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Research on vehicle-mounted pavement crack detection system based on image processing

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ABSTRACT

Pavement cracks as a common highway damage, the complex road condition and the underdeveloped image acquisition software and hardware technology make the achieved pavement images with high noise, it brings difficult image processing and low crack detection. Therefore, it is significant to study a crack detection system processing high noisy images. This thesis focuses on image processing of vehicle-mounted pavement crack detection system, aiming to deal with high noisy images. Doing research in terms of specific system image acquisition, pre-processing, grayscale and color images morphological operations, etc., and to complete the image of binary and determine the optimal threshold to achieve the MATLAB image processing. Experiments show that this method can be a reality.

KEYWORDS

Vehicle-mounted pavement; Wavelet de-noising; Image processing; Crack detection system; High efficiency.

INTRODUCTION

The impact of natural factors and the role of the traffic load, will result in a variety of road surface damage, direct impact on traffic and safety. Damage detection of timely and effective condition becomes the key of highway maintenance, pavement cracks in damaged condition is a key aspect of detection. Initially highway pavement crack detection based on traditional manual way, all the work of human labor by machinery to complete, testing is not only time-consuming, labor-intensive low accuracy of the raw data is also difficult to achieve and maintain records. Then based on the use requirements of people, science and technology promote the development of the detection technology in the era of automation, intelligent pavement checkout automobile arises at the historic moment. On the system research, this paper uses the MATLAB technology, from the image collection, pre-processing, color image gray and image morphology operation to do specific system research, and finish the image binarization, finding the best threshold value of MATLAB image processing was realized.

MATLAB IMAGE PROCESSING TECHNOLOGY INTRODUCTION

MATLAB (Matrix Laboratory) is short of The Abbreviation of Matrix Laboratory, is a commercial mathematical software by The United States The Math Works. MATLAB is a kind of for algorithm development, data visualization, data analysis and numerical calculation of senior technical computing language and interactive environment. Besides matrix operations, common features, such as drawing function/data image can also be used to create the user interface and MATLAB and calls to other languages (including C, C++ and FORTRAN) programs written in[1].

IMAGE PRE-PROCESSING

In general, pavement crack image by CCD camera, the weather, light and shooting Angle different will have had different effects on the quality of the image, the interference factors will affect the follow-up in the process of locating, character segmentation and character recognition accuracy, so you need to use the relevant technology of the digital image processing, the shooting the original image pre-processing, in order to enhance image quality[2]. For images containing cracks, the purpose of pre-processing is to get interested in that part of the information is strengthened, and try to eliminate the interference information, preparing for the back of the job. In this paper, image pre-processing will include four steps:

(1)The original true-color image into a grayscale image.

Figure 1: Original crack image figure

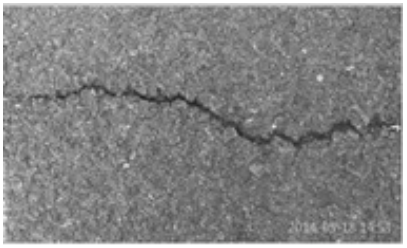

Figure 2: Gray image

(2)The gray images of opening and closing operation to get the background image.

(3)The gray image and background image subtraction, using the method of median filter for image enhancement[3-4].

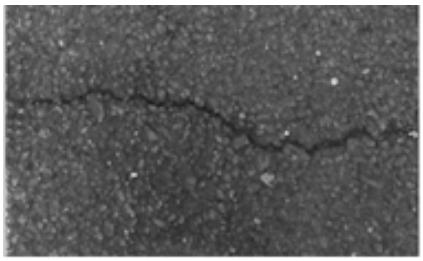

Figure 3: Background image

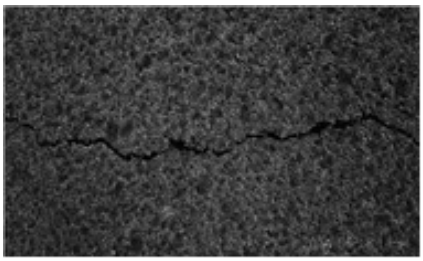

Figure 4: Image enhancement

(4)To obtain the best threshold binary image[5]. Ultimate purpose of pre-processing is to obtain appropriate threshold and the image is converted to a binary image, to provide material for subsequent image edge detection.

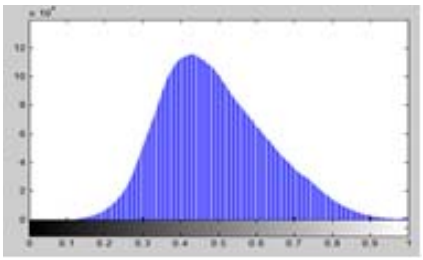

Figure 5: Histogram

HIGH NOISE CRACK DECTION

Wavelet Denoising

Digital image will be affected by shocks, electronic devices such as sensor interference and other reasons in the production process, resulting in a decline in the quality of digital images obtained after conversion, affect users' understanding of image content. In order to guarantee the correctness of the subsequent processing, need to deal with the noise of image. Choose to adopt a low entropy, multi-resolution willfulness, to correlation, flexibility and so on the characteristic of wavelet denoising method for denoising[6].

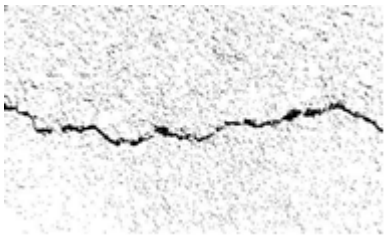

Figure 6: Without the binary image denoising

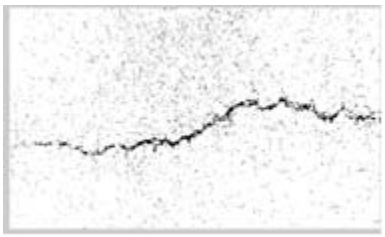

Figure 7: Through binary image after wavelet denoising

Edge Detection

For image processing with high noise, edge detection is a key image processing. Edge detection is the basic idea of using edge enhancement operator first, highlight the local edge of image, and then define the pixel intensity of "edge", by setting the threshold value method to extract the edge point set. After wavelet denoising image, under the Canny edge detection operator, obtained the ideal image results[7-8].

Figure 8: Grayscale image

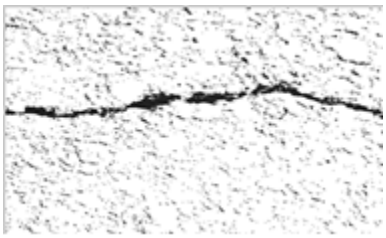

Figure 9: Binary image

Figure 10: Edge detection image

Implementation of Vehicle Pavement Detection System

Asphalt pavement cracks in the image is often due to weak noise, uneven illumination and crack information makes the influence of such factors as the crack edge detected is not ideal, edge of discontinuous, and introduces some false information noise. So connect to edge cracks is very important.

Remember the original pavement crack image size of X*Y, scanning point is P, growing operation results stored in the temporary crack in figure E, processing steps. The following cracks on the block:

Step 1: Remember the scan point is P, from the upper left corner of the image from left to right in turn down the search, until the current point P value is 1, which is the current point of block P is the initial crack block.

Step 2: Determine the current point is P the right endpoint current initial crack block: when the direction of neighborhood value is 0, P is the right endpoint. Otherwise, P is not the right endpoint.

Step 3: If the current point P is the right endpoint starting blocks, so it is base point with between the point P, search the surrounding pixels.

If the search distance point P is larger than 8000 pixels of crack pixels N, said N points where the fracture cracks for candidate blocks, namely the crack piece to connect; otherwise the new cracks in temporary crack figure E, will not grow.

Step 4: If the current point P is not the right endpoints of starting blocks, along the crack to continue scanning until you find the right endpoint.

After the above steps you can connect two blocks E fracture cracks via two-pixel-wide line, break for more than two pixels can be connected through multiple iterations. As shown below:

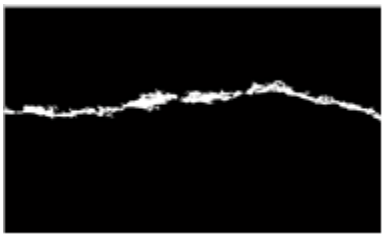

Figure 11: Connection diagram after treatment

To calculate the target area often using the scaling method, the total number of pixels that sets a standard objects in target area. The aim is not only conducive to measure at the same time also can reduce the measuring error[9-10]. The single pixel area was obtained by the following method. A single pixel area is s, the standard object area is A, the total number of object pixels standard for a, s=A/a;

Get the number of pixels of an image through the MATLAB area statistics, the results are as follows:
Height: height=1745
Width: wide=1577
The number of pixels:
Area=76822

CONCLUSIONS

This article first to collected the road image preprocessing in order to facilitate image identification and classification. First of all, through the study of pavement crack image characteristics, this paper tries to adopt the method of wavelet denoising for pavement image denoising processing. Then on the pavement image edge extraction, laid the foundation for threshold segmentation. Using the regional connection method to calculate the crack of pixels. Through the number of pixels with standard objects do calculate finally got crack area ratio, achieved the purpose of the image processing.

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