Optimization Research On Weld Image Based On Computed Radiography System

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Abstract

Computed radiography (CR) with storage phosphor based luminescence imaging plate (IP) is based on the principle that phosphors can be developed in such a way that they retain the latent image information until stimulated by laser light. This paper focuses on the application of industrial X-ray detecting and image processing techniques. In order to improve the validity of the images it is necessary to filter the noises. Analyzed where the noises come from and what the noises' character is and what kinds of relationship between the noise and the useful information from the images. Researched some methods of image enhancement and filtering. The results showed that CR system has its advantage such as high resolution、little radiation dosage.

Keyword: Computed radiography; Imaging plate; Digital Image Processing.

[1]1. Introduction

CR system uses imaging plate (IP) to record X-ray image, which records X-ray image of permeating objects in the imaging plate which is made of the fluorescence material, sensitive imaging plate forms the latent image in the fluorescent material, the imaging plate of the latent image is placed on the readout system[1] in order that the laser beam is used to carry on the fine scanning, which transforms storage signals into optical signals and converted into photomultiplier signals by PSL, then carries on the A / D converting, finally forms high-quality digital images after Computer processing.

During CR imaging process, it will result in the lower contrast, blur, unclear edges and details of image that due to the used physical methods, the complex structure of the detected objects and X-ray scattering, noise and other factors of the imaging system, finally lowers the image quality. CR image noise mainly includes X-ray dependent noise (X-ray quantum noise) and X-ray independent noise (inherent system noise) two categories. Among them, quantum noise is generated in the process of imaging plate absorbing X-ray, which is inversely

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proportional to detected X-ray dose by imaging plate, incident dose is the greater, X-ray quantum noise is the smaller. Inherent Noise includes IP structure noise, laser noise, quantifying noise of A / D conversion, IP structure noise is the main sources of inherent noise, it is subject to the Gaussian white noise. X-ray scattering can be reduced by the appropriate improved ray energy, Pb plate back protection and filtering plates in the ray window and other measures. For the image of the low-dose, the noise is mainly quantum noise; for the high doses, the noise is mainly the inherent noise which almost does not depend on X-ray dose. Low-dose areas are mainly distributed in the image edge, high-dose areas are mainly distributed in the imaging area of testing. Therefore the system inherent noise is the main part of removing noise.

2. Methods

In the CR system, the images are blurred and lots of noise. Regarding the characteristic of X-ray detection images of weld, defect extraction techniques were studied. A new class of threshold function is proposed. The results show that this method is effective in removing noise. We can change dynamic range using grey nonlinear transformation, and make fine structures improved using unsharp masking, enhancement images by wavelet image fusion. Background be simulated, and then defect region were extracted successfully using arithmetic of digital subtraction. The variance ratio of interclass and intraclass segmentation can accomplish defect extraction.

3. Digital Subtraction

DSA first appeared in the medical technology. It is used in the human body's vascular angiography [2]. In engineering, also needs to state component's internal components, we may use DSA technology. X-ray digital subtraction of the working principle is built on the image subtraction. we can subtract two image which in different conditions ,so the background interference is eliminated, enhanced the difference between the two images, highlighted the value of the retained interest from that part of image information.

After X-ray go through the object , the intensity that X-ray arrived at X-ray detector is I , according to Bill - Lambert's law, the attenuation is:

$$I = I_0 e^{-\mu T} \qquad (1)$$

Among them, I is X-ray intensity of through objects, I_0 as the total X-ray intensity; μ is line attenuation coefficient of material, it relate with ray of energy, the atomic number and density of material. T is the thickness of the material. When the same thickness of the specimen, but flawed, are as follows:

$$I' = I_0 e^{-(\mu+\mu')T} \qquad (2)$$

In the formula μ' is the flaw line coefficient of attenuation, (1), (2) takes the logarithm and subtract, we obtain the formula

$$D = -\mu' T \qquad (3)$$

D is called the logarithm subtraction image. From the formula (3), the flaw has separated from the background. Because of taking the logarithm to subtract, the image's

dynamic range reduced greatly, the image contrast gradient is quite low. we must try to restore the dynamic range of image .we can enhancement contrast gradient by grey nonlinear transformation.

In digital subtraction, two images will usually translation, revolving .The two images need the precise matching, the matching process are quite complex. The ideal weld is unable to duplicate under the similar working condition, therefore only embarks from the existing actual weld image, simulates the background images to reduces the shade, here does not need the image match. Commonly used is seeks one kind of filter which have the good low pass characteristic or the methods, the picture detail is filtrated, leaves low frequency band background information, thus achieves the simulation background. We use mathematics morphology theory to carry out the background simulation

4.Experimental

The experiment selects the steel plate welded joint of the defects[3], steel plate thickness is 13mm, whose welding method is the flat welding way. The experimental condition is: X-ray tube voltage is 125KV, the electric current is 2.5mA, the focal distance is 800mm, exposed time is 25s. A piece of 0.1mm copper foil is placed on the ray source port to absorb soft radiation and reduce the scattering. The result is showed in figure1—figure7.

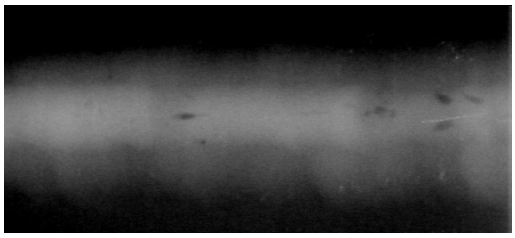

Figure 1 primitive image

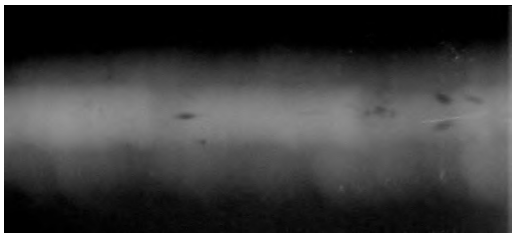

Figure 2 after noise reduction image

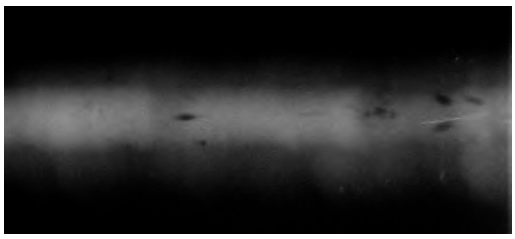

Figure 3 grey nonlinear transformation image

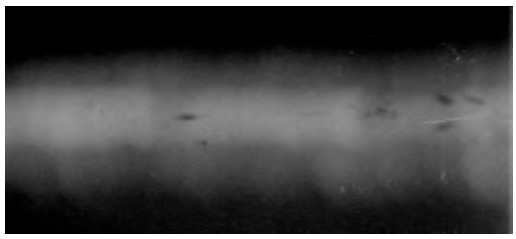

Figure 4 high frequency enhancement image

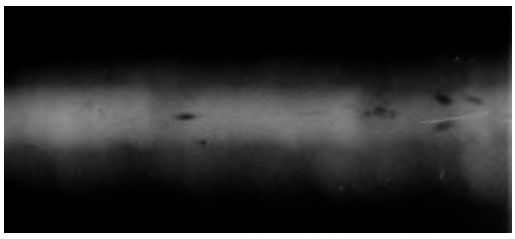

Figure 5 fusion image

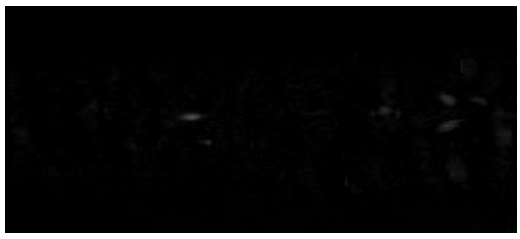

Figure 6 reducing the shade and counter-color image

Figure 7 threshold value division image

5. Conclusion

The actual X-ray detection characteristics produces the lower contrast, blurred defects edges, a great of noise and background fluctuation of the X-ray detected image, which results in the accurate exacted and segmented defects becoming the key problem in this kind of technology correctly. The paper uses the wavelet denoising threshold value function to effectively reduce the image noise, the image fusion's method can effectively increase the detail of the contrast difference, which stands out the image edge and detail characteristics, improves the image quality, and is advantageous for the following processing. The digital subtraction method can maintain the original shape and size of defects, and does not limit the type and size of defects. The experimental result showed that this algorithm can get the approving effect.

Reference

[1] K.Hasegawa, Y.Yoshioka, S.Ohya, and M.Sasano. Imaging Readout System. Nucl.Instr.and Meth.A,vol.310,pp.366-368,December 1991.

[2] Kruger R, Rieder SS J.Basic Concepts of Digital Subtraction Angiography. Bosten: Hall Medical,1984

[3] N. Nacereddine. Automated method implementation for detection and classification of weld defects in industrial radiography. M.S. thesis, Dept. Automation, Boumerdes Univ., Algeria, 2004.

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