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Image Segmentation Techniques for Medical Images

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Abstract- Image segmentation is the process of partitioning an image into multiple segments, so as to change the representation of an image into something that is more meaningful and easier to analyze. Several general-purpose algorithms and techniques have been developed for image segmentation. This paper describes the different segmentation techniques used in the field of MRI Image Processing. This paper investigates and compiles some of the technologies used for image segmentation.

Keywords- *Segmentation, MRI*

1. Introduction

Images are considered as one of the most important medium of conveying information, which can be used for navigation of robots, extracting malign tissues from body scans, detection of cancerous cells, and identification of an airport from remote sensing data. Now there is a need of a method, with the help of which, we can understand images and extract information or objects, image segmentation fulfill above requirements. Thus, image segmentation is the first step in image analysis. Some time image de noising is done before the segmentation to avoid from the false contour selection .To segment the image without loss of information for medical diagnosing purpose is a challenging job. The purpose of writing this paper is to provide a literature review in this arena.

The remainder of this paper is organized as below; section 2 introduces the term image segmentation. Section 3 describes the current image segmentation techniques and section 4 concludes overall study.

2. Image Segmentation

Image segmentation refers to the process of partitioning a digital image into multiple segments i.e. set of pixels, pixels in a region are similar according to some homogeneity criteria such as color, intensity or texture, so as to locate and identify objects and boundaries in an image [1]. Practical application of image segmentation range from filtering of noisy images, medical applications (Locate tumors and other pathologies, Measure tissue volumes, Computer guided surgery, Diagnosis, Treatment planning, study of anatomical structure), Locate objects in satellite images (roads, forests, etc.), Face Recognition, Fingerprint Recognition, etc. Many segmentation methods have been proposed in the literature. The choice of a segmentation technique over another and the level of segmentation are decided by the particular type of image and characteristics of the problem being considered.

3. Current Segmentation Techniques

The Research on Image segmentation for many years has been a high degree of attention. Thousands of different segmentation techniques are present in the literature, but there is not a single method which can be considered good for different images, all methods are not equally good for a particular type of image .Thus, algorithm development for one class of image may not always be applied to other class of images. Hence, there are many challenging issues like development of a unified approach to image segmentation which can be applied to all type of images, even the selection of an appropriate technique for a specific type of image is a difficult problem. Image segmentation approaches are currently divided into following categories, Thresholding, region growing, classifiers, clustering, Markov random field models, artificial neural networks, model based segmentation and atlas guided approach.

A. Thresholding Method

Image segmentation by Thresholding is a simple but powerful approach for segmenting images having light objects on dark background [1]. Thresholding technique is based on characteristics of image [4]. Thresholding operation convert a multilevel image into a binary image i.e., it choose a proper threshold T, to divide image pixels into several regions and separate objects from background. Any pixel (x, y) is considered as a part of object if its intensity is greater than or equal to threshold value i.e., $f(x, y) \geq T$, else pixel belong to background [3, 11]. As per the selection of Thresholding value, three types of Thresholding methods are in existence [12], global, local

and dynamic Thresholding. When *T* depends only on f(x,y) (in other words, only on gray-level values) and the value of *T* solely relates to the character of pixels, this Thresholding technique is called global Thresholding technique . There are a number of global Thresholding techniques such as: minimum Thresholding, Otsu, optimal Thresholding, histogram concave analysis, iterative Thresholding, entropy-based Thresholding, Mom-keeping Thresholding and so on. If threshold *T* depends on both f(x, y) and p(x,y), this Thresholding is called local Thresholding [5]. This method divides an original image into several sub regions, and chooses various thresholds *Ts* for each sub region reasonably. After Thresholding, discontinuous gray levels among sub images must be eliminated by gray level filtering technique. Main local Thresholding techniques are simple statistical Thresholding, 2-D entropy-based Thresholding, histogram-transformation Thresholding etc. If, in an image, there are several objects taking up different gray level regions, the image should be partitioned with vary dynamic thresholds (*T1*、*T2*、… *Tn)* [5], depending on f(x, y), *p(x, y)* and the spatial coordinates *x* and *y*.

In general, dynamic Thresholding techniques include Thresholding Image, Watershed, and interpolatory Thresholding and so on. Thresholding methods can fail if the background illumination is uneven. In local Thresholding, multiple thresholds are used to compensate for uneven illumination [8]. Threshold selection is typically done interactively however it is possible to derive automatic threshold selection algorithms. Limitation of Thresholding method is that, only two classes are generated, and it cannot be applied to multichannel images. In addition, Thresholding does not take into account the spatial characteristics of an image due to this it is sensitive to noise [4], as both of these artifacts corrupt the histogram of the image, making separation more difficult.

B. Region Based Segmentation Methods

Compared to edge detection method, segmentation algorithms based on region are relatively simple and more immune to noise [4, 6]. Edge based methods partition an image based on rapid changes in intensity near edges whereas region based methods, partition an image into regions that are similar according to a set of predefined criteria [10]. Segmentation algorithms based on region mainly include following methods:

1. Region Growing

Region growing is a procedure [3] that group's pixels in whole image into sub regions or larger regions based on predefined criterion [13]. Region growing can be processed in four steps :-(i). Select a group of seed pixels in original image [7]. (ii) Select a set of similarity criterion such as grey level intensity or color and set up a stopping rule. (iii). Grow regions by appending to each seed those neighboring pixels that have predefined properties similar to seed pixels. (iv). 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, shape of the region being grown).This type of segmentation technique is a kind of iterative algorithms so its drawback is that it requires lot of computational time. It also requires manual interaction to obtain the seed points .Thus for each region that needs to be extracted a seed must be planted.

2. Region Splitting and Merging

Rather than choosing seed points, users can divide an image initially into a set of arbitrary, unconnected regions and then merge and/or split the regions in an attempt to satisfy the conditions of reasonable image segmentation. This segmentation algorithm is called region splitting and merging. Region splitting and merging is usually implemented with theory based on quad tree data. Let R represent the entire image region and select a predicate Q (i). We start with entire image if Q(R) = FALSE [1], we divide the image into quadrants, if Q is false for any quadrant that is, if Q (R_i) = FALSE, We subdivide the quadrants into sub quadrants and so on till no further splitting is possible. (ii). If only splitting is used, the final partition may contain adjacent regions with identical properties. This drawback can be remedied by allowing merging as well as splitting i.e. merge any adjacent regions R_J & Rk for which, Q (Rj U R_K) = TRUE (iii). Stop when no further merging is possible.

C. Classifiers

Classifier methods are pattern recognition techniques that seek to partition a feature space derived from the image using data with known labels. A *feature space* is the range space of any function of the image, with the most common feature space being the image intensities themselves. Classifiers are known as *supervised* methods since they require training data that are manually segmented and then used as references for automatically segmenting new data. There are a number of ways in which training data can be applied in classifier methods.

1. Non Parametric Classifiers

These do not depend on any assumptions about the statistical data structure. Some examples of non parametric classifiers include KNN (K-nearest neighbor) classifier: Each pixel is classified in the same class as the training

datum that has the nearest intensity. Parzen window classifier: The classification is made according to the majority of the pixels confined within a predefined window of the feature (for example, intensity) centered at the unlabeled pixel intensity.

2 Parametric Classifiers

These work with the assumption that pixels intensities are independent samples from a mixture of probability distributions, usually Gaussian. Bayes classifier is a parametric classifier. It is based on a probabilistic model specification .The disadvantage of classifier is that they generally do not perform any spatial modeling another disadvantage is the requirement of manual interaction for obtaining training data training sets can be acquired for each image that requires segmentation but this is time consuming and laborious.
They are non iterative computationally efficient and can be applied to multichannel images. Disadvantage is that they do not perform any spatial modeling and manual interaction is required for obtaining training data.

D. Clustering

K-means starts by partitioning the input pixels into k initial clusters. It then calculates The mean pixel, or centroid, of each cluster. It constructs a new partition by associating each point with the closest centroid. Then, the centroids are recalculated for the new clusters, and the algorithm is repeated by alternate application of these two steps until convergence, which is obtained when the pixels no longer switch clusters (or alternatively centroids are no longer changed),

In FCM, each pixel has a degree of belonging to a number of clusters, as in the fuzzy logic, rather than belonging completely to just one cluster, which is the case in K-means. Thus, pixels on the edge of a cluster may be in the cluster to a lesser degree than pixels in the center of cluster. In other words, FCM allows labels to be -"fuzzy," that is, a pixel can be partially in one cluster and partially in others.FCM can also provide information on how well a pixel"fits" a cluster. Since in clustering techniques there is no need for training data, they are termed as unsupervised Techniques [19].Although clustering algorithms do not require training Clustering is an unsupervised learning task, where one needs to identify a finite set of categories known as clusters to classify pixels [17]. Clustering use no training stages rather train themselves using available data.

Clustering is mainly used when classes are known in advance. A similarity criteria is defined between pixels [2], and then similar pixels are grouped together to form clusters. The grouping of pixels into clusters is based on the principle of maximizing the intra class similarity and maximizing the inter class similarity. The quality of a clustering result depends on both the similarity measure used by the method and its implementation. Clustering algorithms are classified as K- means clustering, fuzzy clustering and the expectation-maximization (EM) algorithm.

1. K-Means Clustering

Hard clustering assumes sharp boundaries between clusters [18]; a pixel belongs to one and only one cluster. A popular and well known hard clustering algorithm is K-means clustering algorithm [17]. K-means algorithm is a clustering technique to partition n pixels into k clusters, where k < n. K-means algorithm is a clustering technique [17], which classify pixels in an image into K number of clusters, where K is a positive integer, according to some similarity feature like grey level intensity of pixels and distance of pixel intensities [2], from centroid pixel intensity. 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 number of clusters K must be determined [23], 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 found 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 (vi) . When all pixels have been assigned, initial clustering has been completed. (vii). Recalculate position of Centroids in K clusters [20]. (viii). Repeat step 5 & 6, until Centroids no longer move.(ix). Image separated into K clusters. 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 [19]. 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 [19].

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, uij m = membership function of pixel xj in ith cluster Vi is the centre pixel of ith 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 centers 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 EM algorithm applies the same clustering principles with the underlying assumption that the data follows a Gaussian mixture model. It iterates between computing the posterior probabilities and computing maximum likelihood estimates of the means, covariance, and mixing coefficients of the mixture model The EM algorithm has demonstrated greater sensitivity to initialization than the k -means or fuzzy c -means algorithms

E. Mark of Random Field Modeling

Markov random fields are used extensively in model based approaches, under the Bayesian paradigm, are implemented through Markov chain Monte Carlo**.** Markov random field (MRF) modeling itself is not a segmentation method but a statistical model which can be used within segmentation methods. MRFs model spatial interactions between neighboring or nearby pixels. These local correlations provide a mechanism for modeling a variety of image properties. In medical imaging, they are typically used to take into account the fact that most pixels belong to the same class as their neighboring pixels. In physical terms, this implies that any anatomical structure that consists of only one pixel has a very low probability of occurring under a MRF assumption. MRFs are often incorporated into clustering segmentation algorithms such as the ÿ - means algorithm under a Bayesian prior model. The segmentation is then obtained by maximizing the *a posteriori* probability of the segmentation given the image data using iterative methods such as iterated conditional modes or simulated annealing**.**

F. Segmentation Based on Artificial Neural Network

Artificial neural networks (ANNs) are massively parallel networks of processing elements or nodes that simulate biological learning. Each node in an ANN is capable of performing elementary computations. Learning is achieved through the adaptation of weights assigned to the connections between nodes. Neural Network based segmentation is totally different from conventional segmentation algorithms. In this, an image is firstly mapped into a Neural Network. Where every Neuron stands for a pixel , thus image segmentation problem is converted into energy minimization problem. The neural network was trained with training sample set in order to determine the connection and weights between nodes. Then the new images were segmented with trained neural network, for example, we can extract image edges by using dynamic equations which direct the state of every neuron towards minimum energy defined by neural network.

Neural network segmentation includes two important steps feature extraction and image segmentation based on neural network. Feature extraction is very crucial as it determines input data of neural network, firstly some features are extracted from the images, such that they become suitable for segmentation and then they are fed as the input to the neural network. All selected features compose of highly non-linear feature space of cluster boundary. Neural network based segmentation have three basic characteristics :- (i). Highly parallel ability and fast computing capability, which makes it suitable for real time application (ii) unrestricted nonlinear degree and high interaction among processing units, which make this algorithm able to establish modeling for any process Improve the segmentation results when the data deviates from the normal situation [16]. (iii). Robustness making it insensitive to noise. (iv). Reduced requirement of expert intervention during the image segmentation process. However there are some drawbacks of neural networks based segmentation, such as:-(a). Some kind of segmentation information should be known beforehand. (b). Initialization may influence the result of image segmentation. (c). Neural network should be trained using learning process beforehand (d), the period of training may be very long, and we should avoid overtraining at the same time.

G. Model Based Segmentation

Model based segmentation proceed in two stages. Initialization followed by an optimization stage. There are two basic ways of deforming a shape by deforming the embedding space of a shape and by modifying their parameters or degree of freedom.(DOF)first method is called registration approach it is achieved by applying rigid transform(i.e. rotation and translation)and second method is called deformable model approach it is achieved by modifying the vertex position of mesh .It delineates region boundaries using closed parametric curves or surface that deform under the influence of internal and external forces. To delineate an object boundary in an image, a closed curve or surface is first placed near the desired boundary and is allowed to undergo iterative relaxation process. Internal forces are computed from within the curve or surface to keep it smooth throughout the deformation. External forces are usually derived from the image to drive the curve or surface towards the desired feature of interest the main advantage of deformable model are their ability to directly generate closed parametric curves or surfaces from images they are robust to noise and spurious edges disadvantage is that they require manual interaction to place an initial model and choose appropriate parameters.

H. Atlas Guided Approach

When compared to other methods for image segmentation, the atlas-based segmentation has an ability to segment the image with no well defined relation between regions and pixels' intensities. This can be due to lack of the border or excessive noise or in the case when the objects of the same texture need to be segmented. If the information about difference between these object is incorporated in spatial relationship between them, other objects, or within their morph metric characteristics, the atlas-based segmentation is expected to work well. Another important advantage of atlases is in their use in clinical practice, for computer aided diagnosis whereas they are often used to measure the shape of an object or detect morphological differences between patient groups. On the other hand the disadvantage of an atlas-based can be in the time necessary for atlas construction wherever iterative various techniques for atlas construction are developed for different human organs, like heart and especially the brain.

4. Conclusion

This paper presents the most common methods of image segmentation highlighting the strengths and weaknesses with respect to suitability for medical image segmentation applications.

References

1. Dr. S.V Kasmir Raja, A, Shaik Abdul Kadir,"Moving towards region –based image segmentation techniques –a study ", Journal of theoretical and applied information technology,
2. 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, vol2, no.3, sept 2009"
3. Dr.S.Padamavati, Dr.P.Subashini, Mrs.A.Sumi," Empirical Evaluation of suitable segmentation algorithm for IR Images", IJCSI, Vol7, Issue4, No.2, July2010
4. S.L.A Lee, A.Z.Kouzani, E.J.Hu," Empirical Evaluation of segmentation algorithms for lung modeling", 2008 International conferences on systems, man and cybernetics (SMC 2008)
5. Hossein Mobahi,Shankar R.Rao, Allen.Y.Yang, Shanker.S.Sastry, Yi Ma," International journal of computer vision
6. Jifeng Ning,Lei Zhang, David Zhang,Chengke Wu," Interactive image segmentation by maximal similarity based region merging", Pattern recognition 43(2010)445-456.
7. Francisco J.Estrada and Allan D. Jepson," Quantitative Evaluation of a novel image segmentation algorithm.
8. K.Selvanayaki,Dr.M.Karnan," CAD system for automatic detection of brain tumor through magnetic resonance image –a review., International journal of engineering science and technology vol 2(10)2010,5890-5901.
9. Anjum Sheikh, R.K.Krishna, Subroto Dutt," Energy efficient approach for segmentation of brain tumor using ant colony optimization", ijctee volume 1,I ssue3.
10. Alejandro Veloz, Antonio Orellana, Juan Vielma, Rodrigo Salas and Steren Chabert," Brain tumors: How can images and segmentation techniques help?".
11. Michael R Kaus, Simon K warefield," Automated segmentation of MRI of brain tumors".
12. Bhagwati Charen Patel and GR Sinha," Comparative performance evaluation of segmentation methods in breast cancer images", IJMI 0975-2927 Volume3 Issue 3 2011,130-133
13. Allan Hanbury, Julian Stottinger," On segmentation evaluation metrics and region count"
14. Qingqiang Yang, Wenxiong Kang," General research on image segmentation algorithms", I.J Images, graphics and signal processing 2009, 1, 1-8.

15. B.Sathya, R.Manavalan," Image segmentation by clustering methods: performance analysis", International Journal of computer applications vol 29-no 11, sept 2011.
16. Rajeshwar Dass,Priyanka, Swapna Devi," Image segmentation techniques", IJCET VOL3 Issue 1 Jan 2012'
17. Zhou Wang, Alan C.Bovik, Hamid .R.Sheikh, Eero. P.Simoncelli," Image quality assessment: from error visibility to structural similarity", IEEE Transactions on image processing, vol.13 no.4, April 2004.
18. Ritu Agrawal, Prof. Manisha Sharma," Comparison and analysis of fuzzy clustering techniques for color image segmentation in terms of PSNR and accuracy", International journal of advanced research in computer science vol 2, no. 6 Nov-Dec 2011.
19. Malik Sikander Hayal Khiyal, Aihab Khan and Amna Bibi," Modified watershed algorithm for segmentation of 2D images", Information Science and information technology, vol. 6, 2009.
20. Bjoern H Menze, Koen Van Leempul, Danial Lashkari," A generative model for brain tumor segmentation in multi-modal images"
21. Vijay Kumar Chinnadurai, Gharpure Damayanti Chandrashekhar," Improvised levelset method for segmentation and grading of brain tumors in dynamic contrast susceptibility and apparent diffusion coefficient magnetic resonance images", International journal of engineering science and technology , vol.2(5), 2010, 1461-1472.
22. Kaihua Zhang, Huihuisong, Lei Zhang," Active contours driven by local image fitting energy", Pattern recognition October 2009.
23. Kaihua Zhang, LeiZhang, Huihuisong, Wengang Zhou," Active contours with selective local or global segmentation: A new formulation and levelset method"
24. T.Logeswari and M. Karnan ," An enhanced implementation of brain tumor detection using segmentation based on soft computing", International journal of computer theory and Engineering vol.2, no. 4 Aug 2010,1793-8201.
25. Li Wang, Chunming Li, Quansen sun,Deshen Xai and Chiu-Yen Kao,"Brain MR Image Segmentation using local and global intensity fitting active contours/surfaces"
26. Chunming Li, Chiu-Yen Kao,JohnC .Gore and Zhaohua Ding,"Implicit active contours driven by local binary fitting energy"
27. Hassan Khotanlou, Olivier Colliot, Jamal Atif and Isabella Bloch,"3D brain tumor segmentation in MRI using fuzzy classification, symmetry analysis and spatially constrained deformable models", Fuzzy sets and systems 160(2009)1457-1473.
28. Chuin-Mu Wang, Ruey –Maw Chen,"Vector seeded region growing for parenchyma classification in brain MRI" , International journal of advancements in computing technology", volume 3, no.2, March2011.
29. K.Aloui and M.S Naceur,"3D brain tumor segmentation using level sets method and meshes simplification from volumetric MR images."' World academy of science, Engineering and technology 57, 2009.
30. Jianbo Shi and Jitendra Malik," Normalized cuts and image segmentation ", IEEE transaction on pattern analysis and machine intelligence vol.22, no. 8 Aug 2000.
31. T.Logeswari and M.Karnan,"An improved implementation of brain tumor detection using segmentation based on soft computing", Journal of cancer research and experimental oncology vol2 (1) pp006-041, Mzrch2010.
32. P.Tamijeselvy, V.Palanisamy, T.Purusothaman," Performance analysis of clustering algorithms in brain tumor detection of MR Images, European journal of scientific research ,I SSN1450-216X,VOL.62.No.3(2011), 321-330.