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A Systematic Analysis System for CT Liver Image Classification and Image Segmentation by Local Entropy Method

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Abstract

Image Segmentation is an important procedure in many applications of image processing. Computed Tomography (CT) images have been widely used for liver disease systematic analysis approach. The liver segmentation from CT image is the most basic and important technology for the following process. A CT liver image extract the CT liver boundary and further classify liver diseases. The System comprises a Detect Before Extract (DBE) technique which automatically finds the liver boundary. By using the property of local entropy method, a liver CT image segmentation method has been proposed, that can extracts the edge of the liver CT image. Then use the morphological method to detect the object regions. From the contour modification algorithm and local entropy method, can obtain the liver image and to find the cancer location of the liver.

Keywords: ***Computed Tomography, CT image, segmentation, Detect Before Extract, local entropy.***

1. Introduction

Computed Tomography is widely used in medical technology and it is a method of capturing and finding body organs by scanning them with X -rays and using a computer to construct a series of cross-sectional scans. Due to the wide use of medicine image such as computed tomography (CT) and the advent of computer technology, image processing techniques have become increasingly important in a wide variety of applications. Liver cancer is one of the leading cancerous diseases in China, and the liver CT scan examination is the essential method for liver cancer.

In this paper, presents an automatic CT liver image classification system which can be used to detect two types of liver tumor: hepatoma and hemangeoma. As a first step of extracting liver tumors, need to isolate or segment the liver boundary within a CT liver image. A novel approach called the "detect-before-extract" (DBE) technique is proposed. Since the liver is generally accompanied by other organs which present difficulties for liver boundary segmentation, DBE decomposes the process into two stages. The first stage processing is boundary detection and then followed by a second stage processing, boundary extraction. As a second step, introduced the method based local entropy on liver CT image segmentation. First, compute the local entropy of the original image; then use the morphological method to remove small objects, and morphologically close method to smooth the edge; finally, after the edge connectivity and image filling, the image segmentation is completed; so, which can get the region of liver.

2. Related Work

Computer vision and image processing, image segmentation has been and still is a relevant research area due to its wide spread usage and application. Its accuracy of the segmentation [9] is to find as difficult but very elusive is very crucial in areas as medical, remote sensing and image retrieval where it may contribute to save, sustain and protect human life. Existing System provides a survey of achievements, problems being encountered, and the open issues in the research area of image segmentation and usage of the techniques in different areas. They also suggested what must be done in order for researchers to test their techniques performance and to compare them among other segmentation techniques. The main drawbacks of texture description [3] approach are difficult feature extraction and noise tolerance. That can also consider the neighborhood characteristics of liver CT image, and use the texture analysis approach to segmentation.

For active contours [8] to detect objects in a given image, based on techniques of curve evolution, Mumford–Shah functional for segmentation and level sets. It can detect objects whose boundaries are not necessarily defined by gradient. They minimize an energy which can be seen as a particular case of the minimal partition problem. In the level set formulation, the problem becomes a mean-curvature flow-like evolving the active contour, which will stop on the desired boundary. However, the stopping term does not depend on the gradient of the image, as in the classical active contour models, but is instead related to a particular segmentation of the image. They will give a numerical algorithm using finite differences various experimental results and in particular some examples for which the classical snakes methods based on the gradient are not applicable. Also, the initial curve can be anywhere in the image, and interior contours are automatically detected. The Active Contour model [5] is not based on an edge-function to stop the evolving curve on the desired boundary. Also, they do not need to smooth the initial image, even if it is very noisy and in this way, the locations of boundaries are

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very well detected and preserved. By in this model, can detect objects whose boundaries are not necessarily defined by gradient or with very smooth boundaries, [1] for which the classical active contour models are not applicable. Finally, they can automatically detect interior contours starting with only one initial curve. The position of the initial curve can be anywhere in the image, and it does not necessarily surround the objects to be detected. Liver CT image segmentation mainly uses the threshold. This segmentation is based on the regional property [2] of the image or its transform. A threshold derived from such an average response will often fail to segment small objects or objects with similar characteristics to the global background.

The Fractional Brownian Motion [4] suggested that characterizing texture by variety of contexts. The main drawbacks of these fractals are difficult to find the roughness of the path. The fractal based description of natural scenes [6] are representing the natural shapes and computing their description from image data. The fractal dimension of enlarging images are giving the shape from shading, shape from texture and surface interpolation methods are separated from the confirmation of independent results.

Neural networks [7] can be formed by the computation of nonlinear decision boundaries. This technique contributes their decision boundaries across the Bayesian network. This provides that misclassification of each image with data. The multi resolution fractal features [10] are based on the multiple resolutions imaginary and Fractional Brownian Motion model is to detect diffuse liver diseases. This yield Radio Frequency (RF) signals are to be used and thus can be produced at a very small sample rate.

3. Proposed System

A new method called local entropy on liver CT image segmentation is used for extracting liver tumors. The first stage processing is boundary detection and then followed by a second stage processing, boundary extraction. Next compute the local entropy of the original image. The morphological method is used to remove small objects, and morphologically close method to smooth the edge. Finally, after the edge connectivity and image filling, the image segmentation is completed. So, you can get the cancer location of liver.

3.1 Extracting Liver Tumors

As a first step of extracting liver tumors, need to isolate or segment the liver boundary within a CT liver image. A novel approach called the “Detect-Before-Extract” (DBE) technique is proposed for this purpose.

Since the liver is generally accompanied by other organs which present difficulties for liver boundary segmentation, DBE decomposes the process into two stages. The first stage processing is boundary detection and then followed by a second stage processing, boundary extraction. The detection procedure can be implemented as follows:

- It first transforms the original CT liver image into a binary-valued Normalized Fractional Brownian (NFB) feature bit map from which a region growing technique is used to find an initial liver boundary.
- It is generated by dividing an original image into a set of 16X16 image blocks and assigning either a zero or one to each of the image blocks. This binary value is determined according to its corresponding NFB feature curve. More precisely, each point in the feature bit map represents a 16X16 image block.

A point assigned by a one indicates that its represented image block is considered as part of the liver region. On the contrary, a zero-value point means that its represented image block is not part of the liver region.

Using such zero-one NFB feature bit map, an initial boundary of the liver region can be delineated. Since each point in the NFB feature bit map is actually a 16X16 image block, the detected initial liver boundary needs to be interpolated back in the original image domain.

This interpolation is done by a Catmull–Rom B-spline. Since the interpolated liver contour may not be precise, it is further refined and corrected by a deformable model. The resulting liver boundary will be considered to be the desired liver boundary.

3.2 Computed Tomography

A method of examining body organs by scanning them with x- rays and using a computer to construct a series of cross-sectional scans along a single axis.

3.3 Segmentation

In computer vision, segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels). In order to further process the CT images, must do the image segmentation, which distinguish the liver from other tissue.

3.4 Goal of Segmentation

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.

3.5 Liver CT Image Segmentation

Liver CT image segmentation is to extract the liver department from the all CT images, in order to provide a reliable basis for research for clinical treatment and pathology. Liver CT image segmentation mainly uses the threshold. This segmentation is based on the regional property of the image or its transform; and can also consider the neighborhood characteristics of liver CT image, and use the texture analysis approach to segmentation.

3.6 Contour Modification Algorithm

- Select proper sample pixels with n-pixel apart from the initial liver contour.
- Form a 7-pixel search line segment across every sample pixel with three pixels inside and three pixels outside of the liver contour.

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- Find the best fitting boundary pixel in each search line segment in accordance with prioritized constraints.
- Smooth the resulting liver contour from the boundary pixel.
- Interpolate the contour obtained by the resulting liver contour using a Catmull–Rom B-spline.
- Repeat the above steps until the contour is stable.

3.7 Local Entropy

The different part of image has different information, so if want research the different part in an image, so need compute the entropy of that part. Local entropy is derived by computing the entropy in a local region of image, which depicts statistical characteristics in the area.

$$H = -\sum_{i=1}^{M} \sum_{j=1}^{N} P_{ij} \log_2 P_{ij} \quad (1)$$

$$P_{ij} = \frac{f(i,j)}{\sum_{i=1}^{M} \sum_{j=1}^{N} f(i,j)} \quad (2)$$

H is called as local entropy. To measure dispersion of gray in local region for common used local histogram entropy computation, the size of local region chosen is usually small (m=n=9). There are few pixels in the area, so you can get the following local entropy.

Traditionally, local entropy image is categorized to the local histogram entropy defined by the distribution of gray histogram frequency and the local gray entropy defined by the distribution of gray level. Histogram is obtained by all pixels distributed on gray level for local entropy calculation.

The Architecture Diagram for the CT-Liver Image classification and Image segmentation is displayed below.

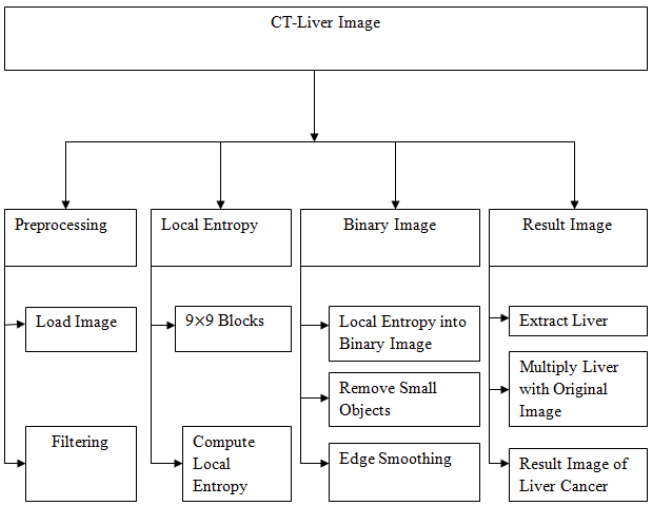

Fig. 1 Architecture Diagram

A. Preprocessing

a. Load Image

In this module, the original image is loaded.

Fig. 2 Load Image

b. Filtering

Here, the median filter is used to remove the noise from the original image.

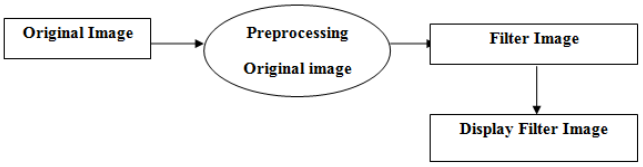

Fig. 3 Filtering

B. Local Entropy

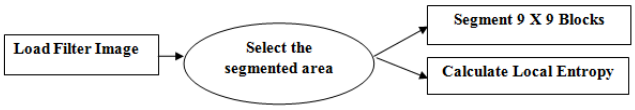

Fig. 4 Local Entropy

a. 9×9 Blocks

In this module, the block with 9×9 is used to compute local entropy.

b. Compute Local Entropy

The different part of image has different information, so to research the different part in an image; the entropy of that part is needed to be computed. The local entropy was computed by using equation (1) and (2).

C. Binary Image

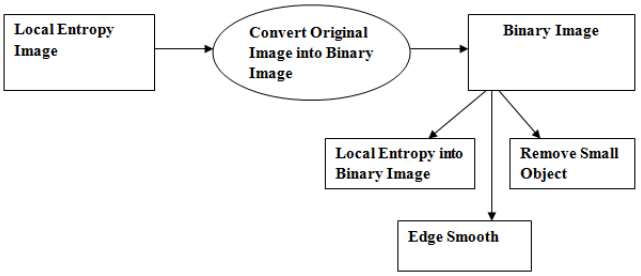

Fig. 5 Binary Image

a. Local Entropy into Binary Image

The local entropy image is converted into binary image with the threshold 0.8.

b. Remove Small Object

The traditional morphological method is used to remove small objects in the image. The algorithm used to remove small objects is:

- Determine the connected components, and the connectivity is 8.
- Compute the area of each component.
- Remove small objects.

c. Edge Smoothing

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In this module, the edge of the image is smoothed.

D. Result Image

a. Extract Liver

As the location of liver in the CT image is known, the objects of liver in the binary image can be selected. Then the section of liver image can be obtained. And then the binary image is negated.

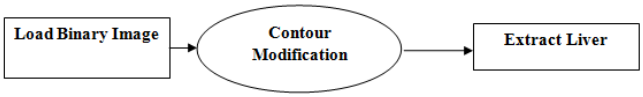

Fig. 6 Extract Liver

b. Multiply Liver with Original Image

In this module, the binary image is multiplied with the original image, and then the liver image is obtained.

c. Result Image of Liver Cancer

The CT image of liver cancer is different from the normal liver tissue. Thus the tumor area is detected in the CT image of liver cancer.

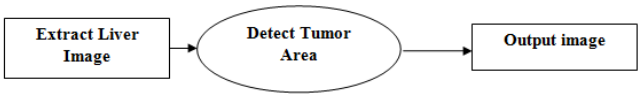

Fig. 7 Result Image of Liver Cancer

4. Results

Fig. 8 Original Image

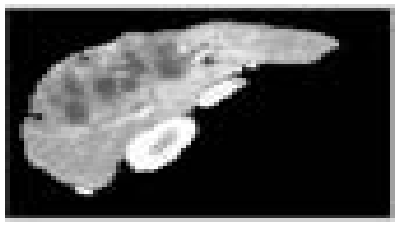

Fig. 9 CT Image of Liver

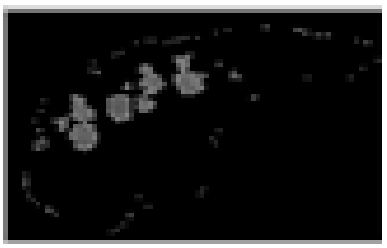

Fig.10 CT Image of Liver Cancer

5. Conclusion

The system consists of an automatic liver contour extraction process, an image enhancement algorithm and a hepatoma or hemangema classification network which helps in the CT liver image classification. The proposed complete CT liver image classification system combines the DBE system with the MPNN classifier to achieve automatic liver boundary extraction and liver tumor classification. The local entropy method can extracts the edge of liver CT image. Then use the morphological method to detect the object regions. From the contour modification algorithm and local entropy method we can obtain the liver image and to find the cancer location of the liver. Thus the local entropy is an effective method on CT liver image segmentation, and can help the diagnosis of liver cancer.

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