Available online at www.sciencedirect.com
ScienceDirect
NDT&E International 40 (2007) 397–404
NDT&E international
www.elsevier.com/locate/ndteint

Research on segmentation and distribution features of small defects in precision weldments with complex structure

Duan-Hu Shi*, Tie Gang, Shuang-Yang Yang, Yuan Yuan

State Key Lab of Advanced Welding Production Technology, Harbin Institute of Technology, Harbin 150001, PR China

Received 31 August 2006; received in revised form 25 December 2006; accepted 19 January 2007
Available online 11 February 2007

Abstract

In order to study the segmentation and quantitative problem of small defects in precision weldments with complex structure, an automated image processing system was setup based on the Visual Basic 6.0 development environment. The weld zones were extracted by adopting the method of twice automatic threshold, and the small defects were segmented successfully by using sharpen, smoothing processing and background subtraction in the extracted weld zones. To determine the spatial distribution features of small defects, calculation formula of defects depth and deviation were deduced individually, and the projection distance of small defects can be extracted automatically also. The image processing system can achieve the goal of small defects segmentation and automatic extraction of projection distance. The depth and deviation of small defects can be obtained through the above deduced formula, and the longitudinal distribution of small defects can be obtained from the detection image, then the spatial distribution features of small defects can be determined.
© 2007 Elsevier Ltd. All rights reserved.

Keywords: X-ray detection; Precision weldments; Complex structure; Small defects segmentation; Distribution features

1. Introduction

Titanium alloy is widely used in aerospace and other important industry products because of its excellent overall properties. Laser welding is greatly fitted to weld titanium alloy sheets because of its marked features such as energy concentration, small heat input, good formation of weld, purification effects and so on. However, porosities and other defects will occur in the weld because of quick cooling velocity and bad protection [1]. Because the fatigue life will reduce when there are porosities and other defects in the weld, and catastrophic accident will take place in some severe states, especially the defects exist in the weak parts of weldments. So nondestructive testing must be done to ensure the security of important structures. As a traditional nondestructive testing method, X-ray detection is widely used for the inspection of industrial products and for the medical diagnosis of human diseases. Because of the expensive cost and time-consuming of radiographic testing with film, real time radiography technology has been developed and applied in the nondestructive testing of important industry products. In order to reduce the subjective and inconsistent of manual interpretation, it is imperative to develop the automatic image processing technology to enhance the objectivity, consistency and efficiency of small defects detection. Since the weld of precision weldments with complex structure is very small, and the weldments structure is very complex comparing with the conventional structure, the segmentation and locating of small defects in complex structure is a very challenging task. And in order to improve the speed of image processing, the extraction of weld zones is needed. Therefore the main task of this paper is focused on the segmentation and locating of small defects in precision weldments with complex structure. In the course of segmentation of small defects in precision weldments with complex structure, we always fall into the dilemma between

*Corresponding author. Tel.: +86 451 86418173; fax: +86 451 86416186.
E-mail addresses: shiduanhu@126.com (D.-H. Shi), gangt@hit.edu.cn (T. Gang).

0963-8695/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ndteint.2007.01.004

identify the true defects and avoiding the false detection. And in order to determine the spatial distribution features of small defects in precision weldments using the real time radiography, much work must be done for achieving the three-dimensional representation of defects. Now there is not an entirely effective method to achieve the three-dimensional reconstruction of small defects. Because the gain of spatial distribution features of small defects is not an easy task from the two-dimensional X-ray detection image, though the computer tomography (CT) method can be used to achieve the goal of reconstructing the small defects, the detection cost and time-consuming are not always applicable to the actual industry application. So we present a new method to segment the small defects in precision weldments with complex structure.

At present, many researches on the segmentation of small defects were studied [2–5]. In Ref. [2] the background subtraction and histogram threshold were performed to segment the defects from the background, because of that there are a lot of small background regions and noises beside the true defects, false detection will happen. In Ref. [3] a real-time automatic detection system of weld defects was established, the minimum size of defects is 0.4 mm, but the detected weld size is very large. When adopting the above technology to detect the smaller defects in the complex structure, the false detection and defect missing will take place. In Ref. [4] several methods which can segmentation the defects in casting parts were related, the main methods used as follows: reference methods which include MONDAN-filter, signal synchronized filter and so on, methods without a priori knowledge and industrial CT. But they do not work well on the segmentation of smaller defects, except the method of CT. Though CT can detect the smaller defects in weld, it is not always feasible to industrial application for its expensive cost. In Ref. [5] an automated flaw detection method in aluminum castings based on the tracking of potential defects in a radioscopic image sequence was presented, special filtering and masking were used to segment the casting defects, and the casting defects in aluminum wheels were extracted by using the software PXV 5000. In addition, the defects detection algorithm can eliminate the false detections without discriminating the real flaws based on the multiple view geometry. However, the above researches were mainly done to detect the relative larger defects, so there are some limitations when using the methods to detect the small defects in complex structure. At the same time the image processing and quantitative researches of weld defects were done also [6–11]. In Ref. [6] a novel automated vision system was introduced to detect the welding defects of gas pipelines from the radiographic film, capture images and various image processing can be done by the proposed vision system, and algorithm which can detect the welding defects and calculate the necessary information such as length, width, area and perimeter of the defects was developed also. However, it is mainly used to detect the larger defects in conventional weld. In Ref. [7] an image processing system was presented, the proposed image processing method can be used to detect the welding defects such as pores, slag inclusions and cracks. In Ref. [8] an automated image processing for radiographic film was presented, the proposed method can be used to enhance and extract the volumetric and planner defects individually. In Ref. [9] a three-dimension radiograph detector for inspecting the location of weld defects and their sizes was presented, the experimental results show that the absolute error is less than 0.3 mm and the relative error less than 5%. In Ref. [10] quantitative crack depth measurements were investigated to evaluate the structural integrity of two pressure vessels with internal cracking in a weld overlay by using the eddy current testing method. In Ref. [11] an approach that is based on the combined use of Dempster–Shafer (DS) theory and fuzzy sets for improving automatic detection of weld defects was presented, the proposed method can make the defect detection more precise and reliable. Eighty percent of defects with a credibility of about 0.55 have been detected without any false alarm. Also, the credibility given by the automatic method is consistent with the confidence rules of the expert. Whereas the above researches mainly studied the relative larger weld defects in conventional structure, the research of segmentation and locating of small defects in precision weldments was not too much. As a complement of the above researches, we present the segmentation method of small defects in precision weldments with complex structure, and according to the deduced formula of defects depth and deviation, the spatial distribution features of small defects were determined by the proposed image processing method, the image processing system can be described as follows: firstly the weld zones which contain the small defects were extracted by using twice automatic threshold, the effects of raster edge high intensity on the image processing can be eliminated in this step. Secondly sharpening, smoothing processing and background were proceeded on the extracted weld zones to segment the small defects, and the small defects in precision weldments can be segmented successfully. Thirdly the projection distance can be automatically extracted, and it can be used in the deduced formula to calculate the depth and deviation of small defects. Finally the destructive testing of samples was done to verify the results of image processing, the experimental results show that the proposed method can meet the demand of segmentation and locating in precision weldments with complex structure.

2. Segmentation of small defects

2.1. Image denoising and enhancement

When testing the I-section structure using the perpendicular irradiation, the penetration thickness is so large, and it is not easy to obtain detection images. In addition, accuracy in locating of small defects cannot be achieved, because the projections of the two sides will overlap

Download English Version:

https://daneshyari.com/en/article/295654

Download Persian Version:

https://daneshyari.com/article/295654

Daneshyari.com