Industrial ray DR/ ICT integration inspection testing system

(1) Hardware system

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Abstract

The multi-detector, multi-ray source switching function ray DR / ICT integration testing system has been developed, which covers international strongly development of ray digital imaging detection technology. Development of the test system forms the ray digital imaging product development capability of independent property serialization, and provides the conditions for the ray imaging detection technology.

Key words: ray detection, detectors, digital imaging, tomography, test system
[1]

1 Background

Industrial-ray detection has been the main use of nondestructive testing technology for the manufacturing, installation, repairing of the special equipment, is the main technical means for manufacturing quality control products, and playing an important role about controlling and using on the product manufacturing quality. At present, the industrial-ray detection is still mainly using traditional film camera. As we all know, this is a technology that needs at least 20 to 30 minutes before conclusions are given about work piece quality inspection.

Although the film camera has high sensitivity, it is low-efficient, high-cost, long-term storing difficulties shortcomings, it is not conducive to the digital archiving, and its defections rely on the manpower assessment, there will inevitably be subjective and uncertainty.

With the development of rapid manufacturing technology and product quality rising, and the requirements of product quality digital management, Above-mentioned shortcomings have made the traditional film radiography become the bottlenecks on improving product reliability and productivity of special equipment manufacturing industry, and has caused great inconvenience to consumer. Therefore the special equipment manufacturing industry and the user require the effective-ray digital imaging technology replace the traditional film

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radiography.

In recent years, the rapid development of computer technology and ray detection technology strongly impetus to the engineering applications of the real-time radiography (RTR), Digital Radiography (DR) and industrial computer tomography technology (ICT). Particularly in the last 3-5 years, X-ray Amorphous Silicon Digital Detector makes the digital imaging replace a film camera become possible.

According to the examination of the domestic introduction several detectors in this year, It showed that the image quality of such detectors is superior to other digital imaging X-ray (such as image intensifier, CCD camera and CsI converter coupled device), but it need further development if truly replacing film radiography. The project adopt the detector, the second development is implemented in order that DR image quality meet or better than film radiography, and develops the research of high-quality, high-precision RTR / DR / ICT based on it.

To the radiography of the important parts, it is not enough that only high-quality RTR, DR detection replace film radiography in quality control. Engineering testing often need further analyze defects for RTR, DR detection, such as when measuring the defective space location, shape and size parameters, it requires industrial CT to achieve the goal.

At present, the majority of the domestic industrial CT equipment is based on the fan scan two-dimensional reconstruction algorithm.

Linear array detector matching with the method makes the reconstructed image contrast up to 0.3 ~ 0.5 percent, and spatial resolution of up to 2 ~ 3 Lp / mm (BIR company ACTIS-600/420 example)with the superior performance of high dynamic range and high signal to noise ratio. However, 2D-ICT only reconstruct a sectional image in each scan, which greatly restricted a wide range of applications of 2D-CT detection

In recent years, the emergence of area array detector as well as some mature and practical three-dimensional reconstruction algorithm (eg Feldkamp algorithm) effectively meet the industrial testing resolution reconstruction requirements for the CT technology efficiency, integration (RTR / DR / CT integration), 3D and so on. Its advantage relies in which it uses open cone-beam ray scanning, rapidly reconstructs all the sectional image within the scan region through using two-dimensional digital projection acquisition sequence, really realizes three-dimensional hologram to the detected object, so that it makes 3D-CT technology become the research focus at home and abroad.

Based on the above background, the project carried out technical research as following:

- RTR, DR, ICT integration technology is placed in a single system to achieve "one machine multi-use."
- Ray digital imaging with high-resolution DR technology and the high IQI sensitivity replace the traditional film radiography.
- Three-dimensional fast chromatography technology reproduces internal product quality information with high resolution CT image based on the cone-beam CT scanning.

2 The system summarize

2.1 The system introduction

We have developed a system CSEI-XIS in the support of the General Administration of Quality Supervision ,Inspection and Quarantine of the People’s Republic of China. The system is an advanced industrial-ray RTR / DR / ICT Integrated detection system , including three subsystems that the RTR/DR/3D-ICT based on panel detector , line scanning

DR/2D-CT based on the linear array detector and the RTR / DR based on image intensifier. Figure 1 Figure the appearance of the system.

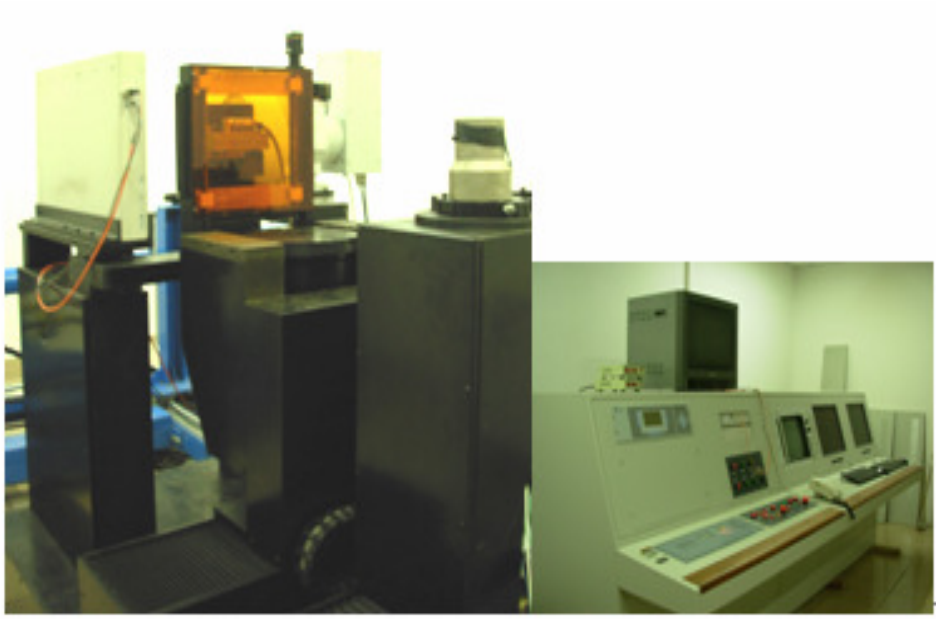

Fig.1 the appearance of the system

System hardware mainly consists of ray sources, PaxScan2520 detectors, linear array detector, image intensifier, precision cast iron base, four Degree of Freedom scanning, ray source bracket, detector bracket, dispersed windows, electrical counters,operation platform and so on. Three subsystems shared a set of ray source and mechanical scanning devices. There are three different detector subsystems only through the positioning pin to realize the switch three detectors. The handle is used to adjust the dispersed window size.

Four Degree of Freedom scanning platform is installed in a base, three motor is used to realize the horizontal (the direction perpendicular to the main-ray - Y), the lift and landing (Z) and rotary movement; Longitudinal (parallel to the direction of the ray - X) is controlled by mechanical handle considering safety. The entire scanning system based on an advanced 6K controller, which can realize high-precision, rapid positioning and scanning movement for detected work piece.

Operation platform includes five parts, The First, a high-grade Hp XW8200 Dual-CPU PC is used to complete system control, image acquisition, parallel reconstruction and processing; The second, a set of common hp PC is responsible for image processing and interpretation; The third is ray source control module; The fourth is flat-panel detector command processor and image intensifier control terminal; The fifth is a systematic assistive devices control module.

2.2 The scanning device main parameters

(1) Installation parameter

a) The distance between ray focus and detector imaging plane: 850mm

b) The height between installation benchmark platform and ray level centre: 950 mm

(2) Motion Parameter

a) Longitudinal routing (X direction, manual): 300mm

b) Horizontal routing (Y directions): 600mm

c) Lift and landing routing (Z direction): 250mm

d) Numerical control rotary diameter: 300mm

(3) Work piece parameter

a) detected platform bearing the weight： 80kg

b) Standard 3D-ICT work piece most diameter： Φ200mm

c) Large view field 3D-ICT work piece most diameter： Φ300mm

2.3 The system performance parameters

(1) Ray energy：225KV，450KV

(2) PaxScan2520 detector effective window and imaging format: 238 × 179mm2; detector spacing of 127 × 127 μ m2; 1920 × 1536 × 12bit; dynamic range :2000:1,low noise full-resolution and rapid scanning two imaging model, Each mode of sampling frame can be set by imaging software.

(3) linear array detector imaging format and length: 157 mm; detector spacing 83.7 μ m; 1856 × 12bit; dynamic range: 2000:1; exposure time and other imaging parameters can be set by software.

(4) The image intensifier effective window and imaging format: Φ225 mm; detector spacing (MAG2 mode) 157 × 157 μ m2; 764 × 570 × 10bit, three vision imaging mode imaging parameters can be set by the software.

(5) The flat-panel detector is based on RTR/DR/3D-ICT subsystems, its RTR IQI sensitivity is up to the 3%;its DR IQI sensitivity better than standard film radiography class B image quality of HB/Z60-96 provisions , the detection rate is up to 30 frames / second, image imaging vision of each frame for the 250 × 200 mm2; its 3D-ICT imaging spatial resolution is 3.5 lp / mm, contrast resolution is 0.3%.

(6) Line scanning DR/2D-ICT subsystem is based on the linear array detector, its DR IQI sensitivity is better than class B image quality standard film radiography of HB/Z60-96 provisions; its 2D ICT spatial resolution is 6lp/mm, contrast resolution of 0.3%.

(7) RTR / DR subsystems is based on the image intensifier, its RTR sensitivity reaches 2 %, its DR sensitivity is better than film radiography standard class B image quality of HB/Z60-96 provisions.

(8) CT image reconstruction Speed: 6 seconds / layer (1024 × 1024).

2.4 Scanning devices basic structure and function

The device consists of precision cast iron base, four Degree of Freedom scanning, ray source bracket, detector bracket, dispersed windows, electrical counters, operation platform and so on. Four Degree of Freedom scanning platform is installed in a base, three motor is used to realize the horizontal (the direction perpendicular to the main-ray - Y), the lift and landing (Z) and rotary movement; Longitudinal (parallel to the direction of the ray - X) is controlled by mechanical handle considering safety. T

The scanning device features are as follows: RTR, DR, CT is integrated into the unity, has powerful detection function; three Degree of Freedom controlling makes detection convenient and fast. It can realize a variety of high performance CT scanning movement according to different work piece diameter. The work piece handling can not only carry out the general RTR, DR detection, but also easily realize a multi-directional RTR, DR testing.It can directly carry out various CT detectors according to RTR, DR test results, and realize the automation detection process.

Numerical control platform can be controlled stepper or continuous precision rotary, and

ensure the RTR, DR, CT various detection methods requirements. The platform horizontal movement enable Numerical control rotary platform center offset ray centre ,which ensure a large field ICT offset requirements, at the same time provide a different mobile location for RTR, DR detection, expand the functions of the detection system; the platform lognitudinal movement changes the imaging distance, and realize magnification ratio for required different parts; The platform vertical movement can make the different height location region of the detected work piece enter into the ray field, and realize on the regional location of the different heights RTR / DR / ICT detection. The whole system controlled by computer. The entire system adopt the computer to control ,all movement design the safety self-locking function to ensure the stability and safety of the system's operation

3 Conclusion

CSEI-XIS system is a set of industrial ray digital fast detection system, which integrates RTR, DR and 3D-ICT three test model, mainly applied on the production and using repair of special equipment. The system has different from domestic and foreign existing DR, CT (including 3-D-CT) imaging testing technology, it is an irradiation, tomography integrated detection technology as the support of the following three technology:

(1) A set of ray system of integration irradiation, tomography detection realizes the RTR, DR, CT quick detection.

(2) Its DR is a Digital imaging of high image quality of (IQI) sensitivity, replacing traditional film radiography to achieve fast digital imaging testing.

(3) Its 3D-CT is a high-resolution three-dimensional tomography imaging, which not only has technological superiority of the traditional 2D-CT and the current greatly developed 3D-CT, but also carry on three-dimensional tomography analyzing for the above DR defects, abnormal condition, particularly small defects and abnormal condition. Compared with the existing 2D-CT,3D-CT is no longer a specified fault detection of quality, structure morphology, but any part of a three-dimensional tomography scanning.

The successful development of the system is an important step forward the industrial digital radiography and tomography technology in our country. The system's overall technical indicators have reached the international level, which resolve the technology discomfiture that the current most CT equipment rely on imported technologies in our country. The project's research results will provide a new and useful technology for quality control of our country’s special equipment production and use. In addition to special equipment, the system can also be used for sophisticated component defects and damage detection of national economic departments, therefore, the system has a good application and promotion prospects.

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