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The study and application of the improved region growing algorithm for liver segmentation

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ABSTRACT

In order to improve the accuracy of the medical image segmentation and reduce the effect of selecting seed points using region growing algorithm, an improved region growing method is proposed in this paper. First, the source images are pre-processed using non-linear mapping method and the region of interest in the liver is selected by man–machine interaction; Quasi-Monte Carlo method is used for generating low-dispersion sequences points in the region of interest and the optical seed points are selected by computing these points; In addition, the region growing criteria is also improved. The improved region growing algorithm is used for segmenting three discontinuous abdomen CT images. Compared with the traditional region growing method, the improved method can get better liver segmentation effects. The proposed method can be effectively applied to liver segmentation and it can improve the accuracy of liver segmentation.

1. Introduction

Medical image segmentation is an important part of medical image analysis and study, and has a great value for computer-aided diagnosis, cancer radiation therapy technology, medical operations, 3D visualization and other areas of medicine [1,2]. The organ, tissue or lesion of interest can be extracted by medical image segmentation, and doctor will develop a proper treatment plan researching the segmented image. Liver segmentation plays an important role in the clinical diagnosis and study. Doctor traditionally segments liver region by manual segmentation, but it is difficult and time-consuming and doctor needs to be experienced in these procedures [3]. So, it is a goal to segment liver region fast and accurately. In abdominal CT image, the gray level of liver region is closed to the tissues around it, the image segmentation effect will be not ideal only using gray information. Medical image itself is complex, many methods are used by a lot of researchers at home and abroad for medical images segmentation, four kinds of methods are usually used for medical image segmentation [4], threshold segmentation, edge detection, region-based method, hybrid segmentation method. The method based on region can enlarge the similarities and the differences in a range, in addition, it is adapted to the original image. So, the method has a certain advantages in medical image segmentation [5]. In this paper, region growing algorithm is used for medical image segmentation. Because the seed points need to be selected by man-machine interaction in the traditional region growing algorithm and the segmentation result may be over-segmentation or under-segmentation. In order to select proper seed points and get better segmentation effect, the contrast of image is enhanced using non-linear mapping and selecting seed points and region growing criteria are improved to segment medical CT image efficiently and accurately. Fig. 1 is the main algorithm structure diagram.

2. Image pre-processing

The abdominal CT image is low gray difference, unclear border, complex texture construction and the liver region is bigger than other organs, so the gray level of tissues around liver region is much similar to liver (as shown in Fig. 2). In order to reduce the effect of high similarity gray-scale for segmentation result, the abdominal CT image is pre-processed firstly. The medical image with a certain noise can affect further operation of segmentation, so Gauss filter is used for processing image smoothly to eliminate noise effects. And then, threshold segmentation method is proposed to remove some high gray level organs or tissues, which can reduce the complexity of segmentation, as shown in Fig. 3.

To prove the feasibility of this method, all abdominal CT images in this paper are low gray difference and the segmentation region is adjacent between the liver and other regions. The traditional segmentation method is difficult to segment the CT image effectively.

How to distinguish liver region from the surrounding tissues is a challenge after threshold segmentation. Grayscale transformation can enhance the contrast of abdominal CT image to get a clear

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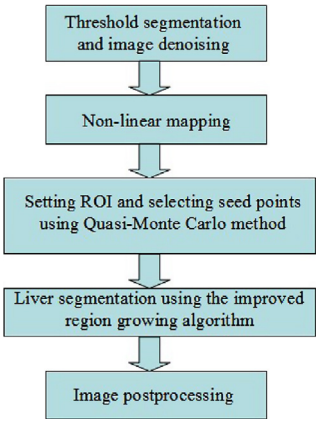

Fig. 1. Algorithm structure diagram.

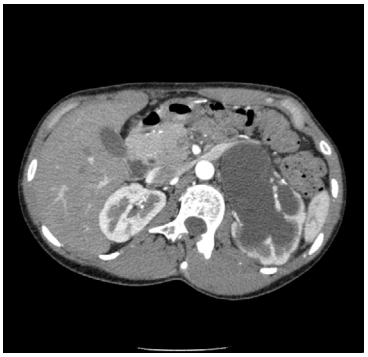

Fig. 2. The abdominal CT image.

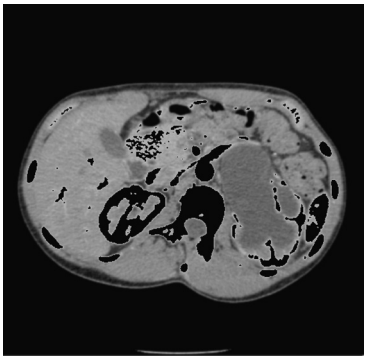

Fig. 3. The segmentation result of threshold method.

texture and obvious features image. So, non-linear mapping method is introduced to enhance image contrast in this paper. The gray level of input pixel is transformed into the gray level of output pixel using the function of non-linear mapping. The Sigmoids filter is used for the transformation, as shown in formula (1).

$$P' = (Max - Min)\frac{1}{1 + e^{-(P-\beta)/\alpha}} + Min \quad (1)$$

where P is the gray level of input pixel, P' is the gray level of output pixel; Min and Max are the maximum and minimum gray level of the output image. α defines the width of the input gray level range, and β defines the gray level around which the range is centered. The method can enhance the contrast of input CT image and a range of

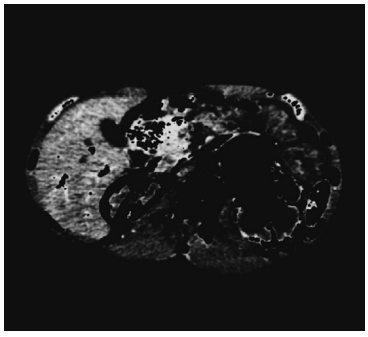

Fig. 4. Non-linear mapping.

gray level is mapped into a new range dividing the CT image into high gray level and low gray level. After non-linear mapping, it is easier to distinguish the liver region from the surrounding tissues and the liver region can be segmented efficiently. The local effects after non-linear mapping is shown in Figs. 4–8.

Liver region can be better distinguished and region growing algorithm is used for liver segmentation after preprocessing. But,

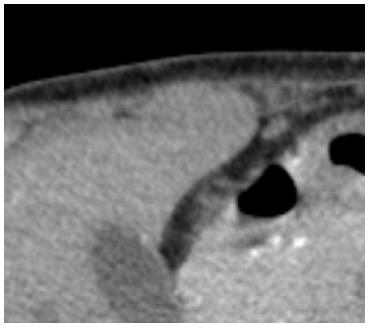

Fig. 5. The local enlarge of abdominal CT image.

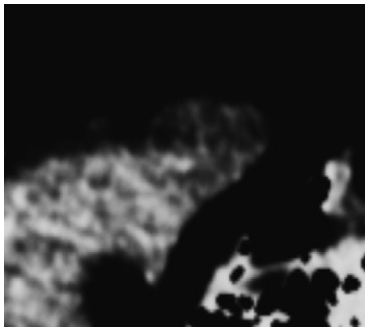

Fig. 6. Using non-linear mapping.

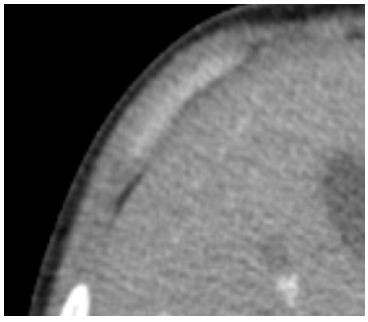

Fig. 7. The local enlarge of abdominal CT image.