Research on 3D Contrast Image Segmentation Based on an Improved Otsu Algorithm

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Abstract. This article mainly introduces typical segmentation methods of medical images, especially when using the advantages of threshold segmentation when segmenting blood vessels, and it is effective when selecting the principle of maximum between-class variance and global threshold. Sex is explained. Based on this, the key role played by the local threshold in the segmentation of angiographic images is explained. In addition, the block method used in this article is a fixed size. Considering when the block size can show the best segmentation effect, the article proposes an index that can determine the block size, namely block the rate of change of the internal standard deviation of the image, and the proposed method is also demonstrated.

Keywords: Otsu algorithm, threshold, image segmentation

1. Introduction
The application of medical image segmentation to the output and analysis of medical images has strong practical significance. This is the basis for follow-up operations such as motion analysis, structure, three-dimensional visualization, disease diagnosis, evaluation and treatment, and surgical guidance. Of course, this is also a medical image. Develop a barrier that is insurmountable. In view of the diversity and complexity of medical image imaging, although each imaging mode is rapidly improved and improved, the imaging quality is far from satisfactory, especially in contrast and resolution. Therefore, different types of segmentation methods should be used for medical images with many types and significant feature differences. For now, there are no less than a thousand medical image segmentation methods that can be applied to different occasions and methods derived or compounded from them. In addition, because the hospital image segmentation method has a strong dependence on the set image, imaging method and other interference factors, although there are many types of segmentation methods, there is no one universal segmentation method, so in-depth It is still necessary to study the segmentation method.

2. Medical image threshold segmentation
Threshold segmentation, as a method that can effectively perform differential segmentation of images, is widely used in automatic image segmentation. Because this method has the advantages of stable performance and fast calculation speed, it has become the most basic and most used segmentation technology in current image segmentation.

The basic principle of this method is: firstly, the threshold of the segmented image needs to be determined according to reasonable feature standards, and then each pixel in the image is compared with
this threshold, and the corresponding sub-subs are divided according to different comparison results. In the image. The specific division formula can be expressed according to formula (1).

\[
g(x, y) = \begin{cases} 
1, & f(x, y) > T \\
0, & f(x, y) \leq T 
\end{cases}
\]  

(1)

In formula (1), T is the closed value selected for image segmentation. If it is a global threshold, then T is a small constant when segmenting the image; if it is a variable threshold T, it will change accordingly with different standards.

For threshold segmentation, the most important thing is to determine the best threshold for image segmentation. According to the characteristics and conditions of different images, the most commonly used threshold methods currently mainly include mutual information methods, clustering methods, local adaptive methods, Maximum entropy method, maximum between-class variance method, etc. The performance of different types of threshold selection methods is affected by many factors such as image contrast, target background pixel mean variance, target weight, and random noise generated in the imaging process. The performance will be affected by the difference in calculation criteria. Big difference. However, no matter which threshold selection method is adopted, the greater the difference between the segmented image and the background for threshold segmentation, it proves that the segmentation effect is correspondingly better.

The best case for threshold segmentation is that the image gray histogram has a deep and steep "valley" between the two "mountains" representing the background and the target, so it can be known that the best threshold for image segmentation is the histogram the pixel value that exists in the bottom of the valley. However, for many images, especially those that are affected by noise and cause the valley to be flat and those where the height of the "mountain" is very small, it is not easy to detect the bottom of the valley. Therefore, in order to solve this problem, many techniques have been proposed, one of which is to sharpen the "valley" by some means, so that the histogram has the characteristics of divination. Another method is to use some parametric techniques for the original histogram. Otsu is a method that can solve the problem by passing the histogram without any other verification information. This method does not have significant peaks or troughs in the image histogram, and can automatically determine the optimal threshold and obtain the optimal threshold. Satisfactory results.

3. Otsu algorithm principle

The maximum between-class variance method is a threshold determination method, which is characterized by being adaptive. If the background and the target have a larger inter-class variance, it proves that there is a larger grayscale difference between the two in the image. When a part of the background is misaligned and classified in the target, the two can be distinguished. The difference between the two is smaller. Therefore, the maximum variance between the classes means the minimum probability of misclassification. This method is applied to the field of image threshold segmentation, which can effectively make up for the insufficiency of the bimodal method in the threshold segmentation histogram.

Assume that the pixel value of a given image is divided into L gray levels, which are represented as 1, 2, 3......L. Then the number of pixels with gray level i can be expressed as ni, and so on, the total number of pixels in the entire image can be expressed as N=n1+n2+...+nL. In order to simplify this problem, the gray histogram can be normalized and expressed in a probability distribution, as shown in formula (2).

\[
p_i = \frac{n_i}{N}, p_i \geq 0, \sum_{i=1}^{L} p_i = 1
\]  

(2)
If a certain threshold $k$ can divide the pixels into two categories: target $C_0$ and background $C_1$. At the same time, $C_0$ means a pixel with a pixel gray level $[1,...,k]$. Therefore, the probability and mean of each type of event can be expressed as:

$$\omega_0 = pr(C_0) = \sum_{i=1}^{k} p_i = \omega(k)$$  \hspace{1cm} (3)$$

$$\omega_1 = pr(C_1) = \sum_{i=k+1}^{l} p_i = 1 - \omega(k)$$  \hspace{1cm} (4)$$

$$\mu_0 = \sum_{i=1}^{k} ipr(i/C_0) = \sum_{i=1}^{k} ip_i / \omega_0 = \mu(k) / \omega(k)$$  \hspace{1cm} (5)$$

$$\mu_1 = \sum_{i=k+1}^{l} ipr(i/C_0) = \sum_{i=k+1}^{l} ip_i / \omega_0 = \frac{\mu_l - \mu(k)}{1 - \omega(k)}$$  \hspace{1cm} (6)$$

The $\mu(k)$ and $\omega(k)$ in the above formula can be expressed as:

$$\omega(k) = \sum_{i=1}^{k} p_i$$  \hspace{1cm} (7)$$

$$\mu(k) = \sum_{i=1}^{k} ip_i$$  \hspace{1cm} (8)$$

$$\sigma^2_T = \sum_{i=1}^{l} (i - \mu_T)^2 p_i$$  \hspace{1cm} (9)$$

The meaning points represented are the intra-class variance, the inter-class variance, and the total variance of the entire image when the gray level is $k$. At this time, the optimal threshold selection problem can be simplified to the solution of the threshold $k$, so that it can meet any of the criteria in the above formula to obtain the maximum value problem, and the three criteria are equivalent to each other. The setting of this evaluation standard can satisfy the threshold of the greatest degree of separation between the background and the target, that is, the optimal threshold to be obtained.

The above three variance formulas can maintain the most basic relational expressions as follows:

$$\sigma_W^2 + \sigma_B^2 = \sigma_T^2$$  \hspace{1cm} (10)$$

$$\eta(k) = \sigma_T^2(k) / \sigma_T^2$$  \hspace{1cm} (11)$$

$$\sigma_B^2(k) = \frac{[\mu_T \omega(k) - \mu(k)]^2}{\omega(k)[1 - \omega(k)]}$$  \hspace{1cm} (12)$$

The optimal threshold at this time is the value of $k$ that can satisfy the formula. If the maximum value corresponding to the function has multiple values of $k$ at this time, the average value of these $k$ values is the optimal threshold.
Although some scholars pointed out: Otsu method as the most practical global threshold method they have tested. However, it needs to be pointed out that because the global threshold calculation method is not different from other methods in nature, its effect is related to the peak and trough distribution of the image histogram to a certain extent, which may cause some details of the angiographic image segmentation to be lost. Therefore, in order to obtain the best image segmentation method of Otsu's method, some necessary improvements are indispensable.

4. The need for local thresholds
When the global grayscale subthreshold distribution of a certain pixel of an object or object in an image is not obvious, segmentation of an incomplete image may only require a single pixel global grayscale subthreshold value. In practice, because the global temperature inside the control image varies greatly, the value below the global temperature threshold is generally considered to be an effective control method. For the global medical image threshold information to be collected for information processing, especially for the full cardiovascular neuroangiography seed image information sequence with relatively scattered target node positions, although the Otsu threshold cannot be calculated, this method has been widely proven to be the most effective A kind of global medical threshold image numerical information determination processing algorithm, and does not need to repeat the tedious preliminary information processing work such as information selection about image nodes, which can greatly help improve efficiency. However, there may still be huge design problems and technical limitations to be able to use a complete light global threshold value light segmentation control technology. According to the human anatomy and pathological structure of the local blood vessels and the acquired malformation imaging data, it can be analyzed that the height between the vascular target (local blood vessel) and the arterial background (other local tissues) in the image of the vascular malformation work site the contrast image level is seriously out of adjustment. The height difference between the image target and the blood vessel background in some special areas is relatively large, and the contrast is also quite high. However, some people may find that there are indeed many special areas, some of which are blood vessels and other local tissues. It is difficult to fully identify the contrast images of the contrast images that are interlaced with each other, and the interference of indoor air and light noise is added, which greatly limits the direct practical application of some Otsu radiography methods.

Otsu and its improved image segmentation methods are currently widely used, such as the two-level multi-threshold Ostu method, the cyclic recursive Otsu method and so on. Whether it is to improve the Ostu method in theory or experimentation, one of the biggest goals is to improve the accuracy of the threshold calculation for a specific target image. Even though a series of methods based on Otsu are good global threshold methods, segmentation of global thresholds needs to be within the gray range of the entire image. For angiography images, the internal differences are relatively large. In many cases, even if extreme methods are used, it is difficult to obtain satisfactory segmentation results by using all the values in the gray level of the image as the threshold segmentation object. Therefore, if blood vessels and other tissues in the angiography image interpenetrate each other, and the threshold is set too large, other tissues will be mistakenly classified as blood vessels. When the threshold is set too small, some information may be lost. Therefore, the choice of the threshold is very critical, and at the same time, it is impossible to find a threshold that can clearly separate the target and the background completely.

Therefore, in order to enable the Otsu method to accurately segment and display more blood vessels and nerve details in the angiography image in the image, according to the actual application of the target image, the choice of filtering method is to perform the previous angiography image. Preprocessing and detection are very necessary. Appropriate filtering methods can reduce the effect of the noise of the target image itself, can well maintain the boundary between each target in the target image, and improve the contrast of the image.

5. Local threshold method
One of the easiest methods in local threshold processing is to divide the entire image equivalent to the image to be segmented into non-overlapping rectangular local areas. The principle of local blocking
threshold is based on the target and background in the image. Only when it is ensured that the space occupied by the target and the background is equivalent, and the contrast is clear, the threshold segmentation technology can achieve the best possible effect. However, the image of cerebrovascular angiography cannot meet this situation, that is, because the large proportion of cerebrovascular in it is limited to extremely small, if the global threshold segmentation method is still used directly at this time, then this method will lead to invalidate.

If the image is divided into appropriately small areas according to appropriate rules, because the area of each area is much smaller than the original image area at this time, in general, for the area containing the target, the target in this area will be more important than the original image. Before dividing the area, all the objects occupy a lot more in the whole image. Such a target-to-background occupation ratio is also more suitable for threshold segmentation.

The key to a partial processing of the image signal lies in the area it occupies. One of the most ideal recognition methods is that the computer can automatically recognize and find a target area, and recognize the characteristics of this area as the focus and core of subsequent signal processing. However, for some low-contrast medical images, under the circumstances and conditions without human-computer interaction, target recognition is also considered to be a technical difficulty. For target recognition, it mainly relies on the salient characteristics of the Japanese standard, and its technical basis still relies on the recognition of the image. In this way, it will not be too difficult to recognize the clear blood vessels with a higher ratio in the angiography image, but for low image contrast and blurred blood vessels, the difficulty of target recognition is not less than that of image segmentation. In order to minimize manual intervention and improve efficiency, the article adopts the simplest way to divide the images in the form of fixed size and size. The schematic structure is shown in the following table. Although this method is simple, in actual applications and operations, when an image area is divided into multiple sizes, whether the best segmentation effect can be obtained is undoubtedly a key in the entire image processing process.

**Figure 1. Image block diagram**

### 6. 3D ray casting rendering algorithm

The limitation of the surface rendering method is that it can only display the user-specified pixel threshold equivalent surface, which means that only a part of the information from the data source can be extracted. When the different organs in the medical image sequence processed by it have higher contrast boundaries, the effect drawn at this time is better. However, when tissues and organs have very low contrast, and when there is mutual penetration between boundaries, the result of surface rendering will also lose its corresponding meaning because of the intermixing of the structures. The volume rendering method developed after that is very different from the surface rendering. The main point is that it can directly draw the volume data set, which means that all pixel data will participate in the rendering process and be reflected in the image. Can describe the internal characteristics of the data well. Therefore, this method is widely used in scientific visualization and medical imaging visualization.
The ray projection method is more dependent on the spatial position in the image sequence. This method can finally display the rays parallel to the line of sight emitted by each pixel on the plane, and each ray can pass through the three-dimensional data set that needs to be drawn. Then, according to each ray, select some equidistant data collection points. For each sampling point, take the opacity value of the eight data points that are closer to it and the color value of each sampling point to obtain these sampling points the color value and opacity value of. After that, the color value and small transparency of each sampling point on each ray are combined according to a certain direction with different weight coefficients, and then the color value at the pixel point of the ray emitted on the plane can be obtained, and the final display on the screen The detailed process of the obtained image is shown in Figure 2.

![Flow chart of ray casting algorithm](image)

**Figure 2.** Flow chart of ray casting algorithm

7. Conclusion
With the emergence of more and more medical imaging equipment, the processing and analysis of medical images are increasingly favored by countries all over the world. The two general directions of three-dimensional reconstruction and image segmentation of medical images are also two important branches in the field of medical imaging. Both theoretical research and real-life applications are constantly being developed and improved, which is for the treatment of people's diseases. And diagnosis provides more reliable basis, and has a great impact on people's life and health. Based on the research of relevant documents at home and abroad, this article has extensively understood the latest cutting-edge medical imaging research technology, and carried out in-depth research and analysis on the angiography image segmentation algorithm.

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