SURVEY ON AN EFFICIENT AUTOMATIC LIVER TUMOR DETECTION FROM CT IMAGES

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Abstract: Liver cancers are one of the most popular cancers occurring now a day. The larger parts of liver carcinomas are because of liquor related cirrhosis and hepatitis. Early detection and diagnosis of liver tumor is important for the prevention of liver tumor. Since the tumor tissues and normal liver tissues have almost same intensity, it is a very difficult and challenging task to detect the liver tumor. For the accurate detection, efficient segmentation and classification methods are essential. Several techniques have been developed for the segmentation of liver tumor. Manual detection of liver tumor requires human interaction and is time consuming. As a result, automation of the tumor detection, segmentation and classification process is essential. This paper reviews different automatic segmentation techniques for the liver tumor detection.

INTRODUCTION

Cancer is one of the common diseases nowadays. According to the statistics the estimated number of people living with cancer in India is about 2 to 5 million. Among the types of cancers, liver cancers are on a hike due to increased alcohol consumption. Also Liver is primary organ that get affected by secondary cancer. The liver tumor can be identified in a CT scan by a difference in pixel intensity from other regions of the liver. Manual detection of liver tumor requires human interaction and is time consuming. Also it depends on the ability of the observer to locate the location, shape and size of the tumor. So, automation of liver tumor detection is essential. Automatic segmentation is a very challenging task due to several factors like, liver stretch over 150 slices in a CT image, intensity contrast between lesions and other nearby liver tissues is almost same and indefinite shape of the lesions.

There are several stages for liver tumor detection. Different stages for liver tumor detection are:

- Preprocessing: Image pre-processing can significantly increase the reliability of an optical inspection. Noise removal is also done here.
- Segmentation: Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.
- Feature Extraction: When the input data to an algorithm is too large to be processed and it is suspected to be redundant then it can be transformed into a reduced set of features also named a feature vector. This process is called feature extraction.
- Classification: Based on the feature vector created the liver segments are classified as either normal or abnormal in the classification stage.

Among these segmentation module plays an important role for the tumor detection. An efficient and accurate segmentation leads to the classification stage. In the segmentation stage the tumor is detected and tumor portion is extracted.

Different segmentation techniques are:

1. Region Growing Method
2. Thresholding Method
3. Clustering Method
4. Graph Cut Method
5. Level Based Segmentation

The rest of the paper describes different segmentation techniques and conclusion.

SEGMENTATION TECHNIQUES

➢ Region Growing Method

In this method, the first step is to manually select the seed points. In the next step, pixels in the region of seeds are examined and added to the region in accordance with the homogeneity criteria. This process is continued until all pixels belong to some region and in last step the object illustration is done by growing regions of pixels. It is a semi automatic technique.

Jayanthi, M., and B. Kanmani,et al.[1] proposes an approach for segmenting liver and tumor using intensity distribution and region growing method. Preprocessing is done first. Here, preprocessing is the combination of contrast enhancement and morphological smoothing. Then the liver is segmented using Region growing method. From the segmented liver, tumors are extracted by thresholding. No feature extraction is performed here. So the false positive rate is very high.

Qi Y., Xiong W., Leow W. K. [6] uses 3-D region growing method for tumor segmentation. Here the intensity distribution of a tumor can be modeled by combining multiple Gaussians. Multiple seed points are placed within the tumor. The mean and standard deviation of the Gaussians are estimated within a cube around the seed pixels. One seed point in the liver is used to estimate the liver's Gaussian. Subsequently, during region growing, the Bayesian decision rule check for every pixel, if its intensity has a greater chance of belonging to liver or tumor tissue based on the Gaussians estimated earlier and classifies it into the most likely class.

➢ Thresholding Method

This is one of simple image segmentation technique. It is the process of separating pixels in to different classes depending on their pixels gray levels. The segmentation is achieved by taking a threshold value. Based on this threshold value, pixels are grouping with intensity greater than the threshold into one class and remaining pixels grouping into another class. The main disadvantage is, using this method only two classes (black and white) are generated and it cannot be applied to multichannel images. MR image contains 0 to 255 gray values. So, thresholding of MR images ignores the tumor cells.

Choudhary A., Moretto N., Pizzorni Ferrarese F. and Zamboni G. [7] use multi thresholding approach for liver tumor segmentation. At first the liver portion got segmented using watershed method from other organs. Once the liver got segmented

it uses multi thresholding technique for the tumor detection. Using the liver data obtained, a Haar Wavelet based de-noising algorithm is used for removing the noise from the liver images. Then a minimum cross-entropy multi-thresholding algorithm segments out the tumors. In order to smoothen the final results the system applies morphological closing and 3D level sets to the bidimensional contours obtained.

- **Clustering Method**

The method of clustering organizes the objects into groups based on some feature, attribute and characteristic. Hence a cluster consists of groups of similar objects. The clustering algorithms are classified in to two categories, exclusive clustering and overlapping clustering. In exclusive clustering, one pixel belonging only one cluster could not belong to another cluster. K-means is an example of exclusive clustering algorithm. In overlapping clustering, one pixel belongs to two or more clusters. Fuzzy C-Means clustering is an example of overlapping clustering algorithm.

Massoptier and Sergio Casciaro [2] use tk-means clustering technique to cluster pixels as belonging to either the liver or tumor tissue. They use the intensity histogram of the segmented liver, decomposed with a Haar wavelet to find the k most represented coefficients. k in this case is two, for liver and tumor tissue. These two coefficients are then used as the centroids of two Gaussian functions used to estimate the intensity histogram. An expectation maximization algorithm is used to assign the pixels to the corresponding cluster.

Yim P. J., Vora A. V., Raghavan D., Prasad R., McAullife M., OhmanStrickland P. and Nosher J.L [3] use Fuzzy-C-Means clustering for liver tumor segmentation. They compared manual segmentation with semi-automatic segmentation using FCM. The algorithm starts with Gaussian smoothing and the manual delineation of a mask, about 0.5 cm outside of the tumor boundary. Then the FCM algorithm is applied with two clusters: liver tissue and tumor tissue.

Kumar S. S., Moni R. S., Rajeesh J. [4] segment the tumor portion in liver using Alternative FCM technique. This method is less sensitive to noise and outlying points, as well as to dissimilar cluster shape and size. Here the liver is segmented using region growing method that starts from a seed point automatically detected and efficiently close around the vessels and tumors and segmentation using AFCM. In AFCM, instead of using the Euclidian distance they use a new distance function, where is β a parameter greater than zero, which is estimated based on the inverse of the variance. This distance function is used to update the membership functions and cluster centers.

- **Graph Cut Method**

The main idea of graph cuts is to represent the image to an undirected weighted graph. Every node represents each pixel of image. Every edge connected a pair of adjacent pixels. The weight of edge indicates the similarly of gray level, colour or texture between each pair. The segmentation is a cut of the graph. Each region represents a subgraph. The best cut is to make the similarity in a subgraph maximum and the similarity between subgraphs minimum. So at first, feature set is extracted from multi-phase contrast enhanced MRI data and color-space mapping is used to reveal spatial-temporal information invisible in MRI intensity images. Then, an efficient tree-metrics graph cut algorithm is applied on multi-phase contrast enhanced MRI data to obtain global optimal labeling using an unsupervised structure. Finally, tree-pruning method is used to reduce the number of available labels for liver tumor segmentation.

Linguraru, Marius George, et al [5] presents a shape constrained graph cut approach for the liver tumor segmentation. This method first segments the liver portion from the CT image. Shape analysis and surface parameterization is done to avoid the shape ambiguities. From the segmented liver, graph cuts are employed to detect and segment hepatic tumors using shape and enhancement constraints. Features are extracted for the tumor candidates and classification is performed using support vector machines.

- **Level Based Segmentation**

Level set is a continuous deformable model method with implicit representation. Its main idea is to embed the deformable model in a d+1 dimensional space, to segment iteratively an object in a d dimensional space, using partial differential equations. The main advantage of level sets is that it allows changes of surface topology implicitly. The original level set method needs re-initialization because the level set function (LSF) typically develops irregularities during its evolution which cause numerical errors and eventually destroy the stability of the level set evolution.

Yang, Xi, et al. [8] presents a robust level set method for image segmentation. Robustness to noise is achieved by embedding a MRF (Markov Random Field) to the level set energy function. The MRF function considers correlation among pixels so that they fall into same category. For fast implementation of this we use SFM (Sparse field Method). This method can segment noisy image in 3s.

CONCLUSION

This paper describes various segmentation techniques for the liver tumor extraction. Each method has its own advantages and disadvantages. So according to the requirement, these techniques can be selected. All the segmentation methods can be categorized to mainly 5 classes including region growing method, thresholding technique, clustering technique, graph cut method and level based technique. In conclusion, we point out that liver segmentation is still an open issue and the tendency is that multiple methods will be employed together to achieve better segmentation performance.

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