# Contour extraction method and implementation of active contour model algorithm based on N-order Bezier curve for cardiac medical images

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***Abstract*—Optimize the active contour model. In the process of optimization, the n-order Bezier model curve is used to smooth the evolution curve of the active contour model to make it more smooth. The optimized curve is applied to the contour extraction and analysis of medical image, so as to promote the processing of medical image. The n-order Bezier curve algorithm is used to optimize the active contour model algorithm. The active contour model is a discrete point curve, and the active contour is smooth and seamless. The active contour obtained by the optimized algorithm is smooth and seamless, which is more suitable for image processing operations such as medical image and contour extraction of medical image. The algorithm of using n-order Bezier curve to optimize the active contour model should be applied to the image analysis of medical images.**

***Keywords- Contour detection; Active contour model; Bezier curve;***

## I. N-ORDER CURVE ALGORITHM

Bezier curve, also known as Bezier curve or Bezier curve, is a mathematical curve used in two-dimensional graphics applications.The general vector graphics software can draw the curve accurately by it, Bates curve is composed of line segment and node, node is a drag fulcrum, Bessel curve is quite important parameter curve in computer graphics, in some mature bitmap software also has Bessel curve tool.

Given two points P0 and P1, a linear Bates curve is just a straight line between two points.The line is given by the following formula:

$$B(t) = P_0 + (P_1 - P_0)t = (1-t)P_0 + tP_1, t \in [0,1] \quad (1)$$

The path of the second-order Bates curve is traced by B (t) of the given points P0, P1, and P2:

$$B(t) = (1-t)^2 P_0 + 2t(1-t)P_1 + (t)^2 P_2 \ , t \in [0,1] \quad (2)$$

The Bates curve of order n can be inferred as follows.Give points P0, P1..., Pn, and its Bates curve is:

$$B(t) = \sum_{k=0}^{n} \binom{n}{i} t^i p_i (1-t)^{n-i} \quad (3)$$

Bezier curve programming needs to consider two dimensions, one is the x-coordinate and the other is the y-coordinate. The formula is the formula of points. In the programming process, formula (3) should be concretized into the equation of horizontal and vertical coordinate points. According to N points, the coordinate of all points in the middle should be calculated using the circular algorithm..

## II. ACTIVE COMTOUR MODEL

In 1988, Kass et al. proposed the active contour model, which used the image segmentation problem and provided an idea for image contour extraction by solving the energy functional minimum problem.The main principle of the active contour model is to construct an energy functional. Driven by the minimum energy function, the contour curve gradually approaches the edge of the object to be detected, and finally the object is segmented.Active contour model is also called Snake model because it uses curve evolution to locate the edge of the target.The biggest advantage is that continuous and smooth closed segmentation boundary can be obtained even in the case of high noise.According to the different construction methods of energy function, active contour models can be divided into two types: edge-based and region-based. At the same time, some researchers proposed active contour models based on the combination of edge and region.

General image segmentation algorithm, are passive model, is overly dependent on image information.If you know in advance what you're looking for.This general shape is the prior knowledge.Prior knowledge can predict the properties of image objects.Can be internal information.Image pixel data is the external factor of image segmentation, called external force.In active contour model, the contour evolves under the action of internal forces and external forces, and finally the contour curve stops at the target contour attachment. This process is an iterative process and keeps evolving until the movement stops when the force is 0.

The force formula of the active contour model is as followssnakeRepresents the resultant force of evolution, the sum of internal and external forces. EintFor internal forcesextSaid the external force.

$$E_{Snake} = \int_0^1 E_{int} + E_{ext}\, ds \quad (4)$$

$$E_{int} = \frac{1}{2}\left[\alpha(s)\left|\frac{\partial v}{\partial s}\right|^2 + \beta(s)\left|\frac{\partial^2 v}{\partial s^2}\right|^2\right] \quad (5)$$

α is the stretching force coefficient of the curve; β is the stiffness coefficient of the curve; ∇ is to take the gradient operation;

The minimum energy value of the energy function needs to satisfy the Euler-Laplace equation:

$$\alpha\frac{\partial^2 v}{\partial s^2} - \beta\frac{\partial^4 v}{\partial s^4} - \nabla E_{ext} = 0 \quad (6)$$

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$\nabla$ represents the gradient operation.According to motion mechanics and force balance conditions of moving objects, the resistance term is added on the basis of Equation (6) :

$$\lambda\frac{\partial v}{\partial s}+\alpha\frac{\partial^2 v}{\partial s^2}-\beta\frac{\partial^4 v}{\partial s^4}-\nabla E_{ext}=0 \qquad (7)$$

Here we define an outline with N (N is a positive integer) nodes:

$$v_{in}=(x_{i,n},y_{i,n})=(x(\frac{i}{N}),y(\frac{i}{N})) \qquad (8)$$

n represents the evolution time, I =1,2... , N - 1.The initial contour is defined as:

$$v_{i0}=k_i \qquad (9)$$

## III. Active Contour Model Based On N - order Bezier Curve

In the active contour model based on n-order Bezier curves, n initial points are selected as the basic contours of the active contour model.The basic contour will evolve into a new lattice under the action of external force.

The salient problem is that these points are discrete, and a large number of initial points are required to accurately represent a curve. So this algorithm requires a lot of number of initial points N.

In order to solve the problem that N value is too large, N order Bezier curve is introduced into the active contour model. Assuming that the number of contour points required by the traditional active contour model is N, and the number of points of the improved model introduced into the active contour model through bezier curves is denoted as N, obviously:

$$n<N \qquad (10)$$

If the quotient of N and N is denoted as parameter K, then:

$$n=k*N(K<0<1) \qquad (11)$$

Here, k value can be set to 0.1, so the number of initial points of the active contour model becomes one tenth of the original. That is to say, the control points of active contour are reduced. Control points are discrete, a total of N control points, through bezier curve algorithm iteration can approximate the fitting curve between control points, so as to ensure the smoothness and continuity of the curve. The greater advantage of the active contour model is that the iteration speed is accelerated and the time complexity of the algorithm is reduced due to the reduction of control points. In other words, by introducing the N-order Bezier curve, the time complexity of the evolution of the active contour model is reduced.

## IV. The improved Active Contour Model Using Bezier Curve Is Applied To The Contour Detection Of Medical Images

Optimize the active contour model, in the process of optimization using n order Bezier model curve to smooth the evolution curve of the active contour model, make it more smooth.The optimized curves are applied to the contour extraction and analysis of medical images so as to promote the processing of medical images. N order Bezier curve algorithm is used to optimize the active contour model algorithm, and the active contour model is improved to be discrete point-state curve, and the active contour has the characteristics of smoothness and seamless.This algorithm is preferentially used for contour detection of heart image. Meanwhile, the time complexity of the algorithm is reduced.

Figure 1. Left ventricular contour extraction experiment of cardiac magnetic resonance images1: Contours of models using traditional algorithms

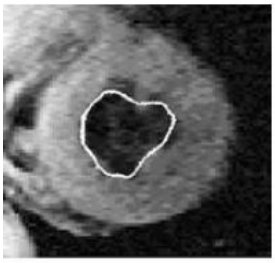

Figure 2. Left ventricular contour extraction experiment of cardiac magnetic resonance : the contour of the improved model using this algorithm

Figure 3. Left ventricular contour extraction experiment of cardiac magnetic resonance :outline drawn by professional doctor

## V. Conclusions

As shown in the figures above, the active contour obtained by the optimized algorithm is smooth and seamless, which is more suitable for image processing operations such as medical images and contour extraction of medical images. In the process of optimization, the n-order Bezier model curve is used to smooth the evolution curve of the active contour model to make it more smooth. The optimized curve is applied to the contour extraction and analysis of medical image, so as to promote the processing of medical image. The n-order Bezier curve algorithm is used to optimize the active contour model algorithm. The active contour model is

a discrete point curve, and the active contour is smooth and seamless. The active contour obtained by the optimized algorithm is smooth and seamless, which is more suitable for image processing operations such as medical image and contour extraction of medical image. The algorithm of using n-order Bezier curve to optimize the active contour model should be applied to the image analysis of medical images

## REFERENCES


[1] WANG Xiaoyi, XING Suxia, WANG Yu, et al. Research on breast tumor segmentation and classification based on adaptive energy migration field without edge active contour Model [J]. Chinese Journal of Medical Physics 2020 vol 37 No 8, Pp 1010-1016, ISTIC CSCD, 2020..

[2] Lu Yuanyuan, Feng Hao, Li Jing. Active Contour Image Segmentation Based on Distributed Metric Statistical Modeling. Computer Engineering and Applications, 2020, 056(007):228-233.

[3] Chen Junying, Swim navy. Automatic Segmentation method of Fuzzy boundary Image Based on Active contour and Deep Learning :, CN110689545A[P].2020.

[4] Liu Xia, GAN Quan, Liu Xiao, et al. Opto-electronic Engineering, 2020, 047(001):10-19. (in Chinese)

[5] CAI Fan. Research on image segmentation based on active appearance model [J]. 2021(2014-2

[6] Non-local weighted fuzzy energy-based active contour model with level set evolution starting with a constant function [J] . Hongli Lv,Shujun Fu,Caiming Zhang,Xuya Liu. IET Image Processing . 2019 (7)

[7] Concatenated and Connected Random Forests with Multiscale Patch Driven Active Contour Model for Automated Brain Tumor Segmentation of MR Images. [J] . Ma Chao,Luo Gongning,Wang Kuanquan. IEEE transactions on medical imaging . 2018 (8)

[8] Feature guided Gaussian mixture model with semi-supervised EM and local geometric constraint for retinal image registration [J] . Jiayi Ma,Junjun Jiang,Chengyin Liu,Yansheng Li. Information Sciences . 2017

[9] SLIC superpixels compared to state-of-the-art superpixel methods. [J] . Achanta Radhakrishna,Shaji Appu,Smith Kevin,Lucchi Aurelien,Fua Pascal,Süsstrunk Sabine. IEEE transactions on pattern analysis and machine intelligence . 2012 (11)

[10] Contour detection and hierarchical image segmentation. [J] . Arbeláez Pablo,Maire Michael,Fowlkes Charless,Malik Jitendra. IEEE transactions on pattern analysis and machine intelligence . 2011 (5)