

# Introduction to The MATLAB GUI Rock Fracture Processing System

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## Abstract

**MATLAB as a powerful algorithm development and visual analysis interactive tool, integrated with a variety of algorithms toolbox, in digital image processing, widely used, has a powerful data processing capabilities. In this paper, systematic analysis is made based on MATLAB the application of GUI's rock fracture processing and analysis system is introduced. The system has good convenience, practicability, interactivity and stability, which provides ideas for the identification and treatment of rock fractures.**

## Keywords

**Rock fracture; MATLAB GUI; Image processing; System applications.**

## 1. INTRODUCTION

It is of great practical significance to analyze the law of rock crack propagation for avoiding the occurrence of various engineering accidents and providing more accurate data for further research.

The rock crack treatment and analysis system is more convenient. Easier to operate, and the requirements for the surrounding environment and the like are not quite strict, the interface design of the detection system is simple, easy to operate, the background and the crack can be strictly distinguished and small changes of the crack can be counted by quantitative image data changes, basic characteristic parameters of rock surface cracks can be obtained, it is of great practical value to be able to analyze the crack growth trend. According to the data investigation, there is a detection system for rock crack, and the specific information of rock crack is known. It is very meaningful to explore the crack propagation under rock stress for the prediction and safety protection of rock disasters. The systematic design and development can provide efficient and convenient means for crack extraction and analysis. This article will introduce the system based on MATLAB application of GUI rock fracture processing and analysis system.

## 2. RESEARCH STATUS

### 2.1. Domestic research status

In theory, Liu Taoying et al. summarized the crack initiation rule of compressed-shear rock cracks under the action of high osmotic pressure and the variation rule of the strength factor of branch crack tip. Although the theoretical analysis of rock cracks has made great achievements, it is not closely combined with the practice, and the change of rock cracks cannot be seen directly. The crack processing and analysis system based on close-range photographic observation technology solves this problem.

In terms of experiments, there are also a lot of domestic research achievements, such as using CT scanning to study the process of microcrack initiation, propagation and fracture of rock under triaxial loading. In addition, real-time holographic interferometry, digital camera and

image processing system are used to continuously observe the rock under uniaxial and compressive shear loads, and the process of rock crack initiation, propagation and deformation is described.

In the field of image processing, many domestic researchers have put forward some crack detection algorithms with good effects [6], such as Cheng Jun et al., based on machine vision technology, proposed a method to detect cracks in firebrick. Zheng Rong et al. detected longitudinal cracks on slab surface images by combining morphology and wavelet transform.

## 2.2. Foreign research status

Some foreign researchers use digital image processing technology to develop some crack detection systems, such as road surface crack automatic detection system, concrete brick surface crack extraction and measurement system. However, there are few digital researches on two-dimensional rock images.

The rock crack processing and analysis system based on close-range photographic observation technology is more convenient and easy to operate, and the requirements on the surrounding environment are not very strict. The interface design of the detection system is simple and easy to operate, which can strictly distinguish the background from the crack and make the slight change of the crack through the quantitative image data change statistics, so as to obtain the basic characteristic parameters of the rock surface crack. It is of great practical value to analyze the crack propagation trend.

## 3. INTRODUCTION TO THE SYSTEM FUNCTIONAL MODULES

### 3.1. The image is inverted

`imcomplement` is the name of a mathematical function that inverts image data (achieving negative complement). Function: carry out inverse operation on image data (achieve negative effect).

Parameter description :IM is the source image data, IM2 is the image data after inversion.

$IM2 = imcomplement(IM)$

### 3.2. Image rotation

Function:  $B = imrotate(A, angle, method, 'crop')$

Where angle: rotation Angle, in degrees, rotates counterclockwise when the Angle is positive. method: This optional argument specifies the interpolation method for `imrotate()`. 'crop': Crop the enlarged image after rotation.

### 3.3. Image Scaling

The bilinear interpolation method is used to scale the grayscale image with a bit depth of 8.

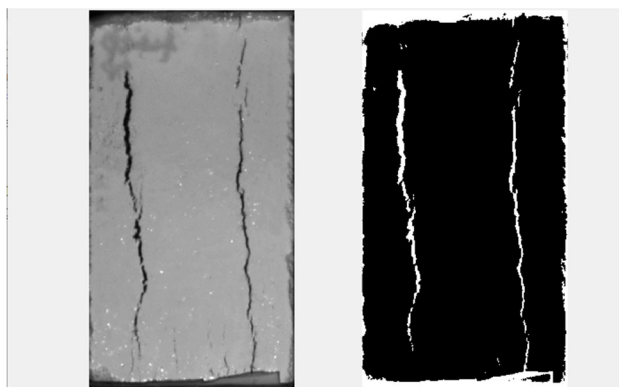
Input the pixel requirements of the original image and the scaled image (width\*height), and output the new image after processing. Use matlab to achieve `scale(input_img, scale_size)` function, input the image path and the required width

scale\_w and height values scale\_h can be realized. The original image is converted into img matrix by matlab, so that the value of element `img(a, b)` is the pixel value at the height a and width b of the original image.

### 3.4. Image threshold segmentation

Threshold segmentation algorithm is one of the most common image segmentation methods, commonly used threshold segmentation methods including Otsu method, minimum error method and maximum category difference method. However, the image generally contains a

number of different types of areas, how to select the appropriate threshold value for segmentation, is still a big problem of image threshold segmentation. As shown in the figure, the image segmentation results obtained by direct application of threshold segmentation contain more noise and oversegmentation.



**Figure 1.** Image threshold segmentation results

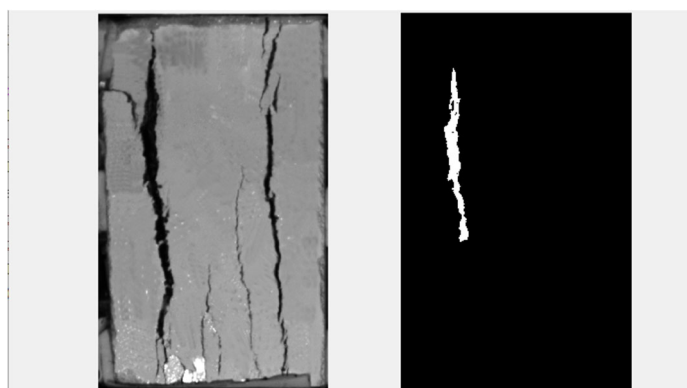
### 3.5. Region Growth

The Region Growing method (Region Growing) is essentially the process of merging seed pixels or subregions through predefined similarity calculation rules to obtain a larger area. First, the seed pixel or subregion is selected as the target location; Then, the adjacent pixels or regions that meet the similarity condition are merged into the target position, and the gradual growth of the region is realized in a loop. Finally, if there are no points or small areas to continue merging, it stops and outputs. Among them, the similarity calculation rules can include information such as gray value, texture, color, etc.

In the absence of prior knowledge, region growing method seeks for the best

Segmentation by rule merging strategy, which has the characteristics of simplicity and efficiency. However, the region growing method generally requires the selection of seed points or subregions in an artificial way, which is easy to lack objectivity. In addition, the region growing method is sensitive to noise, which may cause problems such as holes and noise in the segmentation results.

As shown in the figure, the direct application of region growing method requires manual selection of seed points, and there are more holes and noise edges in the output segmentation results, which also brings some interference to the subsequent analysis. Therefore, it can be considered to automatically select seed points combined with threshold segmentation and apply morphological post-processing to remove holes and noise.



**Figure 2.** Regional growth results

### 3.6. Image Enhancement

The collection of rock crack images is generally carried out outdoors, which is susceptible to the influence of atmospheric, illumination, mechanical vibration and other factors. The collected crack images may have problems such as overall darkening or brightening, and thus produce images with low contrast. The feature of this kind of image is that the gray distribution range is small, concentrated in a few gray intervals, which also brings adverse effects on the subsequent crack detection and recognition, so it is necessary to enhance the image to improve the contrast.

As a statistical table of image gray level distribution, histogram can reflect image contrast details to a certain extent. The gray level histogram of the image represents the relative frequency of different gray level pixels in the gray type of the image, and the horizontal coordinate of the histogram represents the gray level, and the vertical coordinate represents the frequency or probability of gray level. Histogram equalization uses gray level histogram to adjust image contrast, so as to achieve the goal of enhancing image visual effect.

The cracked image region usually belongs to the grayscale region with darker color, while the background region belongs to the grayscale region with relatively brighter color. However, in the process of collecting the crack image, the overall image is often dark due to weather interference, under-exposure and other reasons, so that the brightness characteristics of the crack area and the background area are similar and difficult to distinguish, as shown in the figure. As can be seen from the gray histogram of the original crack image, the distribution of its gray value is mainly concentrated in the low level gray range of 100~200. Therefore, in order to improve the contrast between the crack and the background, it is necessary to expand the gray value range of the original image to form a more obvious gray level difference, and then increase the contrast of the crack image. After gray histogram equalization processing, the gray range of the crack image is expanded to 0~255, and the crack image with enhanced contrast is obtained, which highlights the difference between the crack and the background.

## 4. CONCLUSION

The existing research methods for rock crack propagation mainly include digital simulation, CT scanning, wave velocity measurement, crack detection algorithm and so on. This paper systematically introduces the application of rock fracture treatment and analysis system based on MATLAB GUI. The system interface design is simple, easy to operate, the background and the crack can be strictly distinguished and small changes of the crack can be counted by quantitative image data changes, basic characteristic parameters of rock surface cracks can be obtained, it provides a more convenient operating platform for crack growth trend researchers, it has strong practical value.

The system has many kinds of functions and clear functions, including image extraction, image transformation, image segmentation, image enhancement, image filtering, edge detection, case analysis and other data analysis parts. It can make the user get the histogram of the image, the result of adding noise or removing noise, and the result of image segmentation quickly, which provides a new method for studying the law of rock crack propagation. It also creates a new data analysis platform for other research on fracture.

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