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The Applications of the Edge Detection on Medical Diagnosis of Lungs

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Abstract. With the development of science and technology, medical images have become important assistant means of diagnosis and therapy. However, there are many inevitable defects in biomedical images. In order to improve the readability of images and make the doctor adopt more effective observation and diagnoses way to anatomy structure and pathological part of the patient, it’s necessary to study the medical images processing. Edge detection is an important part of the processing. And the purpose of the edge detection is to enforce the effect of the edge and contour of images, and act on enlarge the contrast of images’ grayscale. First, the edge detection algorithm and detector are summarized and analyzed. Then the paper introduces the method of edge detection in vc++ MFC. Finally, this paper describes the realization process of edge detection in medical images. The results show that edge detection can enforce the readability of medical image that can help doctors make better diagnose to patient.

1. Introduction

With the continuous development of modern medicine, health has become an artistic conception that everyone pays close attention to and pursues assiduously. However, the deteriorating environment, heavy pressure from all sides and fierce competition make people's health become the goal of concern to all mankind. Therefore, the development of medicine is facing serious challenges. Biomedical images play an important role in diagnosis and treatment for doctors[1,2].

2. Edge detection algorithm

Edge is the basic feature of image. Edge detection is the basis of image processing and computer vision technology, it is also the key technology of medical image processing, the purpose is to determine the boundary of the target in the image with noise background. The quality of edge detection will directly affect the follow-up treatment process. Early classical algorithms include edge operator method (Roberts operator, Sobel operator, Prewitt operator, Kirsch operator, Laplacian operator, LOG operator, etc.), surface fitting method, template matching method, threshold method, etc. In recent years, with the development of mathematical theory and artificial intelligence, many new edge detection methods have emerged, such as wavelet transform and wavelet packet edge detection.
methods. In this paper, based on the theoretical knowledge of classical edge detection operator, edge detection of medical images is realized in Visual C++ to avoid unclear, deviation, misjudgment and misdiagnosis of X-ray images\textsuperscript{[3]}. It provides scientific reference basis for rapid and accurate extraction of image edge information and more effective observation and diagnosis of disease.

3. Application of edge detection algorithm

Edge detection has always been highly valued in the field of digital image. The main research directions of edge detection are algorithm and application:

(1) Constantly propose new algorithms. Because people have mastered the traditional edge detection method is very mature, on the other hand, with the continuous development of science and technology, people have more and more stringent requirements on the detection results, the traditional edge detection method has not been able to meet the performance index running speed and other requirements. So a variety of new algorithms have been developed. These new algorithms can be roughly divided into the following two categories: one is the detection technology combined with specific theoretical tools, such as the detection technology based on mathematical morphology, the detection technology based on statistical methods, the detection technology using neural networks, the detection technology based on fuzzy theory, the detection technology based on wavelet analysis and transformation, and the use of them. Information theory detection technology, genetic algorithm detection technology, etc. Another kind of edge detection method is proposed for special images, such as expanding two-dimensional spatial operator to three-dimensional operator to detect the edge of three-dimensional images, detecting the edge of color images, detecting the edge of synthetic aperture radar images, and detecting the edge of moving images to achieve segmentation of moving images\textsuperscript{[4\textendash}7].

(2) Apply the existing operators in practice. Edge detection can be applied to the symptom detection of medical X-ray. By means of edge detection, we can more clearly distinguish the irregular boundaries, unclear boundaries and uneven density. But in the case of lung disease, these "spots" are often seen as tuberculosis, fungal granulomas, or malignant tumors. All in all, in the rapid development of science and technology today, edge detection technology will have a very good prospect.

4. Edge detection algorithm comparison

4.1 Roberts algorithm

Roberts edge detection operator is a kind of edge detection operator using local difference operator. If an image is viewed as a matrix composed of pixels, the algorithm is actually the result of the following two matrix templates.

\[ \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \]

(\(i\), \(j\) is the position of the current pixel point) When we get the pixel value of \(G(x, y)\), let's compare it with a pre-set threshold \(A\), when \(|G(x, y)| > A\), we think that the gradient of this point is larger than we expected, that is to say, the gray level of this point changes very dramatically, and the point where the brightness of the image changes strongly is the edge point we are looking for. For the whole image, we just need to scan each pixel point one by one and calculate the comparison to find the edge of the image\textsuperscript{[8]}.

4.2 Sobel algorithm

For each pixel of digital image \{\(f(i,j)\}\}, the gray weight difference of its upper, lower, left and right adjacent points is investigated, and the adjacent points close to it have a large weight. Sobel operator is defined as follows:

\[ s(i, j) \Delta | \Delta_x f | + | \Delta_y f | \Delta \]  

(1)
Convolution operator: $\Delta_x f = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$, $\Delta_y f = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$

Take the TH threshold appropriately and make the following judgment: $s(i, j) > TH$, $(i, j)$ is the step edge point, $\{ s(i, j) \}$ is the edge image.$^9$

Sobel operator is easy to be implemented in space. Sobel edge detector not only produces better edge detection effect, but also is less affected by noise. Noise resistance is better when large areas are used, but doing so increases the computation effort and results in thicker edges.

### 4.3 Prewitt algorithm
The core idea of the Prewitt algorithm is still Roberts algorithm, but improvements have been made in the construction of two matrix templates. We set the original image as $M$, and the Prewitt algorithm USES two directional templates (vertical and horizontal). $P_v = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$ and $P_h = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$. First, calculate the image to get M1 and M2, and then take the gradient value of the calculated result. The specific process is shown as follows:

$$G(x, y) = \sqrt{(M \otimes P_v)^2 + (M \otimes P_h)^2}$$

(2)

And then we compare it to the boundary value $A$, and we get the edge point that we want.$^{10-12}$

### 4.4 Laplacian algorithm
Laplacian algorithm was also proposed by Prewitt, and it is one of the few edge detection algorithms with isotropy. The idea is to give a 3X3 template, take the center of the template as the pixel point to calculate the image, and then check whether the calculated result is different from the surrounding pixel point. Let's take a quick look. For 4 adjacent points $i, j{-1}$ $i{-1}, j$ $i, j$ $i+1, j$ $i, j+1$, Let's set $g(i, j)$ as

$$g(i, j) = |f(i, j) - f(i{-1}, j)| + |f(i, j) - f(i+1, j)| + |f(i, j) - f(i, j{-1})| + |f(i, j) - f(i, j+1)|$$

(3)

If $g(i, j)$ is less than $A$, that's what we're looking for. The same is true for an algorithm for 8 adjacent points. In this paper, 8 neighborhood point algorithm is used.$^{13}$

### 5. Experimental results and analysis

#### 5.1 Edge detection results of Roberts algorithm
The lower left is an X-ray of a patient's lungs. This is a frontal view. Two black areas represent the lungs. From the original picture, it is difficult for us to see the source of the patient's disease with the naked eye. Roberts algorithm can be used to detect the edge image. The result is shown in the figure on the right:
According to the results of Roberts algorithm's edge detection image, we can clearly see that there are some irregular lumps in the middle part of the chest of the patient in the right picture. After searching relevant medical data, the diseases that cause this type of X-ray are tuberculosis, mycotic granuloma or benign and malignant tumors.

5.2 Edge detection results of Prewitt algorithm

From the figure, we can see that the Prewitt operator can also detect the outline of the image. Every detail in the image can be detected one by one. It has good continuity and location. Compared with the results of Roberts algorithm, we can see that Prewitt has stronger anti-noise ability.

5.3 Edge detection results of Laplacian algorithm

Based on the above detection results, we can see that the detail expression of Laplacian algorithm's edge detection image is not as good as Roberts and Prewitt algorithm's edge detection, but it can still fully show the characteristics of the image edge.

5.4 Edge detection results of Sobel algorithm

It can be found that Sobel algorithm can detect the tumor contour, but the accuracy is not as weak as Laplacian algorithm and Prewitt algorithm, but the anti-noise ability is better than Roberts algorithm.
6. Experimental conclusions
Through the edge detection of lung cancer and lung tumor images above, we find that Roberts algorithm and Laplacian algorithm have high accuracy, but poor anti-noise ability, among which Laplacian algorithm can detect many subtle changes with thin edges, but produces some false edges. Roberts detected a slight discontinuity in the edges; However, Prewitt algorithm and Sobel algorithm can solve the problem of noise, but the accuracy is not as good as Roberts algorithm and Laplacian algorithm. The edges are not sharp enough and a little fuzzy. Canny algorithm is also used to judge edge points based on the first derivative. It has better anti-noise ability, but it is also easy to smooth out part of the edge information.

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