DIP Assignment 1

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November 1, 2020

1 Problem 1: CT contrast enhancement

Because of the huge workload, the hospital's CT machines have malfunctioned, resulting in unclear CT images, which seriously affects the accuracy and efficiency of diagnosis. The CT machine cannot be repaired immediately, but there are still many patients waiting for diagnosis.

To assist Li Hua, we can perform contrast enhancement on images captured by the CT machine and display the enhanced CT images to doctors. For each image in the folder data1, please perform the following operations and submit the required results.

1.1 Calculate histogram

Calculate and plot the histogram of original images and briefly comment on the shape of the histograms.

The histograms of original images are shown in Figure 1. We can see that the grayscale values of all histograms are concentrated in darker areas, which leads to the overall look of the picture darker.

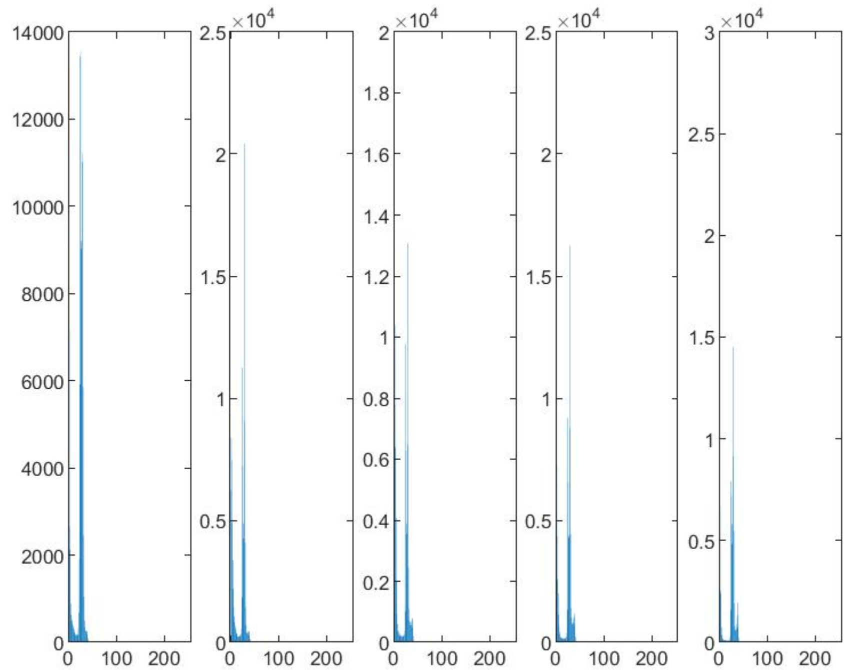

Figure 1: The histograms of original images.

1.2 Global histogram equalization

Apply global histogram equalization to original images. Submit the modified images. Check the histogram of the modified images grayscale values and comment on visually desirable/undesirable regions in the modified image.

After applying global histogram equalization, we have been able to see the image clearly overall. Take CT1 image as an example,which is shown in Figure 2.We can see that the lungs, surrounding tissues and spine can be clearly distinguished, and some details of the lungs can also be distinguished relatively clearly, but the surrounding tissues and spine are still relatively dark, and the details cannot be seen well.

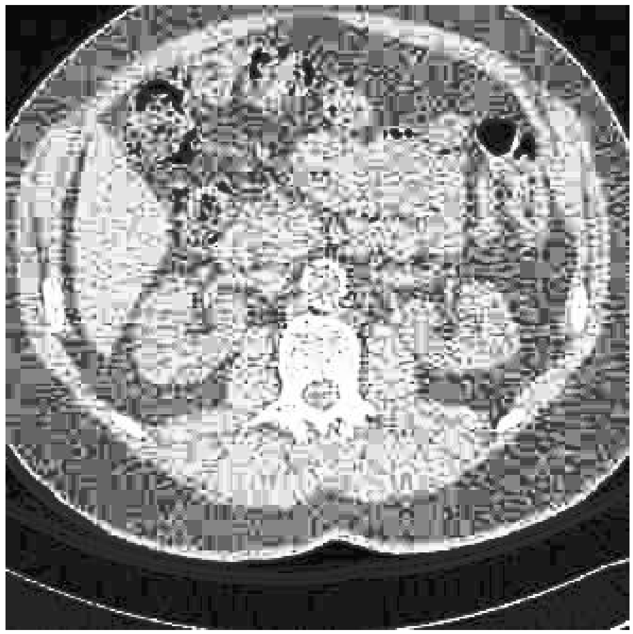

Figure 2: CT1 image after applying global histogram equalization.

The histograms of the images after applying global histogram equalization are shown in Figure 3.We can see that the gray values in the histogram have been relatively evenly distributed, but there are still a very large number of individual gray values and a very small number of individual gray value.And some gray values are not in the histograms, which make the histograms loosely distributed.

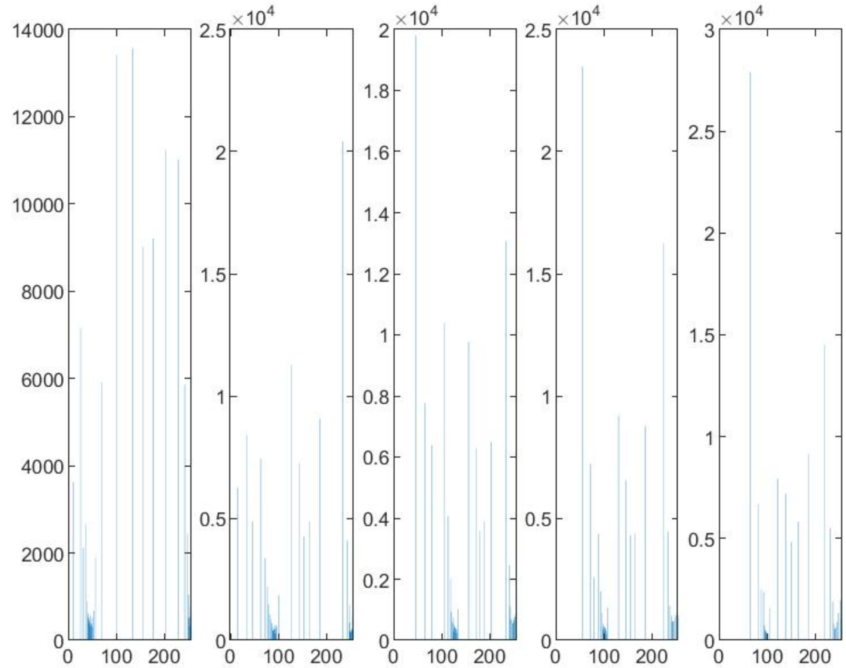

Figure 3: The histograms of the images after applying global histogram equalization.

1.3 Locally adaptive histogram equalization

Apply locally adaptive histogram equalization to original images. Submit the modified images. Check the histogram of the modified images grayscale values. Choose and report the number of tiles and the clipping limit for attaining higher contrast while avoiding the generation of noisy regions and the amplification of nonuniform lighting effects. Describe the subjective quality of the modified image compared to the result in 1.2.

There applied contrast-limited adaptive histogram equalization to the images.The number of tiles and the clipping limit of each image are shown in Table 1.

CT	Tiles	Clipping limit
1	4	0.25
2	4	0.25
3	6	0.4
4	5	0.4
5	5	0.4

Table 1: The number of tiles and the clipping limit of CLAHE for each image.

Take CT1 image as an example,the histogram of the image after applying CLAHE is show in Figure 4.We can see that the gray values in the histogram have been evenly distributed.And compared to global histogram equalization, the histogram is relatively tightly distributed, and each gray value has a certain number.

What's more,from the CT1 image shown in Figure 5,we can not only distinguish the lungs, surrounding tissues and spine clearly, but also see the details of them well.

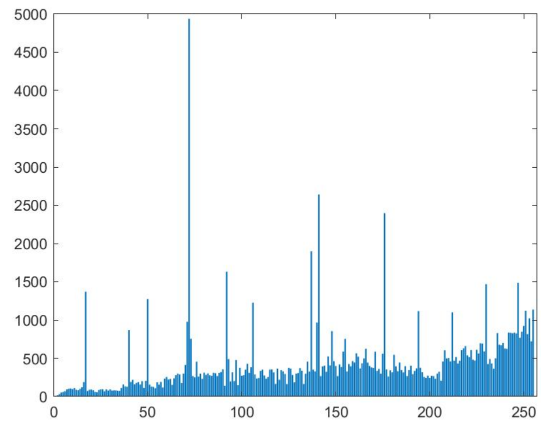

Figure 4: The histograms of CT1 image after applying CLAHE.

Figure 5: CT1 image after applying CLAHE.

1.4 γ-nonlinearity mapping

Apply a γ-nonlinearity mapping to each image to perform contrast enhancement. Submit the modified images. For each image, find and report a value of that allows you to see more details.

The value of γ of each image are shown in Table 2.

CT	γ
1	1.55
2	1.52
3	1.52
4	1.5
5	1.5

Table 2: The value of γ of each image.

2 Problem 2: Resizing X-ray images

In order to further improve the efficiency of diagnosis, the Network and Machine Intelligence Laboratory of school of software engineering helps Tongji Hospital to develop an automatic diagnosis system based on deep learning technology. Because of the mistake in specification identification (requirements engineering is really important), the hospital can only provide X-ray images of size 256×256, but the automatic detection system can only accept input of 1024×1024. Please help Li Hua resize the X-ray images in folder data2 to make the system work properly.

2.1 Nearest neighboring interpolation

Apply the nearest neighboring interpolation methods to X-ray images. Submit the modified images. Check the images and comment on the desirable/undesirable regions in the modified image.

After applying the nearest neighbor interpolation method to resize the image, we can see that the picture is similar to the original in the area with similar gray value.But the gray value has obvious discontinuity, the image quality loss is large, and obvious mosaic and sawtooth phenomenon. Especially obvious sawtooth at the edge of alternating light and dark, which is not smooth enough.

2.2 Bi-linear neighboring interpolation

Apply the bi-linear neighboring interpolation methods to X-ray images. Submit the modified images. Comment on the subjective quality of the modified image compared to the result in 2.1.

Bilinear interpolation uses the gray values of the surrounding four neighboring points to do linear interpolation in two directions to obtain the gray values of the sampling points. This method eliminates the aliasing to a large extent, but it becomes blurry on the edges.

2.3 Bi-cubic neighboring interpolation

Apply the bi-cubic neighboring interpolation methods to X-ray images. Submit the modified images. Compare the modified images to the result problem 2.1 and 2.2.

Bicubic interpolation not only considers the gray value of the four neighboring points, but also considers the influence of the gray value change rate between each neighboring point. It is an improved algorithm of bilinear interpolation. Compared with the first two interpolation methods, better interpolation results can be achieved. But some details of the interpolated image will still be lost, so the edges of the image are blurred.

Appendix A MATLAB Functions

- `[h] = my_imhist(I)` return the histogram of the image `I`.
- `[g] = my_histeq(I)` return the image after applying global histogram equalization to the image `I`.
- `out = my_clahe(I,numTiles,normClipLimit)` return the image after applying contrast-limited adaptive histogram equalization to the image `I`. `numTiles` is the number of tiles and `normClipLimit` is the clipping limit.

- `out = my_gamma(I,a,y)` return the image after applying γ-nonlinearity mapping to the image `I`.
- `out = my_imresize(I,newSize,method)` return the image after the image `I` scaled to the `newSize`. `method` is the name of the interpolation method.