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Matlab-based GUI for medical image processing

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ABSTRACT

Inequalities of outside illuminance data, spatial resolution and thickness parameter of CT machine, movement of human beings' tissue and organ are the main factors which caused the medical images affected by noise pollution, losing slight details and blurring the outline of pathologic tissue, these are problems decrease the image quality that need to be solved. The significance of this GUI design helps to provide comprehensive information about medical images which is beneficial to the confirmation of the pathological information such as location and size, raising accuracy degree of the symptom diagnosis. In this paper, a Matlab-based graphical user interface (GUI) program has been developed for medical image processing. It is an innovative method to process the medical images without user's encoding procedure work compared with previous ways. Users can use this interface system to process the image repeatedly. The result showed that the histogram modification enhanced visibility level of the subtle structure, while the smoothing filtering effectively removed the noise and increased contrast of the image.

KEYWORDS

Matlab-based GUI;
Medical image processing;
Histogram modification;
Smoothing filtering.

INTRODUCTION

With the swift development of computer technology science, a large amount of diagnosis information of hospitals needed to be displayed or stored in a digital image manner, which inevitably caused damage and distortion of medical images[1]. Matlab is a commercial mathematics software created by Mathworks company, now has been widely used in engineering calculation, control system designing, image processing, signal detection and processing, financial modeling and analysis[2]. The application of Matlab covers a lot of subjects, including the e. Presently, the design of Graphical User interface (GUI) based on Matlab was applied in solving various practical engineering problems domestically and internationally[3,4], such as online acquisition and analysis of ECG signal[5], Sports monitoring data and video interface design[6], simultaneous acquisition of force measures and Doppler ultrasound muscular images[7] and programming teaching practice etc. This paper utilized the efficiently integrated developing environment of Matlab GUI to work out a user interface for X-ray images processing system which convenient to medical workers.

PRINCIPLES AND METHODS

Genial design flow chart of GUI

The whole design was divided into 3 big modules, including interface layout, callback functions editing and systematic composition. Firstly, adding all necessary controls and creating main menu bar and its submenu. Secondly, editing the menus' properties and control's callback in M file. Finally, programming the submenu affiliated to main menu bar to open other interfaces conveniently. The genial design flow chart was shown in figure 1.

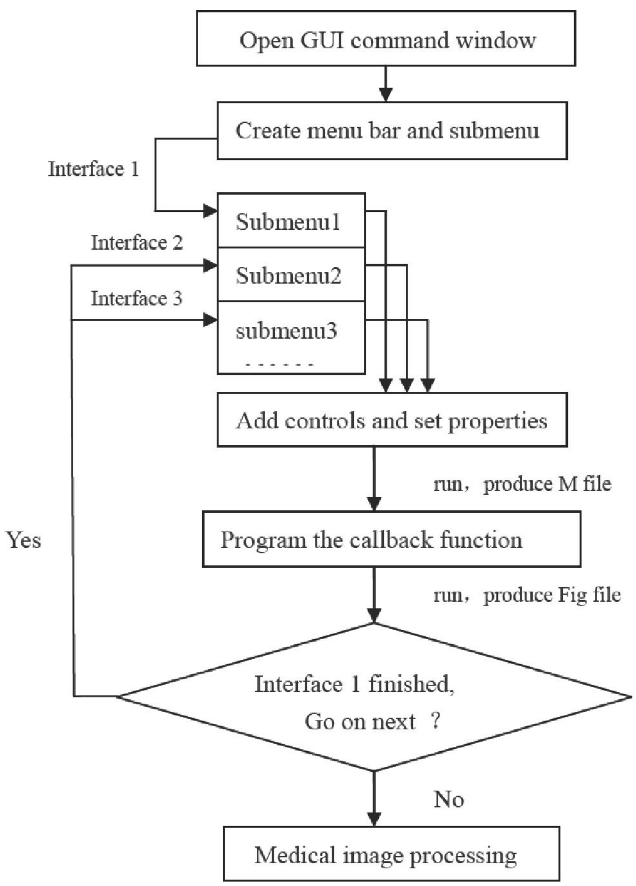

Figure 1 : Genial design flow chart

The principle of digital image processing

The purpose of image processing is to make the region-of-interest (ROI) a more clear geometry shape and high-resolution graphics.

The image histogram denoted the characteristic of the gray distribution. The transformed gray images will have an equally distributed gray histogram and increased dynamic range when the histogram adjusting or mapping transformation is accomplished. Histogram modification can also resume the losing details and improve the contrast ratio.

"Salt and pepper" noise and "Gassian" noise are two main noises commonly existing in CT images. The two noises had bad interference to the signal transmitting channels, the imaging illumination source and the scattering of the X-ray, even could led to the adverse influences on the patients' illness condition which exhibited on the images[8].

$$\delta^2 = \frac{1}{L}\sum_{(x,y)=L}[F^2(x,y) - G^2(x,y)] \quad (1)$$

$$G(x,y) = \underset{(x,y)\in A}{Med}\{F(x,y)\} \quad (2)$$

$$G(x,y) = \frac{1}{M}\sum_{(m,n)\in S} F(x-m, y-n) \quad (3)$$

Equation (1) (2) (3) is respectively the mathematical expression of Winner filtering, Median filtering, Neighbor average filtering.

$G(x,y)$ is the transformed gray value, $F(x,y)$ is the gray value of the (x,y). L is the selected neighborhood unions, δ is the mean square deviation. A is the chosen filtering window, S is the selected neighborhood union, M is the number of pixels in S.

RESULTS AND DISCUSSION

Gray histogram transformation

The results of the gray histogram transformation were shown in figure 2.

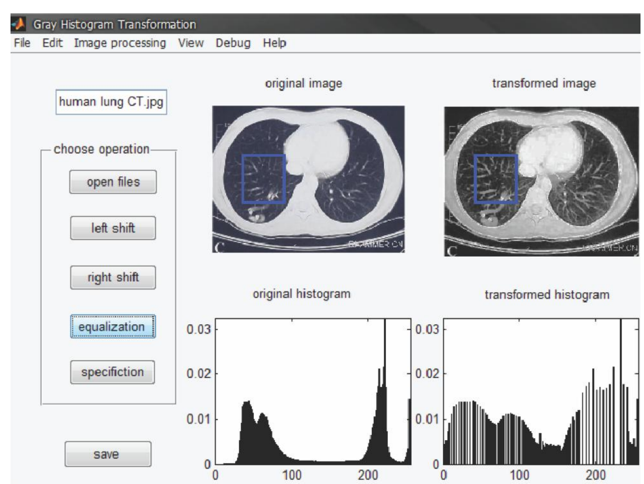

Figure 2 : Graphical user interface for histogram

It can be concluded from the comparison between blue square frames that the transferred image had a more excellent contrast, a raising luminance degree and improved details of the subtle structures. Meanwhile, the interval of the histogram was extended, it also had an even trend. The effect of the equalization was equivalent to transfer the original medical image into n discrete gray scales, resulting a well-distributed gray histogram.

Other results were obtained as shown in figure 3. From the analysis of the consequences marked with green and blue square frame (In this paper, green represents the image before filtering, while blue represents the image after filtering), the pixels gray scale concentration area generally moved toward the low gray scale concentration area when left-shifted, the image correspondingly presented the dark characteristic. While the right-shift had an adverse result. The specification can choose a dynamic range for the gray level based on the real situation, the transformed histogram showed a designated graphic configuration, which made the specific details more clear and distinct[9-11].

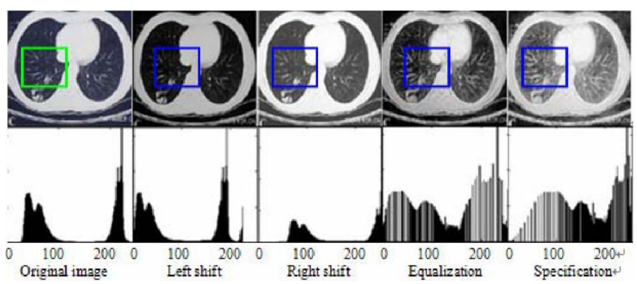

Figure 3 : Results of histogram

Smoothing filtering

The result of GUI design for smoothing filtering was showed in figure 4. The whole course was comprised by two parts, including adding noise and filtering.

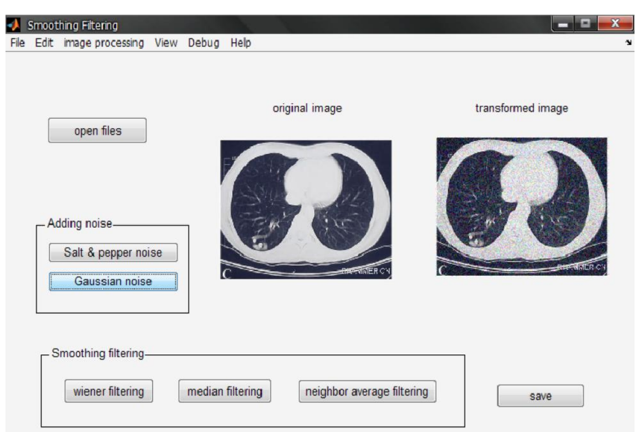

Figure 4 : Graphical user interface for smoothing

In Figure 5, the images row above were the ones added "Salt and Pepper" noise and its results, while the row blow were the images added Gaussian noise and its results. From the analysis of the filtering results shown with mark frames, the smoothing filtering had an effective work both on the attenuation of "Salt and Pepper" and Gaussian noise.

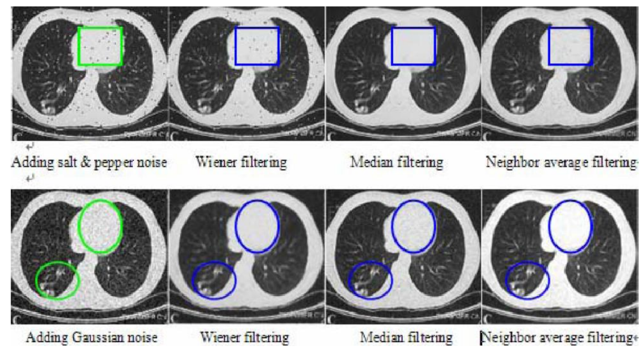

Figure 5 : Results of Smoothing

For the "Salt and Pepper" noise image, Median filtering not only filtered the noise, but also had a good effect on smoothing the image as the blue square frame showed. The Wiener filtering was not satisfactory for filtering all the sparkles completely, while the Neighbor average filtering resulted in a roughness side effect in the image.

For the Gaussian noise image, the result of Neighbor average filtering was satisfied overall, the noise was not only totally filtered, as the blue ellipse frame showed, but also the subtle details of the structure was more clear-cut, as the blue circle frame showed. Comparatively speaking, the median filtering cannot be effectively filter the Gaussian noise, the image remained awful by the noise interference. The Wiener filtering produced a light blur to the details and the image edge, though it filtered the noise well.

CONCLUSION

This paper designed an image processing system based on Matlab GUI. the results showed that this systematic user interfaces can not only improve the image quality, gain the visibility and restore the hidden information, but also the encoding procedure work for the image processing can be left out, so user can directly process the medical images by operating on the icon control in the interface, it is more convenient and simple.

With the progress of the medical imaging technology and continuously deepened hygienization informa-

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tion, the medical digital image processing technology shows predominance over the sharp increase in image data utilization. In order to meet a steadily growing trend with complex and diversity, the science technology concerning the digital image processing requires perpetual exploration and research.

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