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Automatic Extraction of the Internal Organs from Spiral Scanning Type CT Images

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1 Introduction

As for the progress of the inspection technology which CT device was used for, there is a remarkable thing, and CT is the kernel of the image diagnosis in present medical science. A spiral scanning type CT device has been developed, and it draws attention to be especially recently. The spiral scanning type CT device is different from the usual CT device, and it is possible to take CT images in short time, to obtain the data which continued in the body shaft direction, and to re-composite the CT data in the optional position. But, the more it could get the enormous volume data, the more loading which hangs on one inspector increases, and something support what by the computer is necessary to use the data more efficiently. Therefore, it is important to narrow an applicable range by distinguishing the internal organs which aren't necessary from the necessary internal organs.

As for the way of extracting the internal organs territory targeting the medical treatment image, the technique by edge enhancement or dynamic contour model has been proposed. But, there is a problem that the extraction of the internal organs outline is difficult in the image territory of the CT value difference which doesn't get clear. In this research, a liver territory is made the object of the way of extracting it, and toward such the problem by using a Level Set Approach as having taken the three dimensional form of the liver into consideration, the liver territory of the CT value difference which doesn't get clear is extracted precisely.

In this paper, it explains first and first about the general idea of the extracting technique of the internal organs by the Level Set Approach. Next, taking a gradient of the image and a curvature of the section direction into consideration toward the Level Set

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Approach, the two dimensional liver territory is extracted. Finally, taking a curvature of the body direction into consideration toward the Level Set Approach, the three dimensional liver territory is extracted. Thus it is the characteristic of this research to extract the liver territory by using not only a curvature of the section direction but also one of the body direction and guessing the middle outline from the up-down liver territory.

2 Level Set Approach

Level Set Approach which was developed by Osher and Sethian is a technique that extracts a form and an outline of the object which it aims by evolving an initial propagating surface with a defined speed function. By defining the speed function as a gradient of the image and a curvature, it is possible to extract the internal organs territory. Also there is an advantage that calculation time can be shortened by setting up lattice points on the CT images and by computing numerical value separately.

The speed function which is developed the propagating surface consists of three elements which contain a convection term, a diffusion term and a speed parameter. The convection term is a fixed number which the movement speed of the propagating surface is decided as. The diffusion term is a term which depended on the local curvature of the propagating surface. The speed parameter is a term which depended on the gradient of the image, and takes the value of the range form 0 to 1 corresponding to the gradient. Using this speed function, the propagating surface stops around the outline of the internal organs, as a result it is possible to extract the internal organs.

To compute the propagating surface moved in the speed which depended on the curvature in the direction normal to itself precisely, a factor wave is used in this research. So it is possible to calculate propagating surface moved in the direction normal to itself from a point on the surface without calculating a direction normal to curvature. Also the local curvature on the propagating surface is calculated from neighboring three knot points on the surface, and a length of the knot points interval that the curvature is calculated is changed corresponding to one of the surface.

3 Two Dimensional Extracting of Internal Organs

An X-ray CT images to use by this research are three dimensional volume data that size is 512×512 pixel and a slice interval of the image is 7mm. The liver territory is extracted from one sheet of X-ray CT image in the two dimensional extracting technique using Level Set Approach.

First, two dimensional lattice of the equal interval that size is 102×102 is set up toward a X-ray CT image. Next, an initial propagating surface is arranged inside the liver territory, two parameters of the suitable speed function for the liver territory extraction is inputted. The factor wave about each lattice point on the propagating surface is calculated from gradient of the image and curvature of the surface. The curve of the package its factor waves is defined as a propagating surface after an unit time. It is moved through

the propagating surface by the speed function that it was inputted. The territory of the propagating surface when the movement of the surface settled it is defined with the liver territory that it is presumed by two dimensional Level Set Approach. Finally, an agreement degree of the liver territory presumed and the actual liver territory by the specialist's judgment is calculated.

As a result, it was fount out that the territory of the CT value difference which doesn't get clear couldn't be extracted precisely in the two dimensional extracting.

4 Three Dimensional Extracting of Internal Organs

Therefore, a technique that the liver territory of the CT value difference which doesn't get clear is guessed from up-down liver territory and its outline is extracted is proposed. The same CT data as the case of two dimensional extracting is used, and the intervals of three sheets of X-ray CT images is supplemented lineally. So, the liver territory is extracting by using five sheets of X-ray CT images in three dimensional extracting.

First, three dimensional lattice of the equal interval that size is $102 \times 102 \times 5$ is set up toward the three sheets of X-ray CT images. Next, five initial propagating surfaces are arranged inside the liver territory, three parameter of the suitable speed function taking the curvature of the body direction into consideration is inputted. The factor wave about each lattice point on the five propagating surfaces are calculated in three dimension. The curve of the package its factor waves is defined as a propagating surface after an unit time. The territory of the propagating surface when the movements of all surfaces settled it is defined with the liver territory that it is presumed by three dimensional Level Set Approach. Finally, an agreement degree of the middle liver territory presumed and the actual liver territory is calculated.

By introducing the curvature of the body shaft direction, it was found out that the territory which a liver and a heart adjoin and its CT value difference doesn't get clear was extracted. As a result, it was recognized that a general agreement degree was improved, too.

5 Conclusion

In this research, Level Set Approach was used to extract the liver territory from the X-ray CT images. It was found out that it was difficult to estimate territory which a CT value difference doesn't get clear in two dimensional extracting, also was fount out that a good result could get it by introducing a speed function in consideration of the curvature of the body shaft direction.

But, the problem of the suitable parameter decision for the internal organs territory extraction is left. From now on, an automatic internal organs territory including the automatic decision of the parameter must examine the way of extracting it.