The Research of X-ray Bone Fracture Image Enhancement Algorithms

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***Abstract*—As a lower level of the image processing, image enhancement is the preparatory stage of the image processing. Its target is to improve the visual effects and purposeful emphasis the whole or part characteristic of the graphics in the designated applications to enlarge the difference between the different objects in the graphics. So it can meet the requirement of some special analysis. This paper introduced some representative algorithms of image enhancement: contrast enhancement, histogram equalization, smoothing filter, median filter, the ideal low pass filter, butter worth low filter, the ideal high pass filter, butter worth high filter and homomorphic filter. At last, the enhanced image by use of different methods were threshold segmentation and edge extraction, the results were compared to identify suitable methods for X-ray bone image enhancement algorithms.**

Keywords- image enhancement;histogram equalization X-ray; bone fracture image; homomorphic filter

I. INTRODUCTION

Image in the collection process will inevitably be under the influence of various factors such as: sensor sensitivity, noise and ADC quantization, which led to the image can not achieve satisfactory results, so in order to better research on image, made on the original image to improve the behavior of highly targeted, called image enhancement. The algorithm can be divided into spatial and frequency domain algorithm. Processing algorithm based on spatial gray level directly to do computing. The algorithm is based on frequency domain image of a transform domain transformation on the image for a correction coefficient, is an indirectly enhanced algorithms. As the purpose of image enhancement are highly subjective, and enhance the results of the merits of the standard mostly determined with the subjective observer, there is no universal quantitative standard, so in the practical application of image enhancement in the different specific applications, there is a variety of enhancement algorithms to choose from. For this reason, only through several of the image enhancement algorithm in-depth, systematic research, compare, find out the advantages and disadvantages of the corresponding application occasions, this is the subject of the purpose and significance of the study.

II. THE IMAGE ENHANCE OF SPACE DOMAIN

A. Contrast enhancement

Contrast enhancement, also known as contrast stretching to enhance image contrast is enhanced between the various parts of the original image contrast, the basic idea is to improve the image processing gray level dynamic range, that is, the original image by increasing the intensity of a two dynamic range between the value achieved. Figure 1 is a typical change in contrast enhancement, can be seen from the figure 1, the original image's gray value from 0 to s1 and s2 to the L-1 reduces the dynamic range between, and in between s1 and s2 increased dynamic range, so that the contrast within the reach of the enhancement effect, in which the s1, s2, r1, r2 can be achieved with the different demands to take the corresponding any value. If r1 = s1, r2 = s2, then the transformed gray level compared to the original gray-level did not change. If s1 = s2, r1 = 0, r2 = L-1, the transformed image only two gray levels, the greatest contrast at this time, but the complete loss of image details. [9、10]

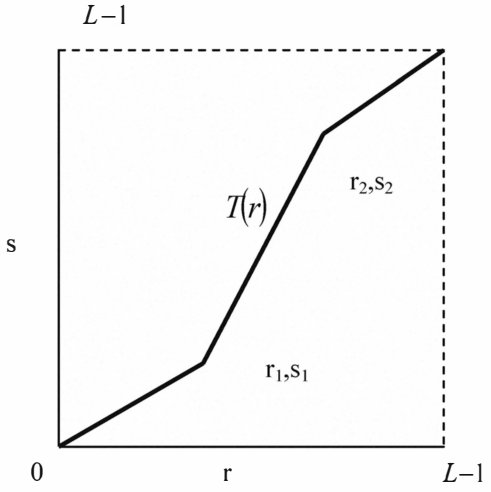

Figure 1. Contrast enhancement function diagram.

Figure 2 shows procedures for the use of Matlab simulation results obtained from the image contrast enhancement.

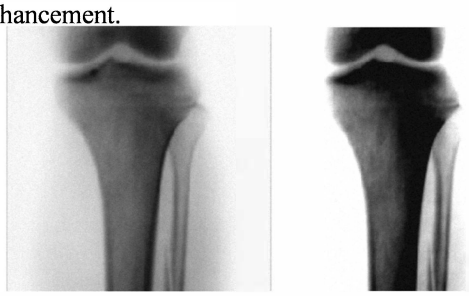

Figure 2. Comparison of Contrast Enhancement

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B. Image sharpening filters

The purpose of sharpening the edges is to make images more vivid, that is, the edges of the image enhancement processing. There are many methods of sharpening images, such as the statistical difference, discrete space and the spatial difference method of high pass filtering.

Here are some commonly used classical operators:

(1) Discrete gradient differential operator D.

(2) Sobel operator S

(3) Prewitt operator Sp

(4) Laplace operator L

Figure 3 shows he result of image simulation using of Sobel sharpening .

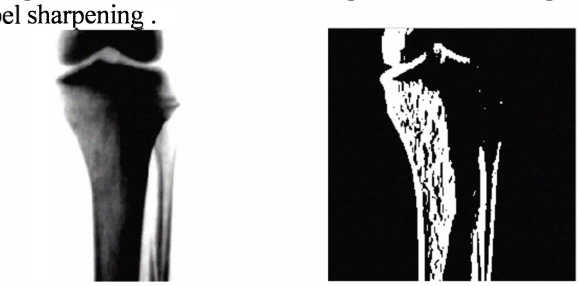


Figure 3. Image Sharpening filtering

III. THE IMAGE ENHANCE OF FREQUENCY DOMAIN

Among the practical applications, frequency domain filtering enhancement is more intuitive than the spatial filtering method and simple. Spatial and frequency domain based on the link between the basis of convolution. In the space domain, the convolution process is the template image pixels in the image point by point move, and each pixel in making the required number of operations. the ideal low pass filter, butter worth low filter, the ideal high pass filter, butter worth high filter and homomorphic filter are all used frequently,but the best effect method is homomorphic.

A. Homomorphic filtering

Homomorphic filter is in the frequency domain while the image brightness range compression and contrast for the image enhancement method. It is the image of the lighting reflection model as the basis for frequency domain processing, using the scope and enhance the contrast of brightness compression to achieve image enhancement. From this, an image pixel matrix can be used not only to represent, but also its lighting and reflection components to that, that is, [6]

$$f(x,y)=i(x,y)\cdot r(x,y)$$

where, $0<i(x,y)<+\infty$; $0<r(x,y)<1$

In order to simultaneously achieve high frequency attenuation of low frequency and enhance the purpose of the profile filter transfer function $H(u,v)$ should have the shape shown in Figure 4, will it be 360° around the vertical axis of rotation can be a complete two-dimensional filter function. Among them, $r_L<1$ and $r_H>1$ means to enhance the low and high frequency attenuation, so that will be able to compress the dynamic range of gray while the image contrast enhancement.

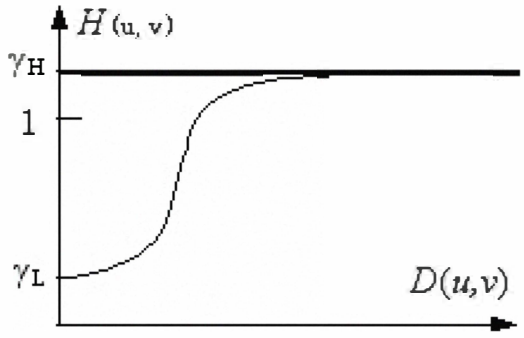


Figure 4. Homomorphic filtering characteristic function

Figure 5 is the state after filtering with the experimental results.

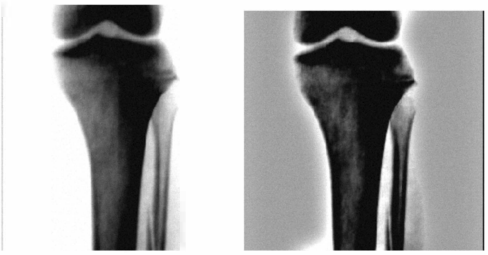


Figure 5. The effect of Homomorphic filtering

IV. EXPERIMENTAL RESULTS AND ANALYSIS DISCUSSED

X-ray medical imaging is a method commonly used. X-ray evaluation of the quality parameters are contrast and contrast resolution, fuzzy with the details of the visibility, noise, artifacts and distortion. X-ray imaging process, by the film, subjects its own, motion blur, and noise and other factors. Image is very vague and difficult to learn for medical diagnosis, so in practice must be some X-ray image enhancement processing .

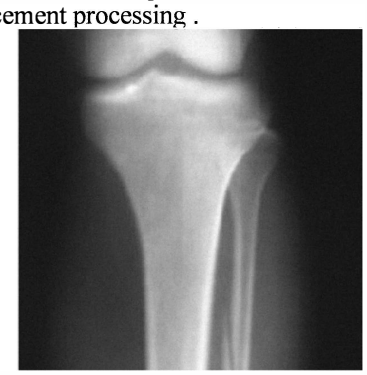


Figure 6. The original x-ray image.

A. The image enhance of space domain

First evaluated against the original image, get the reverse image, and then were on the original image and its complement a simple image contrast enhancement..

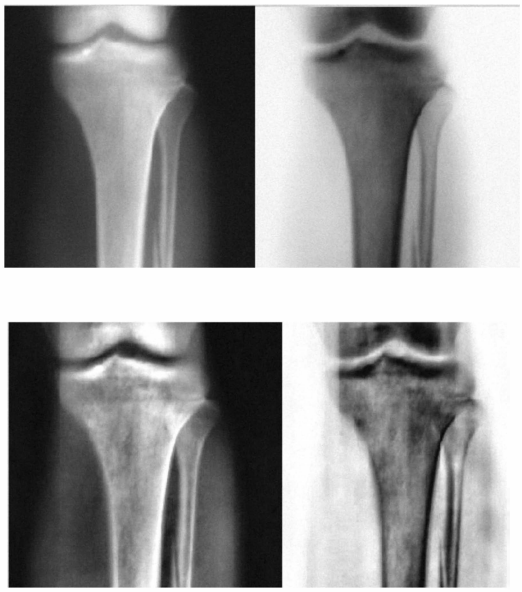
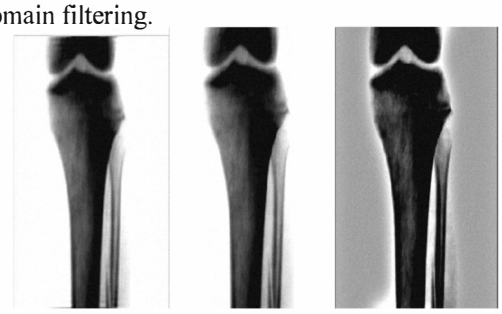


Figure 7. The contrast and spatial enhancement

B. *The image enhancement of frequency domain*

Figure 8 shows is through the airspace of the images in different contrast enhancement algorithm in frequency domain filtering.



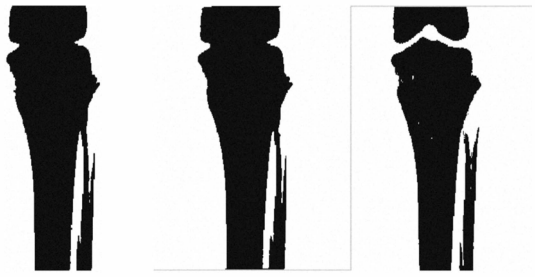
((a) Original image (b) Ideal low-pass filter (c) Homomorphic filter

Figure 8. Frequency domain filtering enhancement

Clear see through homomorphic filtering of images of the pieces of map details more clearly than the above, and the edge of a relatively clear.

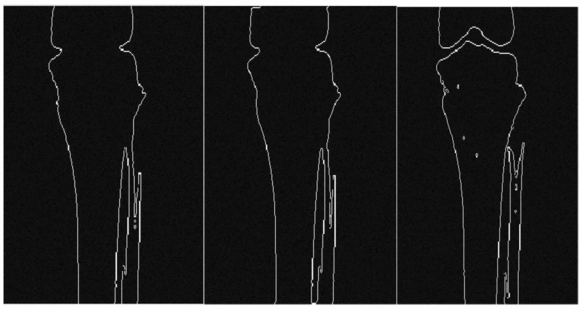
C. *Enhanced image quality assessment*

In order to better evaluate the frequency domain through the enhanced image quality, often used in two ways: threshold segmentation and edge detection. There are many threshold segmentation methods , this paper is to calculate the selected simple, stable and effective Otsu method (Otsu threshold method). The edge of the image is gray or structure information of mutation is the end of a region, is another area the beginning of differential operators by the edge of the image out of this change detection [3]. The paper selected Sobel operator, to carry out edge detection. Figure 6 on a threshold segmentation and edge detection, the results shown in Figure 9 and Figure 10.



((a) Original image (b) Ideal low-pass filter (c) Homomorphic filtering

Figure 9. Threshold Segmentation results



(a) Original image (b) Ideal low-pass filter (c) Homomorphic filter

Figure 10. Edge detection results

The segmentation and edge detection results can be seen: after homomorphic filtering of images although the introduction of the noise, but relatively few, and a greater degree of retention of the original skeleton of the real edge circumstances. Therefore, relatively speaking on the edge of the retention, Figure 10（c）is the best.

In summary, to the X-ray images,the effect of homomorphic filter is better than other methods.

V. SUMMARY

As mentioned above, image enhancement is highly subjective and objective, therefore the application of image enhancement algorithm is also highly relevant. From this, in practical applications for image enhancement and not one for all occasions and the general algorithm is better. This is more typical of several selected a simple algorithm introduced and compared, using an enhanced visual effects through better way. In actual application, the parameters affecting the selection to a large extent the result of image enhancement, so for image enhancement, in practice only the purpose of the user to choose for their own algorithms and parameters.

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