Application of Image Processing Technology in Building Surface Crack Detection

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Abstract. The phenomenon of cracks on the surface of buildings is widespread. The existence of cracks affects the normal use of buildings, shortening the service life, seriously damaging the structure of buildings, resulting in safety accidents. Therefore, regular detection and reinforcement of cracks on the surface of buildings is a necessary link to ensure safety. At present, the detection of building surface cracks is mainly carried out by manpower with means of equipment assisted. However, there are some problems in manpower detection, such as high manpower consumption, low efficiency. This paper presents a method of detecting and inspecting cracks on building surface based on image processing technology in machine vision, which includes image gray transformation, image denoising etc. Curve fitting and least square method are used to obtain crack parameters, so as to improve the inspecting efficiency and realize the automation of building surface inspection.

1. Introduction

Due to unreasonable design, uneven settlement of foundation, different material's deformation to temperature, internal uneven shrinkage deformation, stress generated by load exceeding material strength limit and other factors, cracks on the surface of buildings are inevitable [1]. Cracks will accelerate structural deterioration, affect the use of buildings, shorten the service life of buildings, and seriously lead to safety accidents, resulting in loss of people's lives and property. When evaluating the reliability of building structures, the cracks on the surface of buildings should be detected first. At present, the detection of building surface is mostly carried out by manual means with equipment assistance. It is not only inefficient, but also has the problem of missing detection. It is urgent to replace manual detection with new detection methods.
With the continuous development and progress of machine vision technology, the quality of image processing is getting higher and higher. Exploring how to use computer system image processing technology to make work in various fields more automated and intelligent has become a hot spot and inevitable trend. The application of image processing technology to crack detection on building surface has attracted more and more attention [2-3]. In this paper, a series of pre-processing is carried out to extract fracture features, and then the characteristic parameters of fractures are obtained by curve fitting and least square calculation.

2. Image preprocessing
When obtaining crack image, due to the uneven illumination intensity, noise generated by imaging electronic equipment, transmission media and other factors, it is often impossible to obtain ideal image. the obtained image is lightly characterized by the presence of noise, heavily is blurred and unrecognizable [4]. Therefore, image pre-processing is necessary to improve image quality before image detection or recognition.

2.1. Grayscale transformation of images
The vast majority of visible light in nature is obtained by mixing the three colors of R, G, and B in different proportions and intensities [5]. The image acquired by the camera is a color image, as shown in Figure 1, and the image processing is based on gray-scale image. Gray-scale image is an image with equal brightness values of three-color light components in the image [6]. Comparing with the color model, the gray-scale image does not contain color information, which occupies less memory and can be processed faster by computer. Gray scale image is obtained by gray scale transformation of Fig. 1, as shown in Fig. 2.

![Figure 1. Original view of the building crack](image1.png)

![Figure 2. Grayscale image](image2.png)

2.2. Image filtering
In the process of image transmission, the image acquired by CCD (camera) will be polluted by noise due to the interference of A/D (digital/analog) conversion, line transmission and external environment noise [7]. The image to be processed may have some problems, such as image blurring, black and white impurities, it is necessary to denoise the crack image. The effect of denoising is directly related to the subsequent edge detection of the crack image. The commonly used image denoising methods are: mean filter denoising, median filter denoising, adaptive Wiener filter denoising, Gauss filter [8]. Figure 3, 4, 5 and 6 are the image denoised by median filter, mean filter, Gauss filter and two-dimensional Wiener filter, respectively.

![a) median filtering to remove Gaussian noise](image3.png)

![b) median filtering to remove salt and pepper noise](image4.png)

![Figure 3. Image denoised by median filtering](image5.png)
It can be seen from the figure that Gaussian filtering denoising tends to cause image blurring. Mean filtering and two-dimensional Wiener filtering have poor denoising ability. The median filtering has the best denoising effect and low time complexity [9]. It can retain more edge information of the image while denoising. Therefore, this paper uses the median filtering method to denoise the image.

### 2.3. Image Enhancement

Generally speaking, the crack image area is usually in the dark gray area, and the background area belongs to the relatively bright area [10]. However, the reality is often due to weather, lack of exposure, etc. The crack area and the background area are almost indistinguishable, and the uneven illumination intensity often causes the image to be over-concentrated [11]. In order to highlight the cracks, it is necessary to enhance the contrast of the image, it is necessary to enhance the image. In this paper, the histogram equalization method is used to obtain the histogram of the image as shown in Fig. 7. The enhanced effect diagram is shown in Fig. 8.
2.4. Image Binarization

In image binarization processing, the pixels smaller than the threshold are marked as 1 according to a threshold, while the pixels larger than the threshold are marked as 0, thus separating the cracks from the background [12]. In view of the double peaks of the histogram distribution of the crack image in Figure 7, the global threshold is used to separate the crack from the background, as shown in Figure 9.

![Figure 9. Picture of the crack after binarization](image)

2.5. Image Morphology Processing

Morphological processing of images includes corrosion, expansion, opening, and closing operations [13]. Corrosion eliminates points smaller than structural elements and divides the area; expansion traverses each position of the binary image with a specific structure, and for a structure containing 1 point, the structure has all positions at 1 [14]. Image processing should be combined with corrosion and expansion. Open operation means that the target image is corroded first and then expanded. Closed operation means that the target image is corroded first and then expanded. The fracture image is processed morphologically to obtain the linear boundary of the fracture. Four methods are used for comparison. As shown in Figure 10.

![Figure 10. Comparison of morphological processing results](image)

It can be seen from Fig.10 that only the etching or expansion changes the image size, the image after the open processing is broken, so the image is processed by the closed operation.

3. Measurement of crack width

The purpose of crack detection is to obtain crack width data and angle data at details so as to judge the reliability of buildings [15]. In the previous image obtained by the image processing, the crack image is obvious, but it is not horizontal or vertical, and the width of the crack cannot be directly measured. The crack is formed by connecting adjacent target pixels. Therefore, the local curve of the crack can be linearly fitted by mathematical method. The normal line and its direction of the local cracks can be obtained from the coordinates of the pixels and the vertical relationship with the fitting line, and then the width of the cracks and the angle of the adjacent pixels can be obtained.

4. Conclusion

In recent years, the field of machine vision has developed rapidly. With the continuous optimization of various algorithms, machine vision technology has been applied to all walks of life, and has achieved good results. In view of the problems of low efficiency, low economy and potential safety hazards in the detection of building surface cracks, this paper preprocesses the image with image processing technology to obtain images with obvious cracks. and uses mathematical fitting and least square method to measure the crack width. The detection method is reasonable and efficient, the whole set of image processing ideas and processes also provide a solid theoretical basis and breakthrough for future researchers to deal with similar problems.
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