제31회 한국정보처리학회 춘계학술발표대회 논문집 제16권 제1호 (2009. 4)

MDCT 를 이용한 간과 혈관의 3D 영상분석

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3D Image Analysis of Liver and Blood Vessels using MDCT

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Introduction

In this paper we present 3D image analysis of liver and blood vessels using MDCT. The purpose is to enhance the performance of clinician in assessing anatomical information of liver and blood vessels. The system consists of two parts: 3D image reconstruction and analysis of the 3D liver and blood vessel image. The central vein of the liver is the most important blood vessel for the liver transplantation. We will find the central vein's location and characteristic, and will scheme out a computer assistant liver transplantation planning. It will be an effective tool for interventional radiology, surgical planning, and quantitative diagnosis.

1. Introduction

CT images have certainly aided doctors in inspection of liver and blood vessels because of their high spatial resolution, but 2D projection images have limitation for quantitative diagnosis of the blood vessel. It becomes necessary to develop a 3D image reconstruction method and an analysisi method of a 3D image.

This paper not only shows the 2D and 3D image of liver and blood vessels, analysis the images, find the central vein which is the most important vessel for the liver transplantation, but also provides the incision method, it can help surgeons plan suitable treatment.

2. 3D reconstruction of liver and blood vessels

With the morphological operation and the position searching method, segment the liver from the abdominal CT image, and find it accurate boundary.

CT image use the X-ray intensity will be decrease after though the organ and the image contrast depends on the different organ's flagging coefficient, the image will be represented as the gray value. Every organ has itself flagging or absorbable coefficient, it has itself anatomical character.

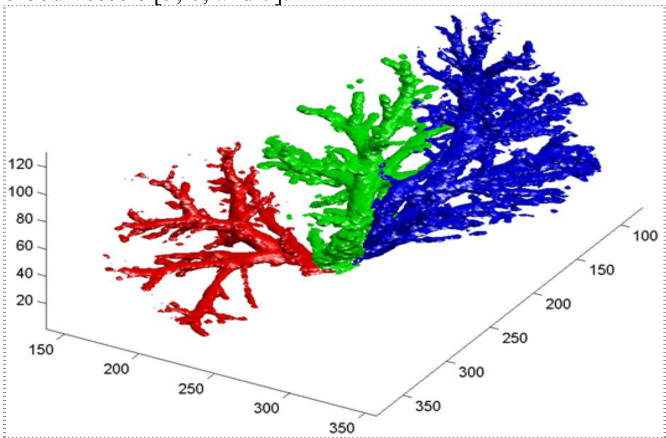
The brightness value of normal hepatic vessels is bigger than the liver tissue. Because there are no other noises in the liver, it can use the threshold method to separate the vessels from the liver directly; it is achievable to segment vessels automatically.

Marching Cubes is also call Isosurface Extraction, is an algorithm for surface rending in volumetric data.

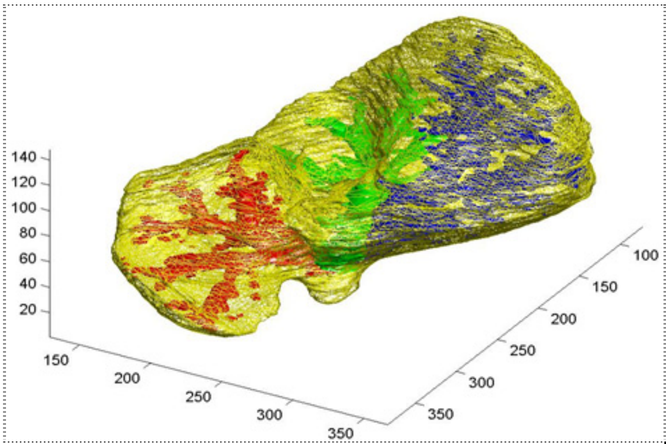
This algorithm is often used to extract the surface of medical organs. It provides serial sections to a complete 3D object [1, 2].

It is think that a series of 2D images make up a 3D data space. Segment something which has the same volume and link them to triangle patch as some topology method [3, 4].

The liver blood vessels are shown in Fig.1. The red, green, and the blue graphs represent the right, central, and left liver blood vessels [5, 6, and 7].



The liver and blood vessels are shown in Fig.2. It shows the liver and blood vessels' location.



3. Analysis of central vein

The liver central vein which is separated from the several segmentation vessel images, is the most important criterion during the incision, and can progress the cutting of the liver. It can be helpful to minimize the damage on the liver's three thick vessels and their surrounding vessels, and to cut the liver according to the volume rate of the liver.

According to the 3D image of central vein, its trunk shape is straight fistulous, so there can be a straight line along with the central vein's right side or left side which slope is same with the central vein's slope.

In the vessels' 2D image, according to the central vein's trunk part's transect image, can make sure the tangent of central vein along with its right side or left side.

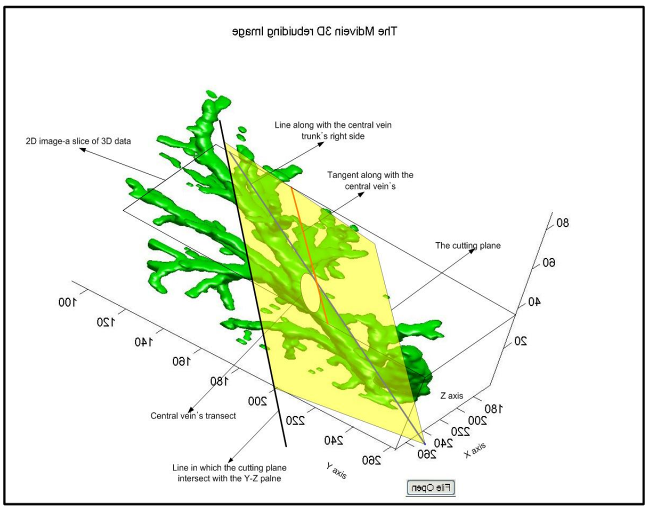
4. Curve fit of cutting plane

It may be difficult to know the equation of the line along with central vein truck, but it is easy to find the equation of the line which the cutting plane intersect with the Y-Z plane, it can be known with the tangent of 2D image and the change with the Z axis in the Y-Z plane.

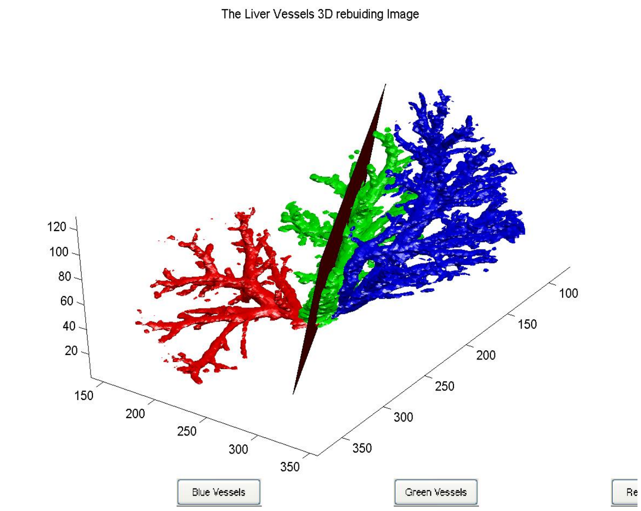
The important problem is how to class a point in the cutting plane. We introduce some symbols; let O stands for the vessel point of intersection. Starting from vertex O, let L stands for the nearest point of the left liver blood vessel, R stands for the nearest point of the right liver blood vessel, M stands for the nearest point of the central vessel, we get three vectors $\overrightarrow{OL}$, $\overrightarrow{OR}$, and $\overrightarrow{OM}$. To simplify the equation of the cutting plane used for the cutting the left liver can be described as in (1):

$$\overrightarrow{OP} \bullet \left(\overrightarrow{OL} + \overrightarrow{OM} + \overrightarrow{OR}\right) = 0 \qquad (1)$$

Here P represents point lies on the cutting plane, • means the dot-production of vectors, + means the vector addition. So it is possible to sure the cutting plane.



The cutting plane is shown in Fig.4.



5. Conclusion

We have presented 3D image analysis of complex vessel systems using MDCT.

It is more advanced than others in research domain of liver. It can complete the segmentation of liver and vessels roundly, automatically and quickly. This paper assists that allow efficient visualization and quantification of liver image.

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