Background Removing for Digital image self-adaptive acquisition in medical X-ra imaging

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ABSTRACT

In this paper, we propose a new method of background removing for digital self-adaptive acquisition in medical X-ray imaging. We analysis the construction of video digital acquisition system and main factors of acquired image quality, propose a more efficiency method to against background non-uniformly. With proposed method, non-uniform illumination back ground was well removed without image quality degradation.

Keywords: Digital image acquisition, pre-processing, X-ray CT

1. INTRODUCTION

Recent years, the digitalization of X-ray imaging has been a very important part for PACS (Picture Archiving and Communication Systems) [1]. Advantage of digital imaging over conventional analog methods include the possibility to archive and transmit images in digital information systems as well as to digitally process pictures before display, for example, to enhance low contrast details, or reduction of noise. Also, it is useful to recognize the valid regions in digital images of medical X-ray imaging and make these regions the only regions to process. Recognition of valid regions not only reduces image storage and the quantity of operations, it also improves the quality of the images[2].

In [3],[4], a self-adaptive acquisition in medical X-ray imaging was proposed. The system construction is shown in Fig. 1. The heart of the PACS system is a digital image processor system which not only acquires images from a television camera but also provides timing signals to both the X-ray generator as well as the image acquisition system to control the flow of data from the X-ray beam into the image processor. The characteristic of medical image is used to extract the valid region of image by integrating region growing, edge detecting, Hough transform, and background removing [5]. After those preprocessing, self-adaptive parameters setting is executed based on dynamic analysis of histogram. Finally, acquisition parameters are studied by expert universality for various samples.

If we remove the background from the acquainted X-ray image with previous method in [3],[4], the details will be weakened where the grade region around the edge of the device cycle overlapped with bones after digital subtraction, which possibly causes information losing. We improved the traditional method by insert a

comparison step before apply digital subtraction. This could prevent the problem efficaciously.

Rest of this paper is organized as follows: Section II introduces background removing principle. Section III proposes a new method to remove background and shows computer simulation results. Section IV concludes this paper.

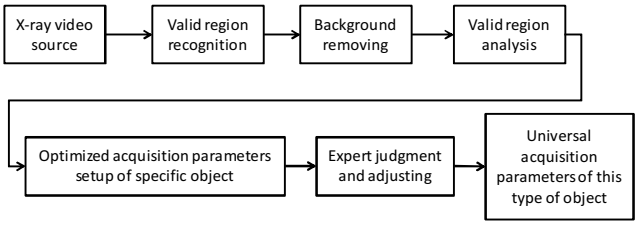

Fig. 1. Self-adaptive digital acquisition system block diagram.

2. BACKGROUND REMOVING

Non-uniform illumination background will affect image quality and the computing of image characteristic to adjust

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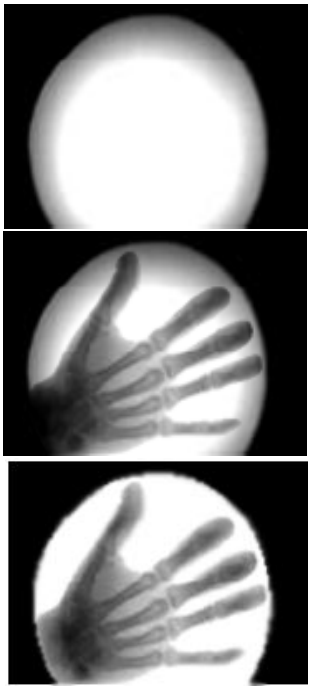
acquisition parameters. When the base color of background is white, the gray shade is mainly appeared near edge as Fig. 2(a). We can remove the background with digital subtraction [6].



(a) **Device background signal**

(b) **Acquired image with nonuniform background**

(c) **Image after removing device backgoround**

Fig. 2. Normal background removing.

In digital image subtraction processing, two images are acquired, the first is "mask" image modeled as $M \times N$ mathematic matrix I_1, which is obtain before the object is put into X-ray beam. Cells of the matrix represented the position and value of corresponded pixels. The second image is the normal image modeled as matrix I_2, which have a superposition with object and gray shade near edge. These can be represented as follows.

$$I_1 = \begin{pmatrix} a_{11} & a_{12} & \cdots \\ a_{21} & a_{22} & \cdots \\ \vdots & \vdots & \ddots \end{pmatrix} \quad (1)$$

$$I_2 = \begin{pmatrix} b_{11} & b_{12} & \cdots \\ b_{21} & b_{22} & \cdots \\ \vdots & \vdots & \ddots \end{pmatrix} \quad (2)$$

Digital image subtraction is applied as follows.

$$I_3 = I_2 - I_1 = \begin{pmatrix} b_{11}-a_{11} & b_{12}-a_{12} & \cdots \\ b_{21}-a_{21} & b_{22}-a_{22} & \cdots \\ \vdots & \vdots & \ddots \end{pmatrix} \quad (3)$$

$$I_4 = 255 - I_3 \quad (4)$$

The main algorithm is: acquire and save device background signal (I_1 Fig. 2(a)) first when device is idle; then acquire images to be observed (I_2 Fig. 2(b)); after that, we apply image operation as subtraction ($I_3 = I_2 - I_1$); background removed image signal is I_4.

It is easy to know that the image of bones in overlapping area in the edge of device circle is also be subtracted and weakened as shown in Fig. 4(a).

3. THE PROPOSED REMOVING METHOD AND SIMULATION

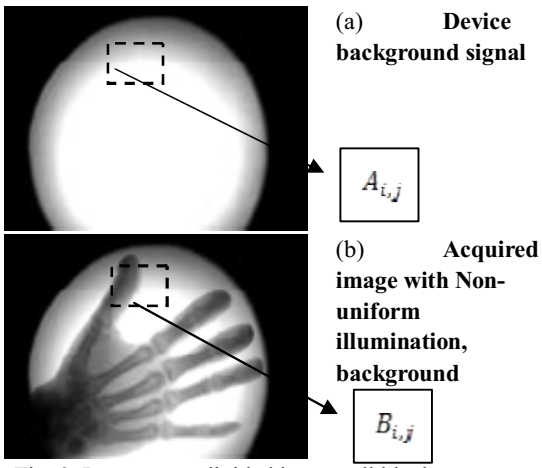
In our proposed method, we make a comparison with "mask" image and normal image, and digital image subtraction only applied where the pixels value of normal picture is greater than the correspond pixels value of "mask" image.

In some situation, the gray shade is appeared variably because of noise or X-ray generator control. So we divided each image into many small blocks as shown in Fig.3. These can be represented with matrixes as follows.

$$I = \begin{pmatrix} A_{11} & A_{12} & \cdots \\ A_{21} & A_{22} & \cdots \\ \vdots & \vdots & \vdots \end{pmatrix} \quad (5)$$

And each block represented as follows.

$$A_{i,j} = \begin{pmatrix} a_{11} & a_{12} & \cdots \\ a_{21} & a_{22} & \cdots \\ \vdots & \vdots & \ddots \end{pmatrix} \quad (6)$$



(a) **Device background signal**

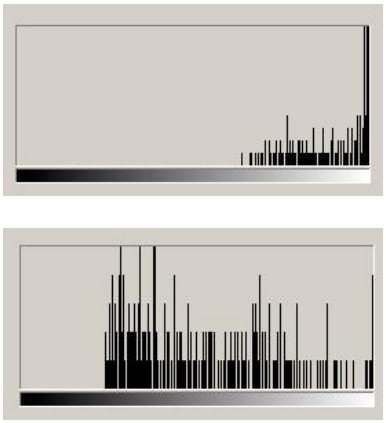
(b) **Acquired image with Non-uniform illumination, background**

Fig. 3. Images was divided into small blocks.

Then make histogram analysis to each pair blocks of "mask" image and normal image. Fig. 4 shows us the histogram analysis results of the areas in image (a) and image (b). From the histogram, we can know the average pixel value of Fig. 3(a) is $\overline{a}$, and Fig. 3(b) is $\overline{b}$. After repeatedly experiments, we can find an appropriate value p where p is the average of

$\overline{a}$ and $\overline{b}$.

Then compare the pixels value of acquired image with p, if the pixel value is greater than p, then apply digital subtraction, and the outcome is value of I_4; otherwise, copy the pixel value to I_4.

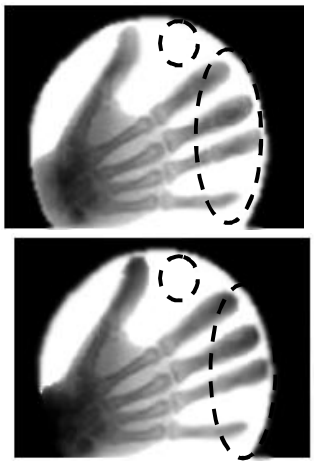


(a) **Histogram of small area in Fig.3(a)**

(b) **Histogram of small area in Fig.3(b)**

Fig. 4. Histogram analysis results for selected blocks

We simulated above mentioned methods using Matlab Ver. 7.0. Fig. 5 illustrates the comparison of the images with different method. And we divided images into many 15 by 10 pixels blocks. Fig. 5(a) shows the simulation result with traditional method, the background is well removed but the finger tips are weakened in edge of the circle also. Fig. 5(b) shows the result with our proposed method, background is well removed while less information losing in the image.



(a) **Simulation result with traditional method**

(b) **Simulation result with proposed method**

Fig. 5. Simulation results with different methods

4. CONCLUSION

In this paper, we proposed an improved method for background removing, which as an important part in digital X-ray image acquisition system. Our proposed method is better than traditional method for removing the background of device where overlapped with required region of bones. With proposed method, the gray region could be well eliminated, which could help doctors to diagnose

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