Research on Surface Crack Detection Technology Based on Digital Image Processing

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Abstract: Digital image technology is used to monitor the fatigue and fracture of components under the operating conditions of mechanical parts, which is beneficial to monitor the causes of shallow cracks and whether the test results affect the life and safety of parts. The detection technology based on the digital image processing mechanism belongs to the category of non-destructive testing. It can quickly detect the surface cracks of mechanical parts and achieve accurate and effective evaluation of the surface defects of the parts. Based on the application of actual digital image processing technology, this paper presents an effective evaluation system for the defect detection of component surface cracks in image processing technology for programming tools used in simulation experiments, digital image processing algorithms, and design experimental software features, calculation methods and steps. After the above argument, the digital image processing method for surface cracks of parts is proposed. We can properly process the acquired images on the spot, obtain the values of piecewise linear stretching mean, median filtering, etc., and prove that digital image processing technology has the advantages of image detail processing the advantage is that it can realize rapid judgment and accurate detection of surface crack defects.

1. Introduction
The stable operation of aircraft heart aero engines needs to be maintained in accordance with the use of digital technology. For example, the application of digital image processing technology is to ensure the flight safety of civil aircraft, and accurately detect the fatigue, crack generation and expansion of parts. The stable operation of the aircraft aero engine has proved to be an important means to ensure the safety of the engine.

2. Overview of Digital Image Processing Technology Principles
Digital image processing technology is a non-contact modern optical measurement experiment technology. It has many advantages such as simple light path, good environmental adaptability, wide measurement range and high degree of automation. Therefore, digital image processing technology has been widely used in many scientific and engineering fields such as civil engineering, machinery, materials science, electronic packaging, biomedicine, manufacturing, welding [1]. For example, based on digital image processing technology, cracks on the surface of aircraft engine turbine blades are detected, and the entire process from crack initiation to disconnection is recorded. The use of digital image processing technology can facilitate the study of fatigue life. The use of non-contact non-destructive testing methods greatly reduces the cost and time of measurement, improves
measurement efficiency, and ensures measurement accuracy.

The development of image processing technology and digital technology has risen as early as the beginning of the 20th century. Humans use images to use computer processing methods to measure various types of instruments and displays. Robot vision system and product quality control have played a huge application value. Non-destructive testing technology can be used to perform initial inspection on samples without damage. For example, ultrasonic testing, turbine testing, radiographic testing, and penetrant testing can all use non-destructive testing methods for the continuity or discontinuity of the surface of the test piece, using relevant inspection media such as radiation and magnetic leakage. Digital image processing is a subject that is widely used at present. It integrates multiple disciplines to form more advanced technologies [2].

Digital image processing technology realizes three-dimensional, multimedia and intelligent, combining three-dimensional imaging and multi-dimensional imaging discovery technology. Driven by the hard chip, the advantages and development potential of image processing using technology such as wavelet algorithm, genetic algorithm, etc., make it more applications in medical and space projects. For example, in the archeological field, image processing methods can restore blurred pictures, save lost or damaged rare items, and establish crack recognition methods based on image information technology. Scientists have chosen a more suitable non-destructive detection method to make the image information more accurate and easy to obtain. In the industrial automation stage, digital image processing technology has been applied to product quality monitoring and fault diagnosis, such as crack detection on the surface of objects, such as ceramic bottle crack detection, track plate crack defect detection, rock surface crack detection, etc. good detection effect [3].

The application of a series of automated systems such as aircraft structural crack detection system, fatigue crack detection system, and automatic surface crack detection system makes digital image processing technology more effective and practical in identifying methods such as engine blade surfaces.

3. Digital Image Technology Application Case

3.1 Welding Crack Image Recognition Technology
Taking welding crack image recognition technology as an example, digital image technology includes:

Image preprocessing: Image enhancement uses the spatial domain method to process the image's grayscale coefficients and modify the image's transform coefficients to better distinguish the defective parts of the image. Image denoising Tongguo suppresses pulse interference, reduces image blur, and preserves important structural features in the image.

Edge detection: The edge is the area where the gray level in the image changes drastically. The boundary area of the weld is extracted to facilitate the statistical analysis of the geometric characteristics of the weld edge, to detect the edge of the pipeline weld defect, and to maximize the influence of edge noise, which provides an effective method for image edge detection and analysis.

Texture feature recognition: Recognizes the boundary definition and the degree of local information refinement, and performs texture recognition through a fully local three-valued CLTP mode.

3.2 Application of Technology
The high temperature fatigue and creep life experimental device, image acquisition device simulation, and turbine blades are used to set the experimental working environment. The collected blade images are used to identify cracks through the experimental system to prepare for subsequent crack detection. For the traditional tensile test, if you want to obtain the strain data during the experiment, you need to install an extensometer on the sample to get the strain data. It measures the average strain of the sample, and the digital image technology can give the point-to-point strain information in the sample, so that you can draw the change process of the strain distribution cloud diagram during the experiment. In order to analyze and study the deformation behavior and failure mechanism of the material provides
a good way.

Figure 1 Typical Image Acquisition System

High temperature fatigue and surface life experiment equipment, including acquisition device, acquisition system, and simulation of the blades in the simulation laboratory. When the state of maximum startup is selected, the stress section of the dangerous section is simulated. The entire experiment is completed in the fatigue experiment system. Including electric industry servo fatigue testing machine, high frequency adder, infrared temperature camera and so on.

An image acquisition device is composed of an image acquisition card and a video camera. A digital camera is used as an image ingestion device. After sampling and quantization, the image is converted into digital signals. The image is processed through the computer memory to improve the real-time of the sampling and transmission speed. Computer software controls the action of the digital camera, transmits the image to the computer, and is affected by the computer's firmware. It implements the processing of the static picture input device, text recognition and automatic drawing of drawings [4].

3.3 Digital Image Processing Effect

There is no noise after image processing, and good edge detection results are obtained. The established defect image database of weld digital images contains parameters such as shape and texture features, image length pixels, image width pixels, gray differences between defects and background, and relative positions of defects. Based on the defect feature database classification, the crack defect shape characteristics were obtained, and the defect characteristics such as cracks, slag inclusions, blowholes, unwelded, unfused, and stripe shapes were identified, and automatic identification and automatic evaluation of digital image defects of pipeline welds were realized.

The image acquisition system is generally small when the lobes are listed. The blade surface crack is measured in a small size, a digital camera is used to obtain a high-resolution image, and the camera driver software is running to shoot and observe. The continuous zoom camera can be used to observe the state of the object.

4. Image Acquisition System Programming

Use VISUALC ++ to design the program, including application software, data source manager and data source software. Through software collaboration, complete the collection and transmission of images. The data source manager is provided free of charge. The software exists in the form of a dynamic link library in the windows environment. It is used to manage application software and data source software. The application software writes an image acquisition interface program.

During the operation of the experimental system, the specific steps are first to open the digital camera to obtain the position between the lens and the blade, turn on the infrared camera, observe the blade surface temperature and control the blade heating through the infrared camera, and change the temperature After adding to the predetermined value, digital image processing programming implements a series of object programming procedures such as image enhancement segmentation,
image labeling and thinning, and feature measurement to complete the image processing technology [6].

In image enhancement, certain information in the image is highlighted according to specific needs, and the specific application of the processed image is suitable for human visual characteristics and recognition systems, enhancing the ability to identify information, and recovering some of the loss of information in the original image. Improve image visual effects. Enhancement technology currently includes a viewshed processing method and a spatial processing method. According to the sharpness of the image components, with the help of computer processing, the operation in a certain transformation domain of the image is implemented, that is, the effect of enhancing the image through the inverter is modified. The frequency domain processing method is a method that uses the convolution principle to enhance the original image, modify the image Fourier transform, and uses the formula to obtain the original data of the image. After the Fourier transform, a certain characteristic is obtained, which is easy to identify and interpret, and emphasizes the low-frequency components in the image to make the image smoother. The spatial processing method can directly process the pixels in the image, enhance the image contrast mapping transformation as the basis, improve the image gray level, and remove Gaussian noise. The linear smoothing filter has advantages, and the phenomenon that the blur becomes blurred is reversed. The basic idea of the non-linear smoothing filter is to replace the gray value of the pixel with the middle finger of the gray value in the pixel field, and retain the edge details of the image.

Figure 2 Image Acquisition Program Flow
In image segmentation, it adapts to the characteristics of human recognition images and visual observations, and generates the source process for image segmentation. The M * M array image is divided into several disjoint areas to obtain two-dimensional image information. Two adjacent Regions do not have similar properties. Image segmentation on the boundary of an area can be understood as the extraction of meaningful feature areas in an image, the gray values of pixels, and the contour curves and drawing of objects. At present, some homogeneous criteria with similar gray levels and similar textures are used. This basis has uniformity and accuracy, can detect edges, and the application of threshold method is to use the concept of threshold method for two-dimensional digital images Plane coordinates are taken. Global threshold value segmentation methods are used more often in image processing. A fixed threshold value is used to segment the entire image. There are many methods, such as the bimodal method [7]. Several different methods of image threshold segmentation indicate that pixel acquisition at each gray level can obtain the probability of occurrence of each characteristic. At the same time, we can select the class-variance and inter-costal-variance of each class, expand and compress the entire range of gray levels of the image, and transform the gray levels into linear and non-linear transformations. The thinning algorithm is convenient for describing and extracting features. It cuts out parts that are not endpoints in the image and eliminates them in the order of the top, bottom, left, and right of the image [8]. The subdivision algorithm uses the subdivision method to cycle through the layers, delete them when they meet the conditions, repair the non-existing images and contours, and then perform image measurement by image segmentation and contour editing detection, and describe the shape of the area of the identified image.

5. Conclusion
The basic principles and implementation methods of digital image technology involve both hardware and software. The use of images as information carriers for automatic detection of cracks on the surface of engine blades is of great practical value.

(1) Aiming at the surface crack characteristics of the secondary turbine blades of aircraft engines, creep and high temperature fatigue simulation methods are used, and digital image processing is used to monitor the surface cracks. The images were acquired by a digital camera with USB, and the noise of surface cracks was detected by high temperature fatigue and creep experiments. The mechanism analysis and composition measurement were used to accurately identify small cracks. After comparing with various image recognition methods, it was proposed that the method is suitable for the identification of the surface cracks of engine turbine blades. The identification method is validated by experiments.

(2) The user interface operation mode, after the parameter analysis results are generated, can be displayed on the large screen, and the entire process from starting to breaking is conveniently recorded. This can not only promote the research of fatigue life and fatigue fracture mechanism, realize fully automatic non-contact non-destructive testing, but also reduce labor intensity and cost, and realize the man-machine dialogue mode of crack detection.

(3) In the course of the research, through continuous research, it was found that the use of digital image processing technology in the surface crack detection of the secondary turbine of the engine can further improve the accuracy and scalability of the automatic detection algorithm, and further improve the ability to automatically identify the generality of the software. The local image of the image is analyzed by the image mosaic technology and the location of the crack is identified.

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