Research on Surface Crack Detection Based on Computer Image Recognition

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Abstract. In the process of large-scale industrial production, in order to control the surface accuracy and quality of components, it is necessary to carry out efficient detection of surface cracks. However, traditional manual visual inspection and other means are not conducive to large-scale industrial utilization due to the subjective human factors such as personnel experience and level. Based on this, this paper first analyses the basic principle of computer image recognition, and then studies the utilization of computer image recognition in surface crack detection, and gives the specific utilization steps, utilization methods and detection results.

Keywords: Surface Crack Detection, Computer Image Recognition, Manufacturing

1. Introduction
With the iterative development of intelligent tech represented by computer image recognition, it has been applied and studied in many fields, especially in the industrial field, which greatly promotes the accuracy and efficiency of surface crack detection. Generally speaking, the surface cracks of components are mainly produced in the stage of manufacture and use. The former needs to detect the parts with cracks on the production line [1]. In order to improve the operation efficiency of the production line, the intelligent means represented by image recognition is needed to carry out the detection. The latter needs to be found and solved as soon as possible in the process of use. The commonly used method is manual visual inspection, but it will be affected by subjective human factors such as personnel experience and level. Therefore, it is also necessary to adopt automatic detection means represented by image recognition to realize the timely detection and treatment of surface cracks of parts.

The surface of parts will be damaged due to various reasons. With the expansion of damage, cracks will be generated on the surface of parts, which will damage the parts themselves. In order to reduce the damage and adverse effects caused by surface cracks, it is necessary to carry out timely detection. In this context, high-precision and practical detection tech and means have become the focus of industrial research. The tech of computer image recognition in surface crack detection is developed and applied gradually on the basis of image processing. Compared with the traditional manual detection methods, this tech has many advantages, such as not easy to be affected by the environment, high recognition efficiency, good recognition accuracy, and can carry out long-term, uninterrupted detection, so it is very suitable for the utilization in the industrial field.
Surface crack detection based on image recognition tech mainly integrates machine vision, image recognition and other technologies to accurately and efficiently measure the surface defects of components. This non-contact detection method can greatly improve the detection efficiency and accuracy, but also can further avoid the occurrence of accidents in the detection process, and can bring more economic benefits. Especially in the field of mechanical manufacturing, parts themselves may leave cracks on the surface during the manufacturing process, and eventually lead to serious consequences of parts damage. Therefore, the surface crack detection based on computer image recognition can accurately identify the surface cracks of small size and complex background components with its characteristics as shown in Figure 1 below. Therefore, the research of surface crack detection based on computer image recognition has important practical value.

![Figure 1. Characteristics of surface crack detection based on computer image recognition.](image)

2. The basic principle of computer image recognition

2.1. Image recognition and interpretation

The classification of computer image analysis tech mainly includes three basic categories: low-level processing, intermediate processing and high-level processing. These three basic categories from low to high, the complexity and intelligence of the images processed by them are also constantly improving [2]. It is shown in Table 1 below. In order to use the correct color space, color conversion is needed. Color space is a description method of color, it has many types. Among them, RGB is the most common color space. Because the display adopts this model, the execution speed of the algorithm is faster.

| Basic category         | Contents                                      | Features                        |
|------------------------|-----------------------------------------------|---------------------------------|
| Low level processing   | Image acquisition and pre-processing          | No need for intelligence       |
| Intermediate processing| Image segmentation, representation and description | Need intelligence            |
| Advanced processing    | Image recognition and interpretation          | Lack of theory, specific design|

2.2. Image edge detection

In the level of image edge detection, edge is a basic feature of the image, which carries a lot of information in the image. Edge detection can not only obtain useful structural information about the boundary, but also greatly reduce the data to be processed [3]. Many image processing and recognition algorithms are based on edge detection. Image edge can be divided into gray edge and color edge according to its color characteristics. The former is described by the image brightness function and
represents the local mutation of the gray function. The latter is described by the image color function and represents the local mutation of the color function.

In addition, image edge detection methods mainly include output fusion method and multidimensional gradient method. The former is to perform edge detection on different color channels and output edge image synthesis; the latter combines three gradients into one and detects the edge only once, thus shortening the whole process of color edge detection, as shown in Figure 2 below.

![Multidimensional gradient method for image edge detection.](image)

2.3. **Image edge extraction and morphological processing**
The edge image obtained by Sobel operator is often used in image edge extraction. In the aspect of image morphology processing, it mainly uses mathematical morphology to realize image processing and pattern recognition [4]. In this method, the probe is used to collect the information of the image and understand the structural characteristics of each part of the image. Firstly, the structure elements are constructed, and then the image is inflated by the constructed structural elements. Secondly, the region is filled and connected region is marked. Finally, the object is selected to complete the whole process of morphological processing.

2.4. **Image feature extraction**
The typical features of image mainly include shape feature and color feature. The former is to get the edge and region of the image after edge extraction and image segmentation, that is to say, the shape of the target can be obtained, which can be used to represent the shape features, including geometric features and moment features [5]. The latter has rotation invariance and scale invariance, so color is one of the most widely used features in image recognition. The extraction of color features is the key to image recognition using color features. Most systems use color proportional distribution as the basic color feature, which is histogram method in image field.

2.5. **Recognition results of image recognition**
After the extraction of image color features, it is necessary to use numerical value to effectively represent the similarity degree of image in color, which will affect the recognition effect. In pattern recognition tech, distance method is used to measure the similarity of features, that is, the similarity degree of features is expressed by the space distance of feature vector. After color edge detection, image segmentation and feature extraction, the pattern matching of the segmented image is carried out, and the user interface is made. Finally, image classification and recognition are realized.

3. **Utilization of computer image recognition in surface crack detection**

3.1. **The advantage of computer in surface crack detection**
With the continuous improvement of the automation degree of each link of industrial production and processing, the traditional manual detection and destructive sampling method for surface crack detection of parts are difficult to meet the practical utilization, and the rapid, nondestructive and accurate detection method is more suitable for the development of modern industrialization. The image detection tech mainly identifies the surface cracks by analyzing the color characteristics of the
surface of the parts [6]. When the surface cracks appear, the surface texture features will be destroyed. Under the external light conditions, the reflection and refraction of the cracks are different, which can be identified by digital image processing method. The surface detection tech based on computer image recognition has the advantages of comprehensive and intuitive reflection of the surface information of parts.

3.2. Steps of surface crack detection by computer image recognition
First of all, the process of image processing and image processing is needed to detect the surface cracks of eggs. The typical computer image recognition system for surface cracks of components includes light source, CCD camera, image processing platform, data transmission module, etc., as shown in Figure 3 below. Through the acquisition of multiple images, and the use of more complex image processing methods to overcome the part surface reflection difference and the interference caused by stains.

![Figure 3. Computer image recognition system for surface cracks of components.](image)

3.3. Concrete method and effect of surface crack detection by computer image recognition
The target area is found through the discontinuity caused by surface defects in color image. The size of the target area is obtained by binarization of the image, and the ratio of the target area to the area of the egg projection rectangle is calculated. According to the comparison results between the proportion value and the threshold value, the high-precision detection of surface cracks on parts can be realized.

In addition, the CCD camera is used to obtain the surface image of the tested parts under the illumination of the light source. The smoothness and geometric shape of the image contour after Sobel filtering are used as the detection standards. The regression model also has ultra-high detection accuracy.

In addition, the computer image recognition is used to extract the parameters which can represent the crack and crack free features of the tested parts, and the algorithm operator is used to optimize the surface characteristic parameters of the detected parts. The SVM model is established, and the panudan model is used to detect the bright spots on the surface of the parts. This method also has high detection accuracy and efficiency for surface cracks.

In order to overcome the self-healing ability of surface cracks and the influence of missing inspection caused by small cracks, the tested parts with micro cracks are placed in the environment less than atmospheric pressure. The micro cracks will become larger due to negative pressure, which enhances the visibility of cracks and improves the recognition rate of cracks. This method has no effect on the quality and safety of the tested parts. According to the texture characteristics of intact and cracked eggs, the fractal dimension is used to analyze the image, and the fractal law curve dimension and the overall box dimension of the image are taken as the feature vectors of the neural network, which can further improve the detection efficiency and accuracy of the surface cracks of the detected parts.

4. Conclusion
In summary, the utilization of computer image recognition tech in the detection of surface cracks of the detected parts has many advantages, such as not easy to be affected by the environment, high
recognition efficiency, good recognition accuracy, and can carry out long-term, uninterrupted detection, so it is very suitable for the utilization in the industrial field. Through the analysis of the basic principle of computer image recognition, this paper studies the process and principle of image edge detection and image feature extraction. Through the research on the utilization of computer image recognition in surface crack detection, the advantages of computer image recognition in surface crack detection, the specific detection steps and methods, and the specific detection effect are analyzed.

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