solution.

Performance of K-means algorithm depends on initial values of cluster centers. Therefore the algorithm should be tested for different outcomes with different initial cluster centers by multi-running. The main advantages of this algorithm are its simplicity and low computational cost, which allow it to run efficiently on large data sets. The main drawback is that: K the number of clusters must be determined [10], it does not yield the same result each time the algorithm is executed and the resulting clusters depend on the initial assignments of centroids.
The process is as follow
(i). Randomly choose number of clusters K.
(ii). Compute the histogram of pixel intensities.
(iii). Randomly choose K pixels of different intensities as Centroids.
(iv). Centroids are finding out by calculating mean of pixel values in a region and place Centroids as much far away from each other as possible.
(v). Now, compare a pixel to every Centroid and assign pixel to closest Centroid to form a cluster.

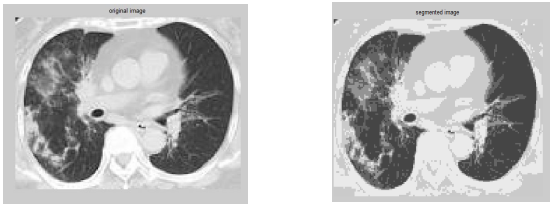
$C^{(i)}= \arg\min \| x^i - \mu \|$

(vi). When all pixels have been assigned, initial clustering has been completed

$$\mu_i = \frac{\sum_{i=1}^{m} 1\{c_{(i)} = j\} x^{(i)}}{\sum_{i=1}^{m} 1\{c_{(i)} = j\}} \qquad (1)$$

(vii). Recalculate position of Centroids in K clusters [11].
(viii). Repeat step 5 & 6, until Centroids no longer move.
(ix). Image separated into K clusters.

The figure 4 shows the input and ouput images of K-Means algorithm



(a) **(b)**

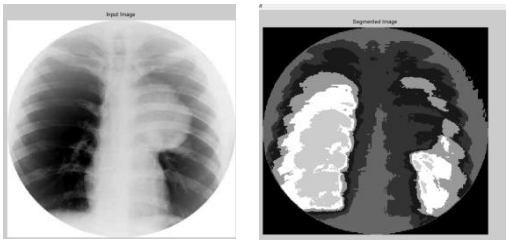
Figure 4:K-Means Algorithm

(a)Original Image(b)Segmented Image

Fuzzy Clustering

In real time applications, one of the most difficult task in image analysis & computer vision is to classify the pixel in an image correctly [11], 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 [11].
.
FCM assign pixels to each class by means of membership function.Let us suppose
X =(x1 ,x2 ,x3-------xn) Denotes an image with N pixels which is to be divided into C clusters, FCM follows an iterative process which minimize following objective function–ijm ||xj – vi ||
Where, u_{ij}^{m} = membership function of pixel xj in ith cluster
Vi is the centre pixel of i^{th} cluster
m is the fuzzifier that controls the fuzziness of resulting clusters & lies between $1<m\leq\infty$
The membership function and cluster centers are updated, the cluster cen ters can either be initialized randomly or by an approximation method.
Disadvantage of FCM is that for noisy images it does not take into account spatial Information , which makes it sensitive to noise & other image artifacts. As FCM cluster assignment is based on
distribution of pixel intensity, it makes it sensitive to intensity variations in the illumination. To overcome these drawbacks of FCM , several other algorithms are introduced as modified FCM,
GSFCM (Generalized spatial FCM), mean shift based FCM,FLICM (fuzzy logic information C-means clustering algorithm),NFCM (novel FCM) , ISFCM (improved spatial FCM)

The figure 5 shows the input and ouput images of Fuzzy C-Means algorithm



(a) **(b)**

Figure 5:Fuzzy C-Means Algorithm (a)Original Image,b.Segmented Image

III CONCLUSION

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image .Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Due to the importance of image segmentation a number of algorithms have been proposed but based on the image that is inputted the algorithm should be chosen to get the best results. In this paper the various algorithms that are available for gray scale images are studied

REFERENCES

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

[2] Aparna Kanakatte, Jayavardhana Gubbi Nallasamy Mani, Tomas Kron_, David Binns" A Pilot Study of Automatic Lung Tumor Segmentation from Positron Emission Tomography Images using Standard Uptake Values" *Proceedings of the 2007 IEEE Symposium on Computational Intelligence in Image and Signal Processing (CIISP 2007)*

[3] Almas Pathan1, Bairu.K.saptalkar " Detection and Classification of Lung Cancer Using Artificial Neural Network" *International Journal on Advanced Computer Engineering and Communication Technology Vol-1 Issue:1 :ISSN 2278 – 5140*

[4] Rachid Sammouda, Jamalabu Hassan and Mohammed Sammouda"Ct Image Analysis For Early Detection Of Lung Cancer" *ICIC International °c 2008 ISSN 1349-4198Volume 4, Number 11, November 2008 pp. 2847—2860*

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

[6] C. Zhu, J. Ni, Y. Li, G. Gu,"General Tendencies in Segmentation of Medical Ultrasound Images", *International Conference on ICICSE, pp. 113-117, 2009.*

[7] S.Naz, H. Majeed, H. Irshad,"Image Segmentation using Fuzzy Clustering: A Survey", *International Conference on ICET, pp.181-186, 2010*

[8] B. C. Wei, R. Mandava,"Multiobjective optimization Approaches in Image Segmentation- the Direction and Challenges", *ICSRS Publication, 2010.*

[9] K. K. Singh, A. Singh,"A Study of Image Segmentation Algorithms for Different Types of Images", International Journal of Computer Science Issues, Vol. 7, Issue 5, 2010.

[9] Preeti Aggarwal, Renu Vig Sonali Bhadoria, C.G.Dethe "Role of Segmentation in Medical Imaging: A Comparative Study**"** *International Journal of Computer Applications (0975 – 8887) Volume 29– No.1, September 2011*

[10] PunamThakare "A Study of Image Segmentation and Edge Detection Techniques" *International Journal on Computer Science and Engineering (IJCSE)*

[11] Rajeshwar Dass, Priyanka, Swapna Devi"Image Segmentation Techniques"*JECT Vol. 3, Issue 1, Jan. - March 2012 ISSN : 2230-7109 (Online) | ISSN : 2230-9543 (Print)*

[12] Tahir Sag, Mehmet Cunkas," Development Of Image Segmantation Techniques Using Swarm Intelligence (Abc-Based Clustering Algorithm For Image Segmentation)"*ICCIT 2012*

[13] Almas Pathan1, Bairu.K.saptalkar, "Detection and Classification of Lung Cancer Using Artificial Neural Network" *International Journal on Advanced Computer Engineering and Communication Technology Vol-1 Issue:1 :ISSN 2278 – 5140*

[14] K. M. Murugesan, S. Palaniswami, "Hybrid Exponential Particle Swarm Optimization Competitive Learning Algorithm for Image Segmentation" *European Journal of Scientific Research ISSN 1450-216X Vol.73 No.1 (2012), pp. 119-125*

[15] Siddhartha BhattacharyyaA Brief "Survey of Color Image Preprocessing and Segmentation Techniques"*Journal of Pattern Recognition Research 1 (2011) 120-129*

[16] Paresh Chandra Barman, Md. Sipon Miah, Bikash Chandra Singh and Mst. Titasa Khatun "Mri Image Segmentation Using Level Set Method and Implement An Medical Diagnosis System"*Computer Science & Engineering: An International Journal (CSEIJ), Vol.1, No.5, December 2011*

[17] Dongxiang CHI1,†, Weizhong CHENG2 "A Hybrid Clustering Method for Automatic Medical Image Segmentation" *Journal of Computational Information Systems 6:6(2010)*

[18] Withey and Z.J. Koles "Three D.J. Generations of Medical Image Segmentation: Methods and Available" Software *International Journal of Bioelectromagnetism,*Vol. 9 No. 2 2007

[19] Siddhartha Bhattacharyya "A Brief Survey of Color Image preprocessing and Segmentation Techniq ues" *Journal of Pattern Recognition Research 1 (2011) 120-129 1*

[20] Dr.S.V.Kasmir Raja, A.Shaik Abdul Khadir, Dr.S.S.Riaz Ahamed. " Moving Toward Region-Based Image Segmentation Techniques: A Study" *Journal Of Theoretical And Applied Information Technology*

[21] Jaime S. Cardoso, and Luís Corte-Real "Toward a Generic Evaluation of Image Segmentation*"* *Ieee Transactions On Image Processing, Vol. 14, No. 11, November 2005*

[22] S.L.A. Lee, A.Z. Kouzani, and E.J. Hu"Empirical Evaluation of Segmentation Algorithms for Lung Modelling"1*-4244-2384-2/08/$20.00_c 2008 IEEE*

BIOGRAPHY

Ms.K.Kothavari: She has completed Bachelor Of Engineering in Electronics &Communication Engineering by 1990 from Madurai Kamaraj University. She received Master Of Electronics Engineering in Applied Electronics by 2004 from PSG College of Technology, Coimbatore under Anna University, Chennai, She is pursuing P.hD in Image Processing. She is currently working as Associate Professor in Dr NGP Institute of Technology, Tamilnadu, India. She has 12years experience