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MEDICAL IMAGE SEGMENTATION AND CLUSTERING METHODS AND APPLICATIONS –A SURVEY

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Abstract -Medical images have an incredible effect on diagnosis and treatment. The most vital part of image processing is image segmentation. Many image segmentation strategies for medical image analysis have been exhibited in this paper. In this paper, we have portrayed the most recent segmentation techniques connected in medical image analysis. Computed Tomography (CT) and Magnetic Resonance (MR) imaging are the most widely used radiographic techniques in diagnosis, clinical studies and treatment. This paper gives the details of various segmentation methods, discussed in the context of CT and MR images. The motive is to discuss the problems encountered in segmentation of CT and MR images, and their advantages and disadvantages in medical images.
Keywords- Medical image , Segmentation , Computed Tomography , Magnetic Resonance Image.

I. INTRODUCTION

Segmentation methods have been used in medical applications to segment tissues and body organs. Some of the applications consist of border detection in angiograms of coronary, surgical planning, simulation of surgeries, tumor detection and segmentation, brain development study, functional mapping Medical images have become essential in medical diagnosis and treatment. These images play an important role in medical analysis. Many techniques have been developed based on X-ray and cross-sectional images like Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) and ultrasound.

In medical image processing, image segmentation plays a key role. Image segmentation is a process of extracting the region of interest (ROI) through an automatic or semi-automatic process[1]. Many image, blood cells automated classification, mass detection in mammograms, image registration, heart segmentation and analysis of heart images[2].

Modalities of Medical Image Segmentation

Segmentation process has many applications in the medical field. There are different medical modalities which are applied in the segmentation process . The most commonly used modalities are MRI and CT .

MRI

Most of the applications of segmentation in the medical field are carried out on the MRI images. The reason is that these images contain high signal to noise ratio which requires enhancement and segmentation of image to find out the region of interest. Another issue regarding these images is that they contain a variety of resolution because of which segmenting the image with required level of contrast is a great problem. The main applications is this regard are extracting volume of brain, segmenting different issues in matter of grey, white cerebrospinal liquid and to outline precise brain formations[3].

CT

Segmentation process has many applications in the analysis of computed tomography images. The main advantage segmentation process is in the analysis of bones, thoracic scans, and segmentation of heart, stomach, brain and liver images The contrast and resolution of these images is not as good as MRI images. Variety of methods are applicable in the segmentation process of CT images.

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In this paper, we discuss about different segmentation techniques which have been utilized as a part of medical image analysis. Every strategy is explained along with its preferences, and drawbacks. We arrange these strategies in various classifications: region based techniques, clustering techniques, and classifier techniques.

II. REGION BASED METHODS

A region consists of some pixels in which two are neighbours and the boundary is made from differences the of two regions. Most of the image segmentation methods are based on region and boundary properties. Here we explain two most popular region based approaches: thresholding and region growing.

A. Thresholding

Thresholding is one of the simplest and fastest segmentation methods based on the assumption that images are formed from regions with different grey levels. The histogram of images has different peaks and valleys which can divide images into different parts . Threshold is a value in a histogram that divides intensities into two parts: the first part is the "foreground" which has pixels with intensities greater than or equal to the threshold and the second part is the "background" in which pixels have intensities less than the threshold .

An inappropriate threshold value leads to poor segmentation results . To divide more than one object with different grey levels, more than one threshold is used , is known as multithresholding. Thresholding segmentation usually does not consider the spatial information of images which leads to sensitivity to noise and intensity in homogeneities[4]. These problems may occur in MRI images which fundamentally destroy the histogram and make partitioning more complex[5] .

Global thresholding works on the idea that an image has a bimodal histogram and the object can be separated from the background using a threshold value. In the following, local (adaptive) thresholding that uses a local threshold value that uses an automatic threshold value are described.

Local Thresholding :

Global thresholding does not provide satisfactory results for some type of images such as images which do not have a constant background and have diversity across the object. For medical images, thresholding provides a good result in one region but fails in other parts of images . In order to find different threshold values for different parts of images, the local thresholding method divides images into subimages and then calculates the threshold value for each part. The results of thresholding for each part of an image are then merged. In this method, an image is divided into vertical and horizontal lines, whereas each part includes a region of both the background and the object. Finally, an interpolation is needed to produce appropriate results . Different statistical methods are used to select the threshold value for each subimage, for example, mean, standard deviation, mean and standard deviation together, and mean of maximum and minimum. Local thresholding needs more time to segment an image compared to global thresholding. This method is more useful in the case of images with varying backgrounds.

B.Region Growing:

Region growing is an interactive segmentation method which requires some seed points to be initialized and start the process. This technique separates a region of images based on some predefined law according to intensity information. In the simplest form, region growing requires one seed point and the region will be grown based on its homogeneity properties according to neighbouring pixels. There are some region-based methods which have differences in homogeneity criteria[6].

The disadvantage of region growing is that the result of this technique significantly depends on the seed point selection. Selecting a seed point depends on human ability; thus, the extracted shape considerably depends on the user. Although noise sensitivity in this method is less than thresholding, but it can make a hole in the extracted shape or produce a disconnected area. Region growing has been widely used in mammograms in order to extract the potential from its background.

III. CLASSIFICATION METHODS

Searching for patterns in data, called pattern recognition, is a basic problem . Classification is a pattern recognition technique which uses training data[7] to find the patterns. Training data includes a sample of image features with their target labels. This technique is known as the supervised learning technique, because it involves training data which are segmented manually and then given to the automatic process . A number of classifier methods are used for image processing. In this section, two classifiers are explained which are oftenly used: k-nearest-neighbour and maximum likelihood. k-nearest neighbour is a simple classifier method is training and maximum likelihood is a popular parametric classifier method. The disadvantage of these methods is that they do not take into consideration the spatial information. Another problem to data which have be segmented through human interaction. Segmentation of sample data not only takes more time, but also depends on human abilities.

A. k-Nearest Neighbour:

k-nearest-neighbour (k-nn) is a most commonly used classification method. This method is known as a non-parametric method because the k-nn algorithm does not require any information about statistical properties of pixels. The k-nn algorithm needs a large amount of sample data which are known as training data. Each pixel is classified according to the number of nearest neighbours which are done before as training data . In this method , k is the number of nearest neighbours.

B.M aximum –Likelihood (ML):

ML method involves less risk and is capable of providing better results because of minimum error rate. The method requires the features range included in the feature space should contain exact information of the probabilities of features[8].The method is not much applicable because accurate information is not often acquired.

IV. CLUSTERING METHODS

The process of clustering techniques is similar to classification technique which do not require any training data. These techniques are known as unsupervised learning methods. The unsupervised learning algorithm tries to summarize and present their data by applying main features. Many data mining algorithms have been used in clustering. In this section, two clustering methods are presented: k-means, and fuzzy C-mean[9]. Regarding unsupervised methods that do not use learning data, they do not need more time to prepare segmented sample data. One of the advantages of these methods is they consume less time. As a disadvantage, we cannot refer to spatial information. As the classification approach, these algorithms do not accept the spatial information; thus, which are sensitive to noise and intensity in homogeneities .

A. k-means:

k-means is a widely used unsupervised method which partitions the image into k sections based on the mean of each section. First, data are divided into k clusters and then find the mean for each cluster . Each data is put in the cluster which has the nearest distance to the mean of clusters using the Euclidean distance. The input data is a vector and the output is a k vector. In order to apply k-means on MRI images which are two dimensional, pixels should be put in one vector. where k is the number of clusters, Nj is the number of data in a cluster j, and mj is the mean of cluster j and some of square errors which determine the condition of the repeat loop as One of the disadvantages of this method is the number of clusters. Users must select the k value to segment the image. Another problem is sensitivity to outliers, noises, and initial values. The initial values are selected randomly from the data vector.

B. Fuzzy C-mean (FCM) :

FCM clustering is an unsupervised algorithm which can be applied medical images. This technique is based on the mean of each cluster and grouping similar data values in the same clusters. Overlapping usually exists in many grey-scale medical images for different tissues. FCM is one of the suitable clustering methods for medical image segmentation[10]. Several FCM clustering applications have been presented for MRI segmentation of different parts of body.It produces better results even in the case of corrupted images,and also requires less human interaction.

V. CONCLUSION

This paper explains various image processing methods which are widely used in medical image analysis. The techniques and their applications in medical image analysis are been presented. Some are applied in MRI images, like brain images. The procedure of each method helps in selecting the suitable segmentation method. An appropriate segmentation method can be selected based on different parameters like image type, and image characteristics . In region based methods, each technique is has both advantages and disadvantages is been discussed . MRI is more useful than CT imaging for soft tissues. Clustering and classification methods are known as the learning methods, which do not use any spatial or shape information. Clustering techniques need training data to start the procedure and obtaining it is a time consuming and difficult task. Among the clustering methods, fuzzy C-mean has shown better results for different medical accuracy for different medical images .

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