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Portable Structure Surface Crack Detection System Based on Android Platform

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Abstract: Cracks, potholes, and other defects often occur on infrastructure such as bridges, among which cracks are one of the most frequent defects. They have diverse shapes and are difficult to detect. Traditional manual inspection methods are inefficient and have low accuracy, while automated inspection machines are bulky and inconvenient to carry and use. Based on the shortcomings of existing detection technologies, this paper proposes a portable structural surface crack detection system based on the Android platform using a portable handheld image acquisition device. The system captures cracks on the structure's surface and obtains high-definition crack images. Then, these images are transmitted to portable smartphone terminals through Wi-Fi. Next, the image is pre-processed using weighted averaging, gray-scale linear transformation, and adaptive median filtering. Then, the improved Canny edge detection algorithm is applied to identify crack information, and the edge segmentation algorithm is used to determine the crack width. Finally, based on camera calibration, the pixels are converted into the length data required for actual measurement. The results show that the system is easy to operate, and it not only has crack storage and tracking functions, but also can effectively measure the crack width on the surface of components. The measurement accuracy of this system reaches the sub-pixel level, and in actual testing, compared with the crack width gauge, the maximum relative error does not exceed 6.25%.

Key words: structural crack; portable; image processing; detection accuracy; crack parameter

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0 Introduction

With the rapid development of the Chinese trans-

portation system, bridges have played an indispensable role in today's infrastructure. At the same time, with these infrastructures being under high load for a long

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time, a large number of constructions, such as bridges, are prone to defects such as cracks and potholes. The number of them that enter the maintenance period is increasing, and hidden safety hazards cannot be ignored^[1].

Among numerous structural defects, cracks are one of the most frequent and far-reaching defects. They may appear in the early stages of building construction. As the service life increases, the degree of cracking will gradually deepen, seriously endangering the service life of the building. Moreover, temperature and weather can cause secondary damage to the cracking area. In severe cases, it can evolve into more complex defects, posing a considerable threat to travelers' safety and society's economy. Due to effects caused by the material, design, construction, and use of concrete structure, the overwhelming majority of the concrete has cracks. For cracks with a width of less than 0.05 mm, the structure will not be destroyed in the normal use process, and the existence of this crack is allowed in specifications. However, when the width of the cracks develops to more than 0.2 mm, it will have a severe impact on the normal use of the concrete structure, destroying the integrity of the structure, causing the protective layer to fall off and the corrosion of the reinforcement, affecting the safe operation of the bridge. Therefore, regular detection of structural cracks is the best way to prevent accidents.

At present, bridge crack width detection traditionally adopts artificial detection methods and uses tools such as feeler gauges, reading microscopes, and crack width meters. These methods have artificial reading errors during the interpretation process. It has the shortcomings of low detection accuracy and low efficiency^[2]. With the development of computer technology, digital photography technology, and computer vision, crack detection technology based on digital image processing has gradually become a worldwide hot spot for scholars^[3-6]. The typical way is to collect and detect bridge cracks using large engineering testing vehicles, climbing robots, and drones. These methods have improved the detection efficiency. However, due to the large volume of equipment and the strong coupling of detection systems, the detection schemes are of high cost, and they are not flexible enough to adapt to any detection scenarios^[7-9]. With the rise of mobile platforms, the need for detection has gradually migrated to mobile clients, and more and more image processing and recognition technologies are applied to Android smartphone platforms^[10-14]. Chen *et al*^[15] used wooden pads to complete the image collection of

smartphones on the crack surface. This method is easily affected by the detection distance and the surrounding environment of the crack. Jing *et al*^[16] studied the detection method of concrete surface cracking defect information based on Android smartphones. Still, this method requires that the mobile phone camera faces the crack area during the image collection process, which is not strictly guaranteed during actual detection. An error analysis of the detection accuracy affected by the shooting angle of the mobile phone camera should also be analyzed. Based on the crack target pixel coordinates, Ni *et al*^[17] calculated the number of pixels contained in the cracks, achieving the measuring detection of the crack feature value. However, calibration is required for different mobile phone models, and the calibration process is complex. Additionally, manual input of shooting distance and camera magnification factor is necessary for each image capturing. Shi *et al*^[18] used deep learning on the Raspberry Pi platform to detect road cracks and designed a corresponding mobile app to display crack information. Lin^[19] migrated the crack detection model to mobile device terminals to achieve real-time crack detection. Zhang *et al*^[20] used deep learning on the embedded terminal OpenVINO platform to achieve crack recognition. However, these systems can only locate cracks and cannot detect the specific width information of cracks. Ni *et al*^[21] developed an Android APP for crack parameter measurement, but its accuracy in actual testing reached 6.322%, which is relatively average. Zhou^[22] proposed a crack pre-processing and measurement method for mobile devices. Still, his proposed mobile camera calibration algorithm requires recalibration after device replacement, and the accuracy cannot meet the actual scene requirements. Tayo *et al*^[23] measured the crack width on Raspberry Pi, but its maximum error exceeded 0.1 mm, which does not meet the actual requirements in terms of accuracy. Jing^[24] proposed a concrete crack measurement method based on Android, but it also performed poorly in terms of accuracy. Chen *et al*^[25] achieved crack width detection on the mobile terminal, but its maximum error can reach 0.12 mm, and the maximum relative error also reaches 7%. In summary, a high-precision and portable mobile end crack measurement device is currently lacking. Therefore, this paper proposes a portable component surface crack detection system based on the Android platform. While fully using the Android platform's convenience and powerful advantages, it applies digital image processing technology to

the measurement of crack width, achieving high-precision and portable crack measurement. The contribution of this paper is as follows:

- 1) This paper designs a portable handheld image acquisition device for collecting crack images. The hardware uses Samsung’s processor S3C2440A as the core, MT9V034 as the camera for collecting crack images, ESP32-S3 chip as the Wi-Fi transmission module, and LED as the device’s lighting system.
- 2) This paper applies various pre-processing algorithms to the collected crack images and proposes an improved Canny edge detection algorithm based on morphology. Finally, a complete crack width detection algorithm is designed.
- 3) This paper tests and analyzes the above design content, verifying the accuracy and reliability of the portable structural surface crack detection system based on the Android platform.

1 Portable Component Surface Crack Image Acquisition System

1.1 Portable Handheld Image Collection Unit

This paper designs a portable handheld image acquisition device to collect the crack image of the bridge surface, as shown in Fig. 1.



Fig. 1 Portable handheld image acquisition device

This device uses Samsung’s 32-bit microprocessor S3C2440, which is based on the ARM920T core of the ARM V9 series. It provides a solution for low-power, high-performance small-chip microprocessors for handheld devices and ordinary applications. The hardware structure of this device is shown in Fig. 2, and its system consists of cameras, Wi-Fi communication modules, power modules, LED lighting modules, etc.

The camera is mainly responsible for collecting crack images on the bridge’s surface. The device’s camera is chosen MT9V034, which has fast imaging speed and low power consumption. Its main parameters are shown in Table 1. The Wi-Fi transmission module selects the ESP32-S3 chip, which follows the IEEE802.11

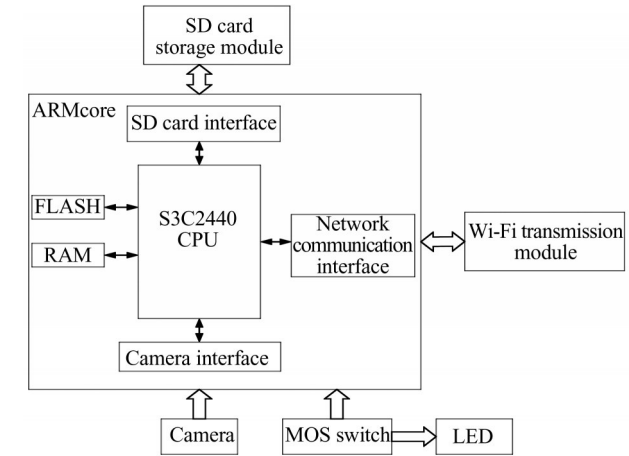


Fig. 2 Hardware structure

b/g/n protocol. It wirelessly transmits the collected crack images to the mobile terminal, thereby completing subsequent image processing work. At the same time, the device will store the collected image information in the SD card module to prevent data loss during the Wi-Fi transmission module, ensuring subsequent bridge information management work. Because the crack images acquisition device is carried out in outdoor environments, it is necessary to design artificial light sources, such as LED lighting modules, during the detection process to suppress the interference of external light on image acquisition and reduce the uncertain impact of outdoor lighting. Therefore, white LEDs are selected as the light source for the acquisition system, and six 0.2 W low-power LEDs are uniformly placed in a circular shape around the camera.

Table 1 Camera information

Specification	Parameter
Optical size/inch	1/3
Pixel size/ $\mu\text{m} \times \mu\text{m}$	6.0×6.0
Effective imaging area/ $\text{mm} \times \text{mm}$	4.51×2.88
Resolving power	752×480
Frame rate	60 frames/s(752×480)
Analog to digital conversion accuracy/bit	10

The features of this device are 1) Moderate size and easy to carry. 2) Collect high-definition video images. 3) Wireless data transmission can be performed with smart-phone terminals. As a portable handheld collection equipment, strict requirements should be met regarding function, reliability, cost, volume, and power consumption.

1.2 System Image Acquisition

The detection of crack width is achieved by digital image processing. The first step is to obtain high-quality crack digital images, namely the image collection. The width of the concrete surface cracks is generally small, and the pixels occupied in the image are also small, so the collection quality of the image will affect the final detection accuracy. When collecting images, the handheld device is placed in front of the crack, trying to make the cracks in the center of the screen and in a vertical state. The working state is shown in Fig. 3.

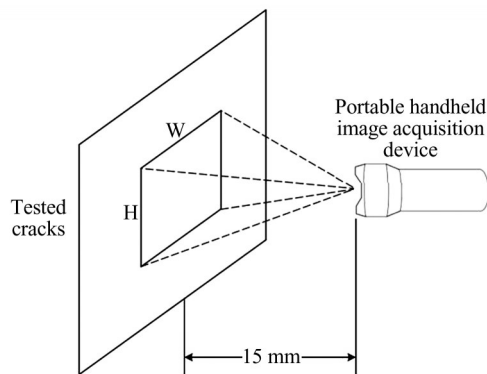


Fig. 3 Working state of the portable handheld image acquisition device

2 Crack Image Acquisition Software Based on Android

After transmitting the surface image of the collected component to the smartphone terminal, the crack detection APP system flowchart is shown in Fig. 4, and this system is designed based on the Android platform. The software enters the main interface of the crack detection system through a welcome interface, including 3 main menus, namely crack image reading, crack image processing and crack width calculation. The image reading includes displaying crack dynamic videos, intercepting crack images, saving pictures, etc.; The image processing function includes gray processing, linear transformation of grayscale, adaptive median filtering, image segmentation, etc.; The crack width calculation mainly includes width measurement, result preservation, etc. The crack image processing module will be introduced in Section 3.

2.1 Image Acquisition Module

The camera module used by the handheld device uses HTTP (Hyper Text Transfer Protocol) protocol,

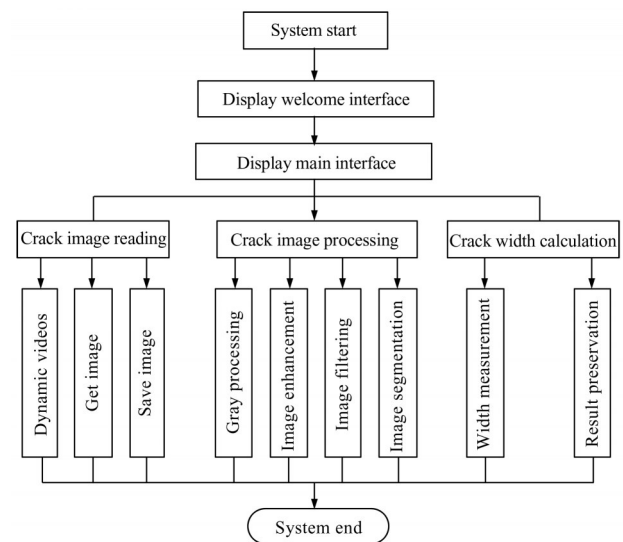


Fig. 4 Crack detection system designed based on the Android platform

which will generate Wi-Fi at work. After connecting the smartphone terminal with this Wi-Fi, this can obtain the camera's video stream's address through the URL (Uniform Resource local) and then create an input-output stream. The key code is as follows:

```
URLConnection urlConnection = url.openConnection();
urlConnection.setDoInput(true);
urlConnection.connect();
InputStream inputStream = urlConnection.getInputStream();
mInputStream = new BufferedInputStream(inputStream, 1024 * 1024);
```

Next, decode it using MediaCodec, which is an API used for audio and video encoding and decoding in Android. The decoding process is shown in Fig. 5. Then start the thread to play the loop; it can display the video on the surface, binding with MediaCodec, and it can use SurfaceView to play the video. Finally, the video is intercepted, and the original crack images are obtained.

2.2 Image Pixel Calibration Module

The obtained image is a digital image stored in the form of a matrix, since the width information is based on mm, and the width after processing is based on pixels. It is necessary to calibrate the pixels of the image. The actual width represented by each pixel in the image can be obtained by calibrating^[26]. Known as the calibration coefficient δ , many image calibration methods exist, and the measurement accuracy and image processing efficiency are comprehensively considered. This paper uses a ruler with a scale. Then, the ruler image is collected with the

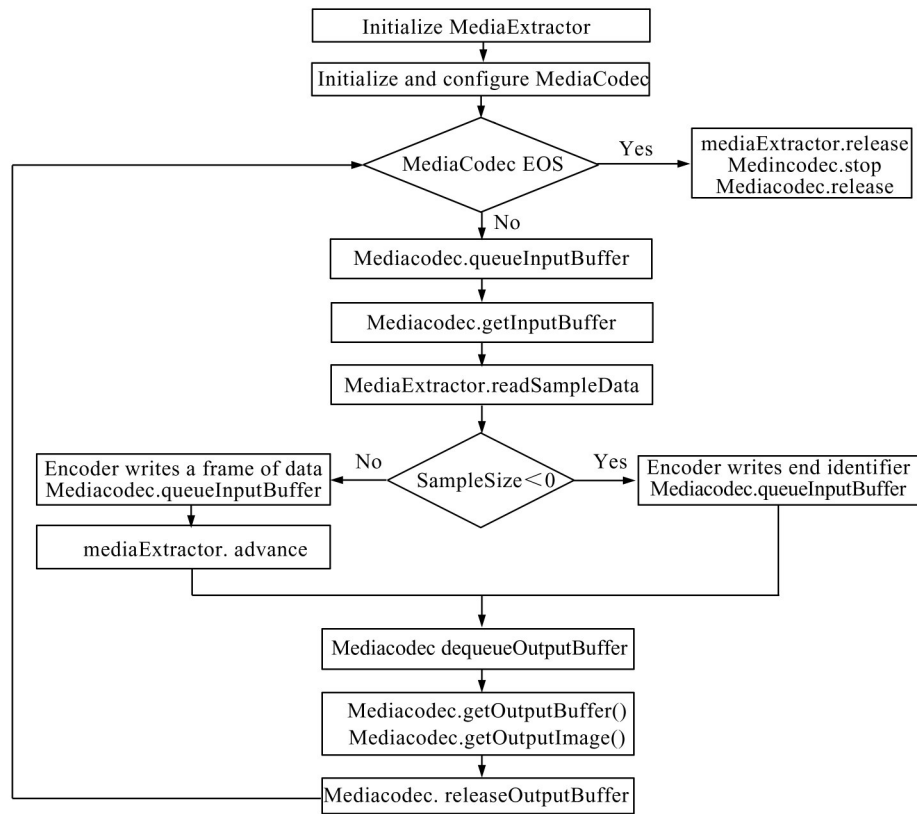


Fig. 5 MediaCodec decoding flowchart

collection device, and then the number of pixels between the fixed scale line of the scale ruler is calculated through image processing to obtain the calibration coefficient. Suppose that the actual length between the fixed scale line is a mm, and the pixel number between the scale is b pixel; the calibration coefficient is as follows:

$$\delta = \frac{a}{b} \quad (1)$$

δ is measured in mm/pix. By using this proportional relationship, the crack length at the pixel scale can be converted to a physical scale.

3 Crack Image Processing

The crack image processing algorithm is divided into two parts. The first part is the pre-processing part of the image, including image gray processing, image enhancement, and image filtering^[27]. The second part is image segmentation of crack images, namely the target extraction of edge information. Accurately positioning the crack edge is essential to calculate the later crack width.

3.1 Image Pre-Processing

3.1.1 Gray processing

The color of each pixel in color images is deter-

mined by three components: R , G , and B , and the gray image is a special color image with the same amount of R , G , and B . In digital image processing, color images are transformed into grayscale images to make the subsequent images less calculated. This process is called the gray processing of the image.

The gray processing of the image can be achieved using the component method, maximum value method, average method, and weighted average method^[28]. This paper uses the weighted average method for gray processing. Human eyes have the highest sensitivity to green and the lowest sensitivity to blue. Therefore, according to the following formula, the weighted average of R , G , and B components can obtain a more reasonable grayscale image.

$$\text{Gray} = 0.299R + 0.587G + 0.114B \quad (2)$$

In this formula, Gray is the gray value of the gray image, R , G , and B are pixel values of basic colors: red, green, and blue. Figure 6 shows the grayscale image after grayscale processing of the crack. It can be seen that the image loss is small, and the crack is more evident.

3.1.2 Crack image enhancement

In crack images, the cracks are the darkest areas, and the background is relatively bright. When collecting

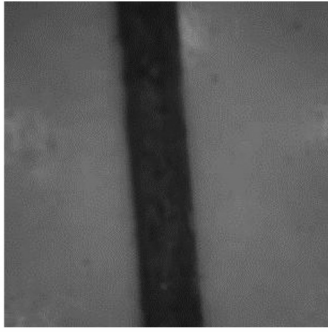


Fig. 6 Crack gray image

the image process outdoors, due to the unevenness of concrete materials, external environmental noise, and other factors, the comparison of crack images is not strong, the crack area and the background area are not easy to distinguish, and the edges are difficult to determine. Image enhancement can increase image contrast and make the crack target more pronounced, providing high-quality images for subsequent detection^[29].

Common image enhancement algorithms include histogram equalization, gray linear transformation, and gray nonlinear transformation. Histogram equalization is an essential application of gray transformation. Histogram equalization is based on cumulative distribution functions, which transform the gray histogram of the original image from a relatively concentrated range of gray values into a uniform distribution across the entire gray range. Gray linear transformation employs a piecewise linear method, adjusting the gray levels of an image through various linear functions to enhance contrast. Gray nonlinear transformation utilizes non-piecewise functions such as logarithmic and exponential functions as mapping functions to achieve nonlinear transformation of image gray. Histogram equalization is simple to implement without the need for parameter adjustments, but it may increase background noise and reduce the contrast of valuable signals. Gray linear transformation can preserve the original features of an image and offer high flexibility in adjustments for different images, but it may lead to excessive enhancement. Gray nonlinear transformation can retain more details and is suitable for complex enhancements, but it requires adjusting nonlinear parameters and consumes additional computational resources for complex transformations.

Crack image enhancement emphasizes crack details while reducing background features. This paper opts for gray linear transformation, balancing computational efficiency and accuracy. Suppose the gray value range of all

pixel points in the original image $f(x, y)$ is $[f_{\max}, f_{\min}]$. If the gray value range of pixel in the image $g(x, y)$ after the linear stretch is expanded to $[g_{\max}, g_{\min}]$, the following mapping function expression can be used:

$$g(x, y) = \frac{g_{\max} - g_{\min}}{f_{\max} - f_{\min}} f(x, y) + g_{\min} \quad (3)$$

Figure 7 is the comparison effect of the crack after the linear transformation of grayscale. It can be seen that the image contrast has been enhanced after processing.

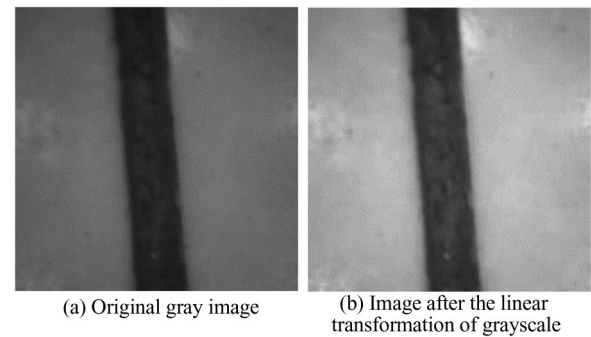


Fig. 7 Comparison effect of the gray linear transformation

3.1.3 Crack image filtering

Affected by external natural factors and human shooting factors, the collected crack images will inevitably contain noise components. Therefore, noise must be removed before the crack target is extracted. Median filtering is a non-linear signal processing method that can effectively suppress noise based on sorting statistics theory^[30]. The calculation method is shown in Fig. 8. The sliding templates that are usually used are square template windows such as 3×3 , 5×5 , and 7×7 , and they can also be filtered with the sliding templates such as cross-shaped, diamonds, and ring shapes.

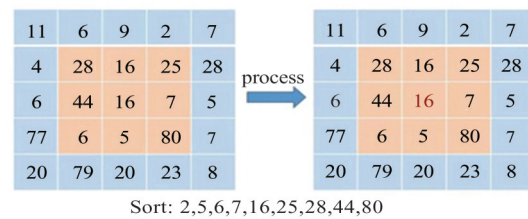


Fig. 8 Median filtering calculation method diagram

The size of the filtering window directly impacts the performance of the median filter^[31]. The smaller window retains the features, but it will affect the effect of noise suppression; in the larger window, the noise suppression is higher, but the loss of image content will be greater, and the image will be blurrier. This paper adopts

an adaptive median filtering algorithm^[32]. According to the preset conditions, the window of the median filter is dynamically changed to take into account the effects of suppressing noise and protecting details. The algorithm steps are as follows:

① Select a 3×3 initial filter window s_{xy} , which will change adaptively during the filtering process.

② If $Z_{med} - Z_{min} > 0$ and $Z_{med} - Z_{max} < 0$, it means that the mid-value point is not the noise point at this time, and then jump to step ③; otherwise, increase the size of s_{xy} , repeat the step ②, find a suitable non-noise point in a more extensive range.

③ If $Z_{xy} - Z_{min} > 0$ and $Z_{xy} - Z_{max} < 0$, it means that the center point is not the noise point, then output Z_{xy} , retains the gray value of the current pixel point; otherwise, output Z_{med} , and the original grayscale value are replaced by medium value.

④ The output result is given to the pixel gray value at (x, y) , (x, y) is the center position of the filtering window.

⑤ Traversing pixels in crack images.

Among them: s_{xy} is the area of the filter, the area covered by the filtering window, and the center position of this area is (x, y) ; Z_{min} is the minimum gray value in s_{xy} ; Z_{max} is the maximum gray value in s_{xy} ; Z_{med} is the median value of all gray values in s_{xy} ; Z_{xy} is the grayscale value at (x, y) .

The gray image of adding salt-and-pepper noise uses mean filtering and adaptive median filtering algorithms, respectively. The effect is shown in Fig. 9. It can be seen that the mean filtering effect is far less than the adaptive median filtering. The adaptive median filtering can not only remove the image's noise but also protect

the crack edge information.

3.2 Crack Image Segmentation

After the pre-processing operation, the characteristic information of the crack target is highlighted to a certain extent. However, the concrete usually appears to have severe cellular, pits, stains problems, etc. These interference factors cannot be eliminated by pre-processing; this type of interference needs to be eliminated by image segmentation. The specific method is to separate the pixel points in the crack area from the background area pixel points so that the processed image contains only the target crack without interference information.

3.2.1 Canny edge detector

The Canny edge detector algorithm is one of the most superior marginal detection algorithms^[33]. The detection process of this method is divided into the following 5 steps:

Step 1: The noise in the image is reduced using a Gaussian filter to smooth images. Under normal circumstances, the 5×5 Gauss filter shown in the formula (4) is used.

$$G = \frac{1}{139} \begin{bmatrix} 2 & 4 & 5 & 4 & 2 \\ 4 & 9 & 12 & 9 & 4 \\ 5 & 12 & 15 & 12 & 5 \\ 4 & 9 & 12 & 9 & 4 \\ 2 & 4 & 5 & 4 & 2 \end{bmatrix} \quad (4)$$

Step 2: Calculate the gradient direction and amplitude of each pixel in the image. First, detect the edges of the X direction and the edge of the Y direction through the Sobel operator, then use the formula (5) to calculate the direction and amplitude of the gradient.

$$\begin{cases} q = \arctan\left(\frac{I_y}{I_x}\right) \\ G = \arctan \sqrt{I_x^2 + I_y^2} \end{cases} \quad (5)$$

Step 3: The non-maximum suppression algorithm eliminates the spurious response brought by edge detection. First, the gradient intensity of the current pixel is compared with the gradient intensity of the two pixels in the positive and negative gradient direction. If the gradient strength of the current pixel is the largest compared with the two other pixel gradient strengths, then this pixel point is retained as the edge point. Otherwise, this pixel point will be suppressed.

Step 4: The double threshold method divides strong and weak edges.

Step 5: Eliminate isolated weak edge.

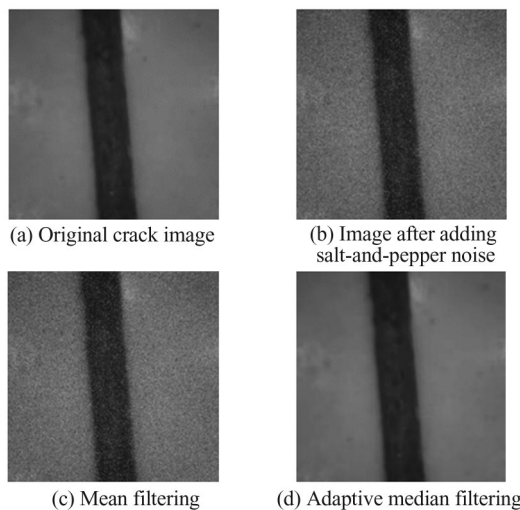


Fig. 9 Crack image filtering effect comparison diagram

3.2.2 Improved Canny edge detector based on morphology

A Canny edge detector algorithm was performed on the crack image, and the crack edge may still contain a few discontinuous and intermittent phenomena. Therefore, this paper uses the method of mathematical morphology processing to improve the traditional Canny edge detector algorithm and connect the intermittent edge information into a continuous curve. Closing operation (morphology) can be defined as a dilation operation and connecting an erosion operation. Figure 10 shows three stages of the image closing operation; the left image is the original image. The intermediate images can

be obtained by diluting the original image using 3×3 rectangular structure elements. After that, the erosion operation was performed to get the right image.

Because closing operation can be used to fill the small holes in the body, connect neighboring objects, and smooth the boundary, it does not significantly change its area. Therefore, based on the traditional Canny edge detector, a closing operation is added to the edge of the crack; this can connect the tiny fracture of the crack edge. The original image after the traditional Canny edge detector algorithm is shown in Fig. 11 (a), and Fig. 11 (b) is the effect diagram of the improved Canny edge detector.

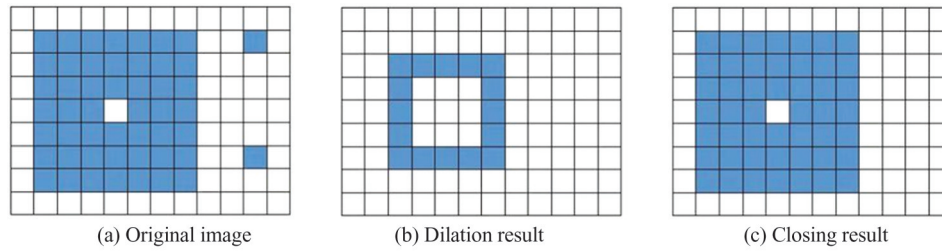


Fig. 10 The three stages of image closing

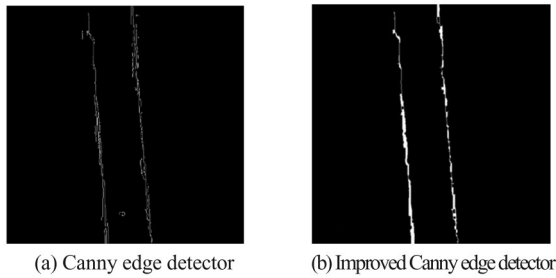


Fig. 11 Crack image edge detection effect comparison diagram

4 Crack Width Calculation

Considering engineering practice and the requirements of quality control and inspection, the crack's maximum width and average width are selected as the main feature parameters in this paper. The average width and maximum width represent the degree of damage to the crack. The maximum width is to determine whether the concrete structure needs to be maintained for maintenance. Considering the calculated amount and the irregular development of the crack, this paper uses the edge tangent line method to measure the width of the crack^[34]. This method uses the tangent line of each point on one edge of the crack to make a perpendicular line to inter-

sect with another edge. The distance between this point and the point of intersection is used as the width, as shown in Fig. 12.

For any point $P(x_i, y_i)$ on the left edge curve, through the slope of the two adjacent pixel points coordinates on the left and right, the tangent line $T(x)$ of this point can be determined. A vertical line $N(x)$ is intersected with the right edge curve of the crack to point $Q(x_j, y_j)$. The width of the crack at the P can be expressed as:

$$w = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (6)$$

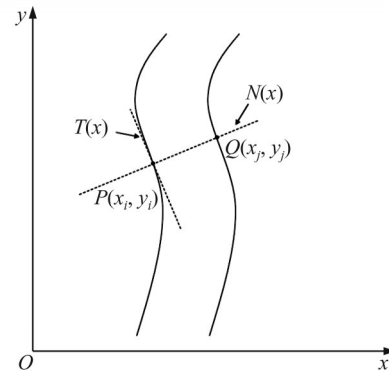


Fig. 12 Calculation diagram of edge tangent method

Traversing the width of all pixels on the left edge curve of the crack, the actual maximum width $w_{\max}$ and average width $\bar{w}$ can be calculated through the calibration coefficient δ of the camera.

$$w_{\max} = \delta \times \max(w) \tag{7}$$

$$\bar{w} = \delta \times \frac{\sum w}{n} \tag{8}$$

5 Experiment

In order to verify the integrity of the entire system and the accuracy of crack width detection, a series of experiments were conducted in this paper to ensure that the design requirements were met. The equipment used in the experiment is Honor V20; its parameters are shown in Table 2.

Table 2 Honor V20 main performance parameters

Main performance indicators	Parameter
CPU	Huawei Kirin 980
Running memory	8.0 GB
Screen resolution/pixels	2 310*1 080

In order to verify the feasibility of this system, the experiment selected a crack located in the complex concrete background. This crack is thinner, and its shape is not regular. Install the detection application’s installation file (.APK) on the phone and run the system. The detection process of the crack detection APP is shown in Fig. 13.

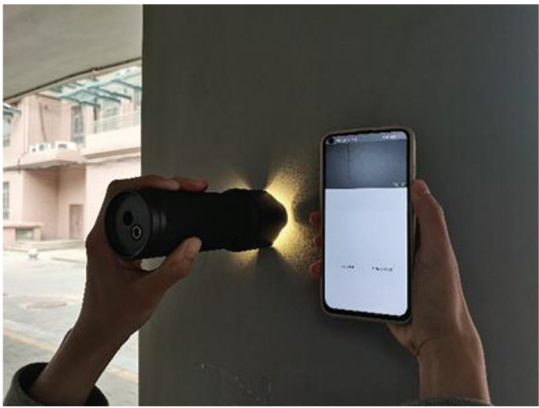


Fig. 13 Crack detection process

Next, the display interface of the APP is shown in Fig. 14, from which the maximum measured crack width is 0.86 mm, marked with a yellow arrow, and the average width is 0.5 mm.

In order to verify the reliability of this system, this

paper uses AutoCAD2014 to draw analog cracks, and the width of cracks is 0.5 mm, 1.0 mm, 1.5 mm, 2 mm, and 5 mm. The analog image is shown in Fig. 15.

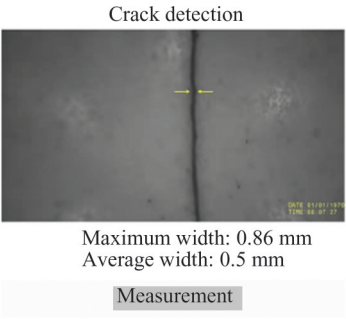


Fig. 14 APP crack width measurement interface

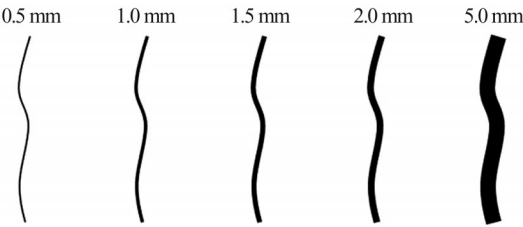


Fig. 15 Simulated crack image

These photographs are collected using the system and printed on the scale of 1:1 of the above-simulated crack images, which are then detected. At the same time, these simulated cracks were measured directly by using a crack width gauge. When measured, the same crack is measured multiple times, and then the average value is taken. The measured by crack width gauge results are compared with the results calculated by this system. The comparison results are shown in Table 3. It can be seen from Table 3 that the relative error of the crack width gauge is basically less than 5%, and the relative error of the APP measurement is less than 7%, which is slightly larger. The higher relative error in APP measurements is due to the introduction of closing operation in the improved Canny algorithm. The closing operation connects minor interruptions and small voids with the cracks, resulting in an increase in the detected crack width. Nevertheless, the accuracy of the measurements still meets engineering requirements.

In order to further verify the detection accuracy of the crack width of this system, the actual concrete structure cracks are experimented. At the same time, measure these simulated cracks through the use of a crack width gauge. When measured, the same crack is measured multiple times, and then the average value is taken. The results of the measured by the crack width gauge are compared with those measured by this system. The results

Table 3 Simulated crack width measurement results comparison

Crack number	Simulation width/mm	APP measurement value/mm	Relative error1/%	Instrument measurement value/mm	Relative error2/%
1	0.5	0.53	6.00	0.52	2.00
2	1.0	1.04	4.00	1.02	2.00
3	1.5	1.43	4.67	1.54	2.67
4	2.0	2.07	3.50	2.06	3.00
5	5.0	4.89	2.20	5.18	3.60

are shown in Table 4.

It can be seen from Table 4 that when the width of the crack is more significant than 0.2 mm, the maximum relative error of the two measurement methods does not exceed 6%. Due to the instrument's accuracy and artificial factors during measurement, errors will inevitably occur for cracks less than 0.2 mm wide. Therefore, the deviation of cracks that are less than 0.2 mm is relatively large. The above experimental results show that the crack detection APP designed in this paper has high stability and accuracy to meet the needs of engineering practice.

Table 4 Actual crack width measurement results comparison

Crack number	APP measurement value /mm	Instrument measurement value /mm	Relative error /%
1	0.17	0.16	6.25
2	0.55	0.58	5.17
3	0.95	0.98	3.16
4	1.63	1.70	4.12
5	2.92	3.04	3.95

6 Conclusion

Aiming at the cracks on the surface of concrete bridges, this paper combines Android development technology and platform a portable handheld image collection equipment. It develops a bridge surface crack detection system based on the Android platform. This system collects the crack area image with handheld image collection equipment. It uses the weighted average method to perform gray processing, linear grayscale transformation for image enhancement, adaptive median filtering for image filter, and improves the Canny edge detector to identify crack information. Finally, the crack feature value is calculated and interpreted through the edge tan-

gent line method.

Compared with the traditional detection method, this system not only has a simple detection process and is easy to carry but also depends on the communication function of smartphones; the crack detection results can be transmitted in real-time and provide a real-time detection basis for non-on-site experts. The experimental results show that this system can effectively detect the width of the cracks, and compared with the crack width gauge, the width relative error is not more than 6.25%, which can meet the needs of engineering practice.

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