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The Segmentation of Liver from CT Image by using Deformable Model

C. M. Yang(1)   Y. N. Sun(2) and Y. L. Chou(3)

(1) Graduate Assistant, Institute of Biomedical Engineering.
(2) Institute of Information Engineering.
(3) Institute of Biomedical Engineering.
National Cheng Kung University, Tainan, Taiwan, 70101, ROC.

ABSTRACT

Computerized Tomography (CT) is one of the most powerful diagnostic tools in modern hospitals. Many researches have been done on CT images for the segmentation of organs. However, there are still little success in discriminating organs from soft tissues. We have developed a new method based on deformable model to segment the liver from abdominal CT image. The model can deform itself to fit the contour of the liver through the iterative procedures of minimizing contour energies which includes ***image energy, internal energy*** **and** ***external energy.*** The image energy is obtained from computing the energy of edge and line of the CT pattern. As the deformable model approaches to the contour of liver, it also reaches the local optimal condition with minimum image energy, and naturally limits the variations of the contour shape. The internal energy restricts the variations at each step and makes the model change smoothly. The external energy restricts the changes of the geometric properties of liver contour shape. Since we know the characteristics of liver contour and imaging conditions, we can use a priori knowledge in setting up external energy to make the deformation efficient and avoid wasting time on searching in impossible regions. The experimental results have shown the effectiveness of our proposed method.

1.INTRODUCTION :

In a CT image the difference in grey intensity between the organs is not clear, so the borders of the organs are always vague. To segment the organs and find its contours become an important research task to make CT imaging more useful in medical diagnoses and study. In this paper, we have developed a new method which is based on energy–driven and model–matching concepts to segment the contour of liver from an abdominal CT image. This model can iteratively deform itself according to the characteristics obtained from CT image. This process makes the energy of the contour model approach to the local minimum. The contour model contains three energy functions (1) Image energy (2) Internal energy (3) External energy. they are described as follows.

The image energy contains two functions, one is the line–energy function, the other is the edge–energy function. The line–energy function is defined as the intensity and the edge–energy function is defined as the gradient at the evaluated point. The model will approach to low intensity and high gradient, when it reaches the real contour of liver. Thus, the model can converge to the local minimum energy at the same time.

The internal energy is a shape constraint embedded in the model to make the model maintain shape characteristics during the deformation process. In fact, the internal energy limits the deformations at every step to make the model change smoothly. It is found that the contour of liver is a closed curve with small curvature everywhere except at upper–right and lower–left regions. Therefore, we can assume a shape constraint that a deformable contour model is always described by a closed spline curve under any deformation. Since corners reside at upper–right and lower–left regions of the liver contour, the shape constraint allows large curvatures appearing at those two positions.

The external energy plays the major role in keeping the geometrical properties of the deformable contour model. We extract the external energy from the condition of the neighboring region of liver. The regions to search for lines and edges are limited by the external constraint during its deformation process. Therefore the external constraints make the deformation efficient without wasting time in searching at impossible contour regions.

2.THE DEFORMABLE MODEL

The deformable model is a model which can adjust its shape to fit the real contour of liver. It searches the position of edge and line while keeping the shape constraints, given by high level training and sampling processes. The characteristics of the liver CT image ,which includes intensity, shape, position, ..etc properties, are used as the a priori knowledge. After the a priori knowledge is embedded in the model, the model can deform toward the real contour of liver by minimizing the total energy. For example, the image energy will be minimized when the model deformation approaching to the position of line and edge. Thus,the energy converges and model stops at that position. The deformable contour model utilizes the available knowledges which are represented in different forms of