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The Fast Medical Image Segmentation of Target Region Based on Improved FM Algorithm

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Abstract

This paper studies several kinds of image segmentation algorithm, and region-growing algorithm and fast level set matching algorithm FM are programmed by VC and verified, thereinto, the speed of segmentation of region-growing algorithm is fast. It is primarily affected by the identity of gray level of object region, for the inconsistent object region, excessive segmentation and missing segmentation will happen. The fast matching method can easily handle the geometric objects which topological structure is complex or changing, but the evolving curve also easily leak from the boundary, if there are holes in an object which has been segmented, it will not quite separate the interior outline of the object, so, aiming at the characteristics of medical image, an improved fast matching algorithm is presented in this paper, it can effectively enhance the image segmentation effect and prevent the loss of details of lines, and the internal change of topological structures of the objects can also be segmented better by it.

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Keyword: Fast matching algorithm; Target region segmentation

1. Introduction

As an important application of image processing technology, the goal of medical image segmentation is to perform an operation on original medical images and extract or show the interesting object. Medical image segmentation plays a very crucial part in qualitative and quantitative analysis of medical image, it is a precondition of analyse and processing of higher level medical image, it has a direct effect on the late

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analyses and processing, so, it has drawn a worldwide attention and research. Up to now, there are a great variety of relevant algorithm in medical image, but it can not completely satisfy the effective demand of people. For example, it can not completely describe the practical problems now facing humanity using mathematical model, the structure and character of image is different which will lead to the degenerate quality of image and anticipate goal of people for the result of segmentation are widely different, therefore, researching a more efficient fast medical image segmentation algorithm has very important meaning.

2. The Common Image Segmentation Method

Image segmentation can be boiled down to the classification problem of image's pixels. There are many kinds of concrete methods, it can be divided mainly into two classes [1] by different adaptability of segmentation algorithm, one is region-based method which often take advantage of the uniformity of same area to identify various areas of the image, another is a edge-based image segmentation method which often take advantage of the different interregional characters (such as the discontinuity of gray in region) to segmente the borderline between each region.

Conventional region-based segmentation method have the threshold segmentation, region growing, division and combination, clustering [2], classifier and the method based on random field. The basic idea of region growing, division and combination is to gather the pixels which have same characters to constitute the area. Firstly, select a seed point, then, combine in turn the similar pixel around the seed pixel into the region that it is in, this method is also simple which is suitable to separate smaller structure.

People often combine the method of region-based and edge-based, whereas what method is adopted to combine? how to acquire the best result of segmentation by making full use of their own advantages? all of this is the recent research emphasis.

3. The Image Segmentation Method Based on Deformable Model

The method based on deformable model can be divided into two categories as the model of parameters variable and geometry variable. During the deformation, the model of parameters variable express virtually the curve or surface with parameters form, while the model of geometry variable is based on the curve evolution theory [3][4] and the level set method [5], express implicitly the curve or surface in level set of higher dimensions form. The basic idea of the model of geometry variable is to coupling image data with deformation velocity, and cause the evolving curve to stop on the border of the object. In practice, the process of evolution can adopt level set method.

The level set method is not change over time and track curves, but realize the curve evolution by the change over time of level set function in fixed coordinate system. The main features of the method is that the level set function will remain effective function when the nested curve change its topology. The level set method is not change over time and track curves, but realize the curve evolution by the change over time of level set function in fixed coordinate system. The main features of the method is that the level set function will remain effective function when the nested curve change its topology.

4. The Simulation Results and Analysis of Target Region Segmentation of Medical Image

4.1. The Image Segmentation by the Region-Growing Algorithm

General, the region-growing algorithm has three question of great import:

- (1) the selection of seed point.
- (2) the principle of growth.

(3) the conditions for terminating.

The selection of seed point adopt man-computer interaction method,the principle of growth is that pixel' value of neighbored pixels is less than threshold, the conditions for terminating is going on untill have no pixels which meet the needs of the principle of growth.

The experimental results are shown in figure 1.

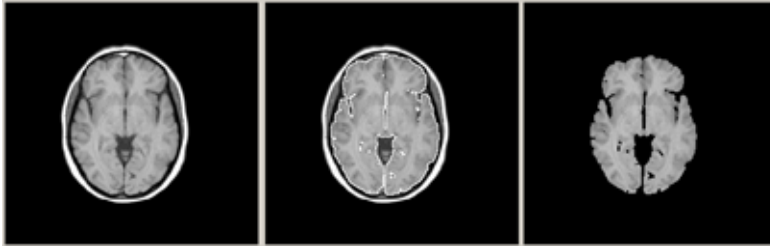


Fig. 1. (a) Original MRI Image; (b) The Image with Segmentation Edge; (c)The Image after Segmentation

4.2. The Image Segmentation by the Fast Matching Level Set Method

The basic idea of image segmentation by level set method is transforming the motion of curve into the deformation of surface, although, the complex of problem have increased in form,but it have many advantages, such as it can naturally deal with the change of curve' topological structure,and it also can get their geometry nature, curvature, normal vector and so on, this will surely do much to the analysis of change in image' shape.

The level set method also have two critical problems in the application of image segmentation, the form of velocity and setting of stopping criteria. On the one hand, only the velocity is related to images property in evolution equations, so these characters have directly affected the effect of image segmentation, but on the other hand, the velocity is always equal to or larger than 0 in the fast method, it can not draw back once the evolving curve pass the target edge,so,the setting of stopping criteria is also very important.By far, the velocity item $F(x,y)$ is mainly applied to two kinds of situations.

$$F = e^{-a|\nabla I(x,y)|}, a > 0 \quad (1)$$

$$F = \frac{1}{1+a|\nabla I(x,y)|} \quad a > 0 \quad (2)$$

From the expression(1),it can be seen that the velocity item is the decline function of the amplitude of image'gray level.Image'gray level is a important characteristics of target edge,if the target edge of the segmentation image has more other obvious characteristics, such as texture features, the gradient factor in velocity item can also be substituted by factor which can reflect those clear edge characteristic.

Then, using the level set algorithm for image segmentation by the fast matching method[6],the process is as follows:

Firstly,setting the assemble points by the following ways:

- (1)alive points:define the given initial points.
- (2)close points:the distance between close points and alive points will only be one pixel.
- (3)far points: define all the points except alive and close points.

Then tracking the boundary contour by the following step:

- (1)set trial points:define the points which T value is the smallest in close points.

- (2)chang trial points to alive points and delete it from the close points.
 - (3)marked all the non-alive points in trial points'first-order neighborhood with close points,at the same time,changing original far points to close points,so realize the transformation from far to close.
 - (4)re-calculate the T value of all points of neighborhood by expression(2),thereinto,T=1/F.
 - (5)return to the step(1) and get into the next round.
 - (6)at last, constitute the boundary contour by the aggregation of all trial points.
- The experimental results is as shown in figure 2.

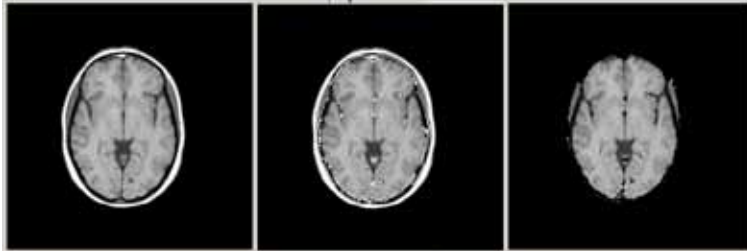


Fig. 2 . (a) Original MRI Image; (b) The Image with Segmentation Edge; (c)The Image after Segmentation

It is found in the experiment result that there are some problems in traditional Fast matching method,first of all, the evolving curves of traditional method is easily leak from edge if the border of object which has been divided is unclear, secondly, traditional method can not better separate the internal outline of target object if there is cavity in the interior of the divided object.

4.3. The Improvement of Fast Matching Algorithm

Through the experiments, it can be concluded that the gray of medical image is generally lower, the transition of target'edge is comparatively slow,and it often occur in the low-lever gray region,so,while using the fast matching algorithm to comput velocity by the velocity function, it can solve the problem of edge'leakage caused by small boundary gradients of the low-lever gray region,the small terminating force and high speed.The improvement of velocity function is as shown in expression (3) and (4).

$$F = e^{-a|\nabla I(x,y)*255/\overline{I(x,y)}} \tag{3}$$

$$F = 1/(1 + a |\nabla I(x, y) \times 255 / \overline{I(x, y)}|) \tag{4}$$

Finally, the experimental results can be obtained as shown in figure 3.

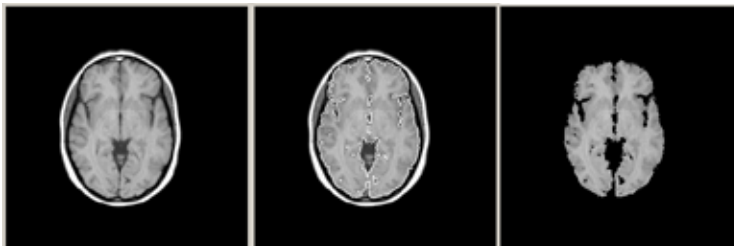


Fig. 3 . (a) Original MRI Image ; (b) The Image with Segmentation Edge; (c)The Image after Segmentation

The simulation results show that the improved algorithm can effectively enhance the segmentation effect of image and prevent the loss of image' edge, and the separated object which inner topological structures is changing can also be better segmented by it. But there are still some shortcomings in the algorithm, for example, the segmentation process is sensitive to image'gradient because the velocity function is mainly computed by it, in addition, for the velocity function has combined gray information, so, the improvement of segmentation effect is not very clear for the segmentation target in the high-lever gray region which edge gradient is relatively small, but the interesting target region can be highlighted by corresponding image processing of image filtering, image enhancement and image fusion,the edge information will be enhanced and segmentation effect of target region is increased.

5. Conclusions

In this paper,many image segmentation algorithm are analyzed and studied.Because level set algorithm of the model of geometry variable has the features of automatic process the changing of topological structures, it is not relying on parameters in the process of evolution and evolving line or surface can be implicitly expressed as level set of high-dimension function,so,the article mainly research image segmentation based on the level set algorithm of the model of geometry variable and improve its fast matching algorithm. By using VISUAL C++ to program and establish experimental system,the fast matching algorithm' efficiency is validated, it is simultaneously better than the region-growing algorithm and fast matching algorithm, it can effectively guard against edge'leakage,it is a fast and efficient medical image segmentation algorithm of target region.

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