Design of Film Digitizer Equipment and Film Weld DefectRecognition Technology in Pressure Vessel

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Abstract: According to the characteristics of image defects, this paper integrated use of image preprocessing, image segmentation algorithms, expert systems and other methods, presented a film weld defect identification method for non-destructive testing in the pressure vessel weld defect recognition, and to achieve in MATLAB. This paper also described the expert system's basic principles, structure, establish methods and identification strategy. In the light of the weld defect characteristics from different levels of recognition, through continuous testing to improve the film defect system library and to further enhance the defect recognition rate.

Keywords: Film Digitizer; Pressure vessel; Weld; Defect identification

1 Introduction

Industrial ray detection (RT) is an important method of non-destructive testing industry. In the internal quality testing of pressure vessel welds and castings, X-ray detection is an important non- destructive testing method[1], use the results to determine the type of weld defects, the location and size, thus, to judge whether the welding qualified. The usual X-ray film weld assessment is in a artificial way, putting the film on the fluorescent lamp to determine the welding quality, by experienced staff. The main shortcoming is this artificial weld evaluation full of uncertainty, evaluation results vary from person to person according to the level of employee's business, lead to the assessment results lack of accuracy and standardization. Another key point is that assessment operation process always is hard to grasp, using standard methods, cumbersome manual and a few inefficient ways to assessment the welding[2], therefore, traditional ways are starves for innovation. With the rapidly development of image processing technology and artificial intelligence technology, we can use computer to improve the assessment efficiency and accuracy, reduce the labor intensity and ensure the consistency of evaluation results, also can improve the recognition stability and liberate the workforce[3].

This paper summarizes existing research, proposed the weld defect recognition technology of the film pressure vessel.

2 Film digitizer equipment design

2.1 Equipment components and operating mechanism

The system uses machine vision approach to design a complete set of film digitization system, uses cold light source through the radiation film, in addition, the adjustable brightness are more than 1000001x, and take the 12bit industrial line matrix CCD camera as the image scan and capture device[4]. In order to shield the ambient light and cut the CCD noise, using a sealed enclosure loaded up all the devices, only opens a small window between the light source and CCD. CCD camera communicates with the computer through the USB port. With its own configured of the optical lens of Nikon AF 50mm. Equipment components shown in Figure 1.

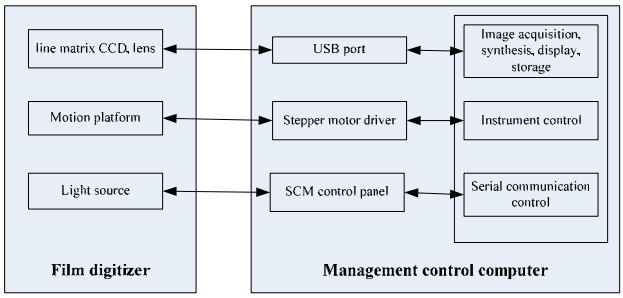

Figure 1. Equipment composition diagram.

Equipment using linear industrial CCD camera to capture the image, solve the shortcomings of array CCD's slow scanning speed, low resolution and the digitization of long film; Using the uniform LED line light source as the background light source to solve the common light source heat, insufficient strength, uneven light intensity and other issues, also can control the light intensity by the the gear switch on the chassis; Using the vertical film transport mechanism witch adopt two step motor drives the left driving wheel and the right driving wheel to control the negative transfer mechanism and the

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clamping plate movement ,respectively. We can measure the location of film through the photoelectric position sensor, gather the running speed by the signal of circular grating sensor and control the speed of the stepper motor by movement control card. Thus, we can realize the synchronous control of image scanning and ensure the accuracy of the linear CCD scanning. The film recycling box is installed at the lower part of the back end of the case, so when the film scanning is over, the film will fall into the recovery box,automatically.

2.2 Information contained in digital film

Digitized film mainly consists of three areas: the weld zone, date area and code region. Weld defects present in the weld area. Defect feature and defect size obtained through image processing, according to the structure, size, surface morphology, etc. Combined with national standards and expertise to identify and classify the weld defects, ultimately. Defect characteristics are divided into boundary characteristics and regional gray feature. The boundary shape of defects is just a reflection of the type of defect, and the internal region of defects contains a large number of closely related with the defect type information. Based on the pressure vessel fusion welding butt joints quality grading requirements, weld defects can be divided into the following five categories: crack, incomplete penetration, lack of fusion, strip defects, circular defects. According to the nature and number of weld defects, quality grading are divided into four, I class quality is the best, IV class quality is the worst[5].

The instrument will transmit the digital film picture to computer, then, we can carry out the image enhancement, image denoising, image correction by computer software witch embeded out image preprocessing algorithm and defect recognition algorithm. Finally, we can realize the complete remote evaluation system.

3 Defect type recognition

Expert system based on image characteristics to identify parameters and the structure of expert systems is in the ongoing process of identifying logic until they have to meet the actual requirements of the solution. The system uses forward reasoning strategy, starting from the image input processing, forward reasoning, to the target state[6], the specific steps are as follows, shown in Figure 2.

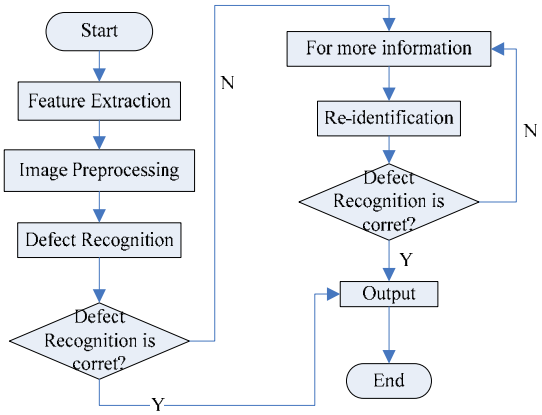


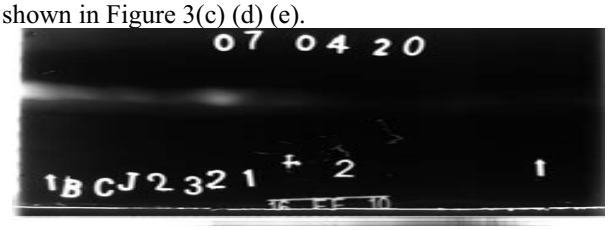
Figure 2. Defect type recognition flow chart.

The film weld image information's obtaining includes extraction of image features, image pre-processing and double-precision transform, and received the binary image[7]; Inference of the user input information and knowledge base helps to match the conditions of the various rules and regulations to the conclusions being stored in an integrated database for the initial identification. The results obtained defect category; If the results confirm the identification of weld defects, then, terminate the expert system knowledge-based identification of reasoning and output the results to identify; If the weld defect identification is not correct, system will give question to the user again, up to obtain more information about the characteristics of film defect feature and other information; Using reasoning inference results, again, to match with the information of expert system knowledge base for the deep identification, until the defect is correctly identified, it will output the reasoning results and defects type[8].

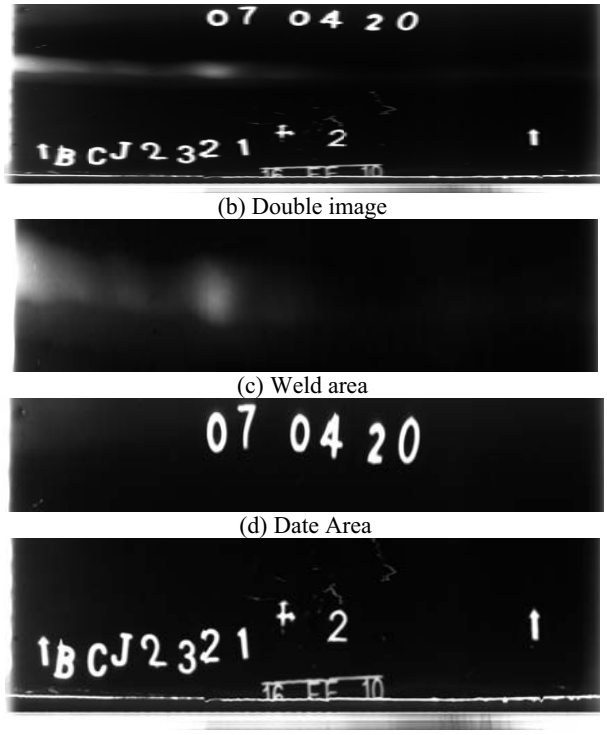
4 Results

Through film digitizer to obtain the original grayscale image film, as shown in Figure 3(a), and then process the original image by various image preprocessing method. Such as double of grayscale images, using im2double functions convert the original image to double precision image, then double-precision image result shown in Figure 3(b).

The nest image-processing operation are cut and split the double-precision image. Image segmentation is the key step of weld defect identify. The various parts of the image region will noticeable and obvious by pre-processing and with that use threshold-based method to achieve image segmentation. Film images will eventually be divided into three regions: the weld zone, data area, coding region, three regions of the image shown in Figure 3(c) (d) (e).



(a) Original image



(b) Double image

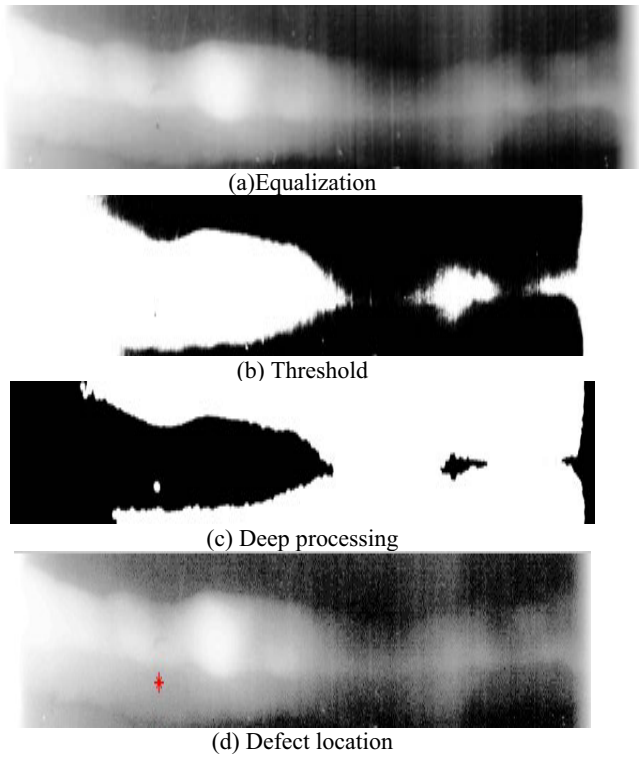
(c) Weld area

(d) Date Area

(e) Coding region

Figure 3. Film image.

And then we will implement the deep image processing of the split image parts, take the focus on the weld area. After equalize the weld area images, we can get the high contrast image shown in Figure 4(a). And then take the processing of image threshold on Figure 4(a) , we obtain the Figure 4(b). Finally, corrode the image and invert the pixels, at the same time, connecting the edges noise and the background to remove noise, then we get the image as shown in Figure 4(c).



(a)Equalization

(b) Threshold

(c) Deep processing

(d) Defect location

Figure 4. The results of weld area.

For the weld area images, first step is regional mark, mark the background area of 1; then, judge the dimension value is greater than 1, if the mark value is greater than 1, indicating a defect exists; finally, calculate the center defect region, for defect location. Positioning results shown in Figure 4(d). The red points are the weld defects. The conclusion is that the film's defect is non-fusion defect type.

5 Conclusion

In this paper, we proposed the expert system based film pressure vessel weld defect recognition technology in MATLAB for simulation and implementation. By a large number of repeated tests and constantly enrich and improve the expert system to improve the system's ability to identify defects, experimental results show that the system identification of typical defects is better than traditional ways. But for some cross defects, the effect is not very satisfactory. The training with small sample size of typical film defects is also the cause of low recognition rate. In order to improve the recognition rate, we can combine the fuzzy neural network with expert system, thus further improve the recognition rate.

In pressure vessel X-ray detection in our industry, the results of this research both meet the current efficient and accurate detection of requirements, also meet the digital needs for the analysis of X-ray detection and identification of defects. The promotion of the technology can achieve good economic returns, and improve the standardization, traceability of detection, which full of great significant.

Acknowledgements

This work was supported by the 2011 Special research projects in shaanxi province education department (Project name: Intelligent analysis technical research film defects based on the expert system in pressure vessel NDT, Project number: 11JK0921),and transverse project of special equipment inspection institute in Shandong province (Project name: Digital film and defects in intelligent analysis technology research and promotion in the X-ray testing) ,and 2013 industrial research projects in shaanxi province science and technology department(Project name: X ray film digitizer and weld image defect detection and recognition system in nondestructive testing, Project number: 2013K07-15).

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