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Medical Image Segmentation Approaches: A Survey

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Abstract

Segmentation is an important preprocessing step in medical image analysis. Its main aim is to partition the image areas into several regions concerning similar distinctiveness such as texture, color, and intensity. It has been widely useful in many purposes such as recognition of tumors and coronary borders, planning for surgery, measuring the tumor volume, blood cell classification, and extraction of heart image from cardiac cine angiograms. In recent years, for the medical image, many approaches have been proposed for the segmentation process. Thresholding, region-based, edge-based, and clustering-based methods are the important segmentation process techniques for medical image analysis. This paper studies the different types of segmentation approaches that have been used in medical imaging frameworks.

Keywords — *Segmentation, Medical image, Speckle noise, Fuzzy Clustering Technique***.**

I. INTRODUCTION

In medical image processing, segmentation is an important part of studying or analyzing an image in a proper way. The segmentation process is to divide an image into numerous sections depending upon the factors like textures, colors, and grayscale value. In general, there is no particular rule for image segmentation. Hence it is obvious that various general purposed ideas are accessible for segmentation, which in turn direct to different studies on medical image segmentation. The process of image segmentation drives the image area into different regions that are accessible, definable, profitable, and actionable. And those regions, too, can be analyzed separately with no interface among them. Based on the performance, the segmentation process is classified into five different methods, as illustrated in the following figure1.

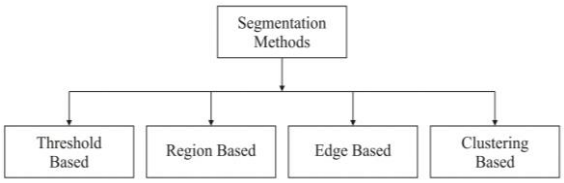

Fig.1 Segmentation Methods

Image segmentation plays an important role in many fields such as hospitals, industries, and wireless devices. Mainly it can be broadly utilized in fingerprint and face recognition technologies. In medical image processing, it is very useful to know the anatomical structure, size, and location of a tumor and the measurement of tissue volume. Because of the wide requirement of image segmentation, the researchers always discover innovative approaches by mixing the best technique from various algorithms or methods. And also, they try to create the required outcome as accurately as possible.

II. THRESHOLD BASED METHOD

Thresholding is always considered the earliest technique where binary segmentation takes place. It means that the input image is classified into two different regions such as foreground and background. Establishing a threshold value of more than one is called as multi thresholding method [1]. The segmentation results for thresholding are based on the image characteristics and how the threshold value is decided. Thresholding techniques fail to consider the spatial relationships among the characteristics in an image and are very responsive to noise. These issues mostly happen in MRI images, which obliterate the histogram and create the partitioning more complicate [2]. Global thresholding is suitable only for the image which has a bimodal histogram. It does not produce good results for the images with no constant background and variety across the object. The local threshold method first divides the image into sub-images and then calculates the threshold value for each of them. Finally, the thresholding results of each part of the image are merged. In this method, for each sub-image, different statistical

techniques such as mean of minimum and maximum, mean and standard deviation are utilized to allocate the threshold value. When compared to other traditional methods, it takes more time for segmenting process. But it is more suitable for images with diverging backgrounds.

III. REGION BASED METHOD

The users need to define a sort of seed pixels to start the region growing methods. Then they examine the neighboring of the seed pixels to observe that the neighboring should be included in the region, which protects the same connectivity and uniformity criteria [3]. Region-based methods always consider the information of neighborhood pixels, and therefore, they are vigorous to noise compared to traditional methods. However, they are sensitive in choosing the Seed location and pixel connectivity type [4].

IV. EDGE BASED METHOD

Edge detection plays an important and fundamental role in medical image analysis, processing, pattern recognition, and computer-oriented techniques. Commonly, the boundary among two regions of an image is considered as an edge. Mostly edges and region boundaries intimately related to each other. Occasionally in some images, a sharp intensity adjustment is needed for the region boundaries. The main purpose of utilizing edge detectors in a digital image is to identify the points at which more brightness and discontinuities happen. Once the edge detection task is completed, then the consequence, therefore, is considerably simplified. Edge detection is a basic tool in machine and computer vision, image processing, mainly in feature detection and extraction. The two important methods in edge detection are zero-crossing-based and search-based. The zero-crossing methods estimate the edge smoothness using the Laplacian operator. In search-based methods, direction and position of edges are detected by calculating gradient magnitude employing the first-order differential method.

V. CLUSTERING BASED METHOD

Clustering is an unsupervised process of sorting a set of entities into groups of similar features. It has been widely used in many fields such as statistics, machine learning, geology, medicine, and engineering systems [5]. Different clustering algorithms are available in the literature. Among them, Gustafson- Kessel, fuzzy algorithm, Fuzzy C-Means, and Non-Fuzzy K-Means are considered as most popular algorithms [6].

K-Means algorithm is otherwise known as hard C-Means algorithm. This method runs many times to decrease the sensitivity created by the primary random collection of centroids, which was proposed by Macqueen. This algorithm classifies image data into C Clusters, and each cluster has only one object at a given point of time [7]. Even though this technique is more robust, it has numerous weaknesses such as missing small clusters, sensitivity to outlines, and dependency on initialization.

Different clustering methods are proposed to overcome the above-described drawbacks, for example, C-Means. This method partitions the image data into C-Clusters by compressing data in the alike clusters and dividing data is unlike ones [8]. C-means clustering carries crisp segmentation, which does not consider the fine aspects of hybridization or mixing of data [9]. An additional and most broadly utilized method to decrease the lack of the other clustering model is the fuzzy approach.

Fuzzy set theory is an extension of the classical set and developed in 1965. Fuzzy logic is one of the essential approaches of soft computing technologies. It deals with the vagueness of input data and domain information to provide modest, rapid, and frequently sufficient good estimation of the predictable results [10]. Fuzzy logic differs from probability theory for the cause that it is deterministic instead of probabilistic. Ambiguity is modeled through linguistic variables, fussy sets, inferences, membership functions, and defuzzification. The main advantage of fuzzy logic is (i) economical, (ii) simple to learn, and (iii) simulated with traditional techniques.

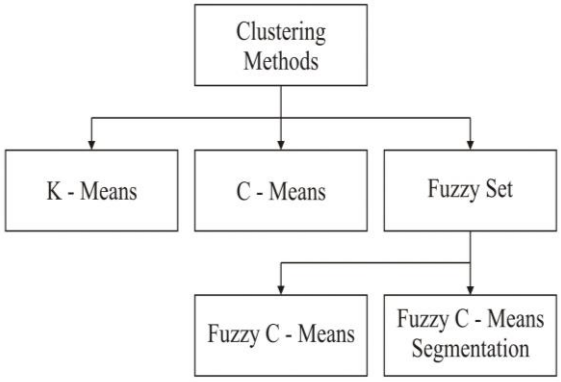

Fig. 2 Clustering Approaches

Fuzzy clustering is also known as the soft segmentation technique. It has been widely learned and successfully used in image classification. Figure 2 shows the different clustering approaches for the segmentation process. Among the fuzzy clustering techniques, the Fuzzy C-Means algorithm is the widespread technique employed in image classification as it has dynamic uniqueness for ambiguity and can recall more information than hard segmentation techniques [11]. FCM has appeared to be a competent approach when it comes to data clustering. In this mechanism, two or more clusters have the same portion. It is considered an effective tool for partial volume effect. However, it has suffered lots of problems such as sensitiveness between classes due to intensity overlap, drifting of

clusters center. FCM algorithm provides a possible automatic image segmentation approach under a situation of fuzziness and vagueness. In addition to this, FCM has provided efficient results for the fields such as machine learning and pattern recognition.

VI. CONCLUSION

After an extensive survey of the segmentation process in medical image analyzing, the most important weakness and strength of applying segmentation technique for resolving medical image processing tasks are being examined. A few interesting potentials for segmentation approaches in the medical image framework are also noticed. Traditional segmentation methods like thresholding, region-based, and edge-based showed incapable of exact segmentation due to low contrast, noise, and image objects complexity. By integrating previous knowledge of objects into fuzzy c means clustering algorithm, researchers produced more robust techniques to segment targeted objects.

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