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Segmentation of blood vessels using tracking based approach in cardiac images

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Abstract- This paper introduces a active contour technique for curvilinear structures detection in 3D medical images. This paper for tracking based algorithm to track the curvilinear structures. Tracking-based approaches apply local operators on a focus known to be a vessel and track it. On the other hand, patter recognition approaches apply local operators to the whole image. Vessel tracking (VT) approaches, starting from an initial point, detect vessel centerlines or boundaries by analyzing the pixels orthogonal to the tracking direction. Active contour method is used to segment the vessels from the angiography cardiac images.

Keywords- Curvilinear structures, Energy, Vessel tracking, cardiac.

I. INTRODUCTION

The key components of Vessel segmentation algorithms are automated radiological diagnostic systems. The essential step in Blood vessel delineation on medical images to solving several practical applications such as diagnosis of the vessels (e.g. stenosis or malformations) and registration of patient images obtained at different times. Segmentation methods vary depending on the application domain, imaging modality method being automatic or semi-automatic, and other specific factors. There is no single segmentation method that can extract vasculature from every medical image modality. While some methods employ pure intensity-based pattern recognition techniques such as thresholding followed by connected component analysis some other methods apply explicit vessel models to extract the vessel contours. Depending on the image quality and the general image artifacts such as noise, some segmentation methods may require image preprocessing prior to the segmentation algorithm . On the other hand, some methods apply post-processing to overcome the problems arising from over segmentation. In current vessel segmentation tracking based method, covering both early and recent literature related to vessel segmentation . We introduce active contour segmentation method for extracting the vessels from the CT cardiac images.

Sina hooshyar [1], present a novel fuzzy algorithm for vessel tracking in retina images. Vessel tracking is one of the common methods that are used in vessel segmentation. Most of vessel tracking methods begin from given initial points on the vessel and estimate the vessel width and orientation within a local region about the current point. Then a small step is taken along vessel direction and the procedure is repeated until stop conditions are satisfied The results demonstrate the good performance of method in the whole tracking process and detecting more complete vessel network in the ocular fundus photograph

Hanwei Shen[2], present a semiautomatic image segmentation tool which combines conventional manual segmentation utilities with a novel automatic image segmentation algorithm. We use a bimodal thresholding algorithm to determine the boundary segments in the local region .When the user picks an initial point, a small local window is placed around this point. A local histogram is then computed according to the values of pixels located inside the window. The pixel value in a histogram that separates the pixels of an image into two major groups determines the most significant value. Image segmentation, the process of defining boundary domains in 2D images, the boundaries of interesting regions must be defined before surface reconstruction mesh generation, and other modeling operations begins. This approach works only in 2D images

II. MOTIVATION

An automatic model based segmentation method extracting blood vessels in poor quality coronary angiograms. This paper addresses the problem of automatic segmentation of complicated curvilinear structures , with the primary application of segmenting vasculature in magnetic resonance angiography (MRA) images. The method presented is based on recent curve and surface evolution work in the computer vision community which models the object boundary as a manifold that evolves iteratively to minimize an energy criterion. This energy criterion is based both on intensity values in the image and on local smoothness properties of the object boundary, which is the vessel wall in this application.

III. MECHANISM AND ALGORITHM

The first step of the method is filtering the cardiac images .The filtering process is used to reduce the noise from the images .The Gaussian and kalman filter is used to blur the image sequence. A graph cut algorithm is used for minimize the energy level from the CT cardiac images. Subsequently, apply tracking based approach is used in the design of a computational system for automatic images segmentation

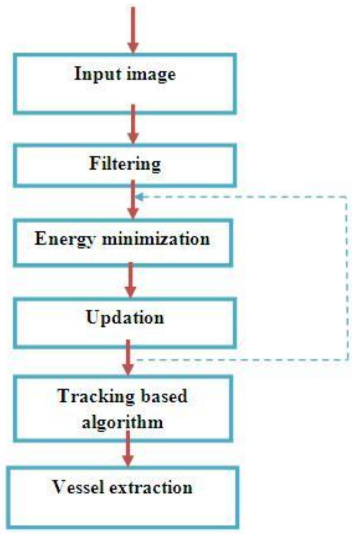

Figure1 Proposed Methodology

A. Filtering techniques

The filtering techniques is used for reduce the noise.Image Enhancement programs make information more visible to range of possible intensities ,usually 256 gray-scale levels.Unsharp masking-Subtracts smoothed image from the original image to emphasize intensity changes. Histogram equalization-Redistributes the intensities of the image of the entire. Convolution programs are 3-by-3 masks operating on pixel neighborhoods.Highpass filter-Emphasizes regions with rapid intensity changes. Lowpass filter-Smoothes images, blurs regions with rapid changes. Noise filters decrease noise by diminishing statistical deviations. Adaptive smoothing filter-Sets pixel intensity to a value somewhere between original value and mean value corrected by degree of noisiness. It is good for decreasing statistical, especially single-dependent noise. Median filter-Sets pixel intensity equal to median intensity of pixels in neighborhood. It is An excellent filter for eliminating intensity spikes. Sigma filter-Sets pixel intensity equal to mean of intensities in neighborhood within two of the mean. It is a good filter for signal-independent noise.

1. Gaussian filtering

The idea of Gaussian smoothing is to use 2-D distribution as a point-spread function, and this is achieved by convolution. Since the image is stored as a collection of discrete pixels we need to produce a discrete approximation to the Gaussian function before we can perform the convolution. In theory, the Gaussian distribution is non-zero everywhere, which would require an infinitely large convolution kernel, but in practice it is effectively zero more than about three standard deviations from the mean, and so we can truncate the kernel at this point. It is not obvious how to pick the values of the mask to approximate a Gaussian. The value of the Gaussian at the centre of a pixel in the mask can be used, but this is not accurate because the value of the Gaussian varies non-linearly across the pixel. The integrals are not integers: the array is rescaled.

The Gaussian function is:

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}} \qquad (1)$$

Gaussian distribution with mean 0 and σ = 1 .The effect of Gaussian smoothing is to blur an image, in a similar fashion to mean filter. The degree of smoothing is determined by the standard deviation of the Gaussian. Larger standard deviation Gaussians, of course, require larger convolution kernels in order to be accurately represented. The Gaussian outputs a weighted average of each pixel's neighborhood, with the average weighted more towards the value of the central pixels. This is in contrast to the mean filter's uniformly weighted average. Because of this, a Gaussian provides gentler smoothing and preserves edges better than a similarly sized mean filter.

2. Kalman filter

A Kalman filter is an optimal recursive data processing algorithm. The Kalman filter incorporates all information that can be provided to it. It processes all available measurements, regardless of their precision, to estimate the current value of the variables of interest. Computationally efficient due to its recursive structure. Assumes that variables being estimated are time dependent.

(a) Operation of Kalman Filter

Kalman filter Provides an estimate of the current parameters using current measurements and previous parameter estimates. It provides a close to optimal estimate if the models used in the filter match the physical situation.

(b) Two step in kalman filter

In the prediction step, the Kalman filter estimating the state vector at the current time, based upon all past measurements.

Once the outcome of the next measurement is observed, these estimates are updated

B. Energy minimization

Graph cut algorithm is used for the energy minimization. The Graph Cuts method of interactive segmentation has become very popular in recent years. This method performs at interactive speeds for smaller images/volumes, but an unacceptable amount of storage and computation time is required for the large images/volumes common in medical applications.

1. Graph cut

A graph G = (V,E) can be partitioned into two disjoint sets, $A, B, A \cup B = V, B = 0$by simply removing edges connecting the two parts. The degree of dissimilarity between these two pieces can be computed as total weight of the edges that have been removed. In graph theoretic language it is called the *cut*:

$$cut(A, B) = \sum_{u \in A, v \in B} w(u, v) \qquad (2)$$

Graph Cut is Delete enough edges so that is each pixel is (transitively) connected to exactly one label node .Cost of a cut is the sum of deleted edge weights. Finding min cost cut is equivalent to finding global minimum of energy function.

C. Segmentation

Active contour techniques are used to segment the vessels from the CT cardiac images. Snake is an energy minimizing, deformable spline influenced by constraint and image forces that pull it towards object contours. Snakes are greatly used in applications like object tracking, shape recognition, segmentation, edge detection, stereo matching. Snakes may be understood as a special case of general technique of matching a deformable model to an image by means of energy minimization. Snake is an "active" model as it always minimizes its energy function

In Snakes, we use the technique of matching a deformable model to an image by means of energy minimization. A snake initialized near the target gets refined iteratively and is attracted towards the salient contour. A snake in the image can be represented as a set of *n* points

First possible regularization of H by $C^2(\overline{\Omega})$ functions, as proposed

$$H_{1,\varepsilon}(z) = \begin{Bmatrix} \mathbf{1} & \boldsymbol{if\ z > \varepsilon} \\ \mathbf{0} & \boldsymbol{if\ z < -\varepsilon} \\ \frac{1}{2}\left[1 + \frac{z}{\varepsilon} + \frac{1}{\pi}\sin\frac{\pi z}{\varepsilon}\right] & \boldsymbol{if\ |z| \le \varepsilon} \end{Bmatrix} \quad \mathbf{(3)}$$

Let *Ω* be open and bounded. For the purpose of illustration, we consider for the moment the two dimensional case, but any dimension could be considered. For instance, we will also treat the one dimensional. Let *C* be a closed subset in *Ω*, made up of a finite set of smooth curves. The connected components of *Ω**C* are denoted by Ω*i* .We also denote by |*C*| the length of curves making up *C*.Let *u*0 :*Ω* → R be a given bounded image-function.The segmentation problem in computer vision, as formulated as follows: given an observed image *u*0, find a decomposition Ω*i* of *Ω* and an optimal piecewise smooth approximation *u* of *u*0, such that *u* varies smoothly within each *Ωi* , and rapidly or discontinuously across the boundaries of *Ωi* .

IV. Result

The input image and filtered output

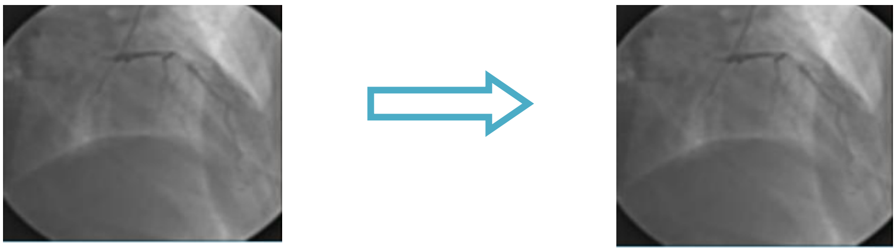

Figure2 Input Image With Filtered Results

The Segmented blood vessels from the cardiac angiography image

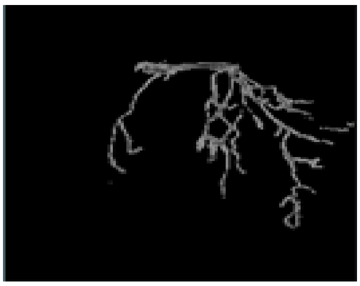

Figure3 cardiac blood vessels

V. CONCLUSION

Segmentation algorithms form the essence of medical image applications such as radiological diagnostic systems, creating anatomical atlases, visualization, computer-aided surgery and multimodal image registration. Even though many promising techniques and algorithms have been developed, it is still an open area for more research. The future direction of vessel segmentation research will be towards developing more accurate and faster more automated techniques. Accuracy of the segmentation process is crucial due to the nature of the work and is essential to achieve more precise and repeatable radiological diagnostic systems. Accuracy can be improved by incorporating a priori information on letting high level knowledge and vessel anatomy guide the segmentation algorithm. To achieve faster segmentation using active contour algorithm. Manual segmentation is time consuming, thus difficult to perform in large of scans. Due to technological development the number of images to be analyzed is increased drastically, making manual segmentation an even less efficient option in clinical practice. so we need tools for automated segmentation.

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