

Building Materials Defect Monitoring Based on Digital Image Recognition Technology

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Abstract. On the basis of using the vacuum impregnation technology to obtain microscopic images of building materials, algorithms such as image scaling, index image, image recognition and image identification are respectively designed to identify the pores of the building materials through programs. The images zooming adopts bilinear interpolation to realize the lossless compression of the original microscopic image. The identification of the aperture adopts the method of logical screening and the operation of morphological opening and filling. Through the identification of the pores, the material defects can be further analyzed by mesomechanics.

1. Introduction

The microscopic defects of building materials will produce different levels and structures due to different destructive effects, thus affecting the behavior and quality after the material is damaged. Therefore, the quantitative study of the microstructure of materials can provide an effective solution to the deterioration. It will reduce the failure of macroscopic mechanical properties of materials. Developments in microscopy and image processing techniques have facilitated the study of concrete microstructures [1-4]. Common methods include acoustic emission [3,4], sonication [5], radiographic tomography [6], radiographic methods [7], scanning electron microscopy [8], and optical microscopy [9]. In this paper, immersion dyeing technology [10], which is less used in the country. This technology combined with image processing methods can provide numerical and microscopic modeling of concrete point and material information. Appropriate image processing and analysis techniques involve a variety of complex digital image algorithms; the practical use of these techniques and materials requires adaptation of the algorithm to the microstructure of the material [11]. Once used effectively, they can reflect meaningful quantitative data in the nature of material engineering and provide a basis for the development of structure-property relationships. In this work, sample preparation techniques have been developed to automatically investigate the cracks and pores in materials by means of electron microscopy and fluorescence microscopy. Image processing and analysis programs have been developed to distinguish meso-structures in material specimens.

2. Building materials digital image processing methods

In this paper, the module have been built and developed based on Matlab to identify the defects of the electron micrographs of building materials respectively, which lays the foundation for further micromechanical analysis. Through the existing experimental EM photo processing, the following is the flow chart of the entire process in Figure.1.



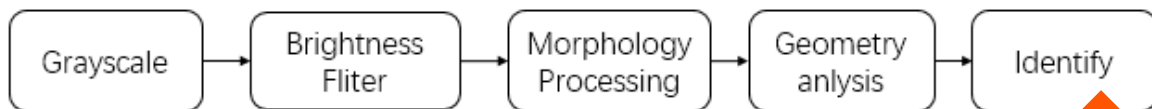


Figure 1. Electron microscope image processing in Matlab

2.1 Image Pretreatment

Electron microscopy is more pixels and takes up more memory, dealing with the picture directly has some difficulties. So before the image processing, the image needs to be scaled. There are commonly used methods like the geometric mean, neighbourhood sampling interpolation, quadratic interpolation, cubic interpolation. In this paper, the use of bilinear interpolation method to scale the image processing. Bilinear interpolation method can handle the high image quality, and does not appear that the pixel value is not continuous. This method is always used to deal with such large-scale electron micrographs which have million pixels or even tens of billions of photos without distortion of the situation. Before recognizing the image, we also need to filter the part of the image that contains noise to reduce the impact of the image itself.

2.2 Grayscale

By the principle of digital image processing, the true color image must be converted into an index image, that is, the value of RGB is normalized to be in the range of 0-1. Where it in unit8 format, where the brightness value for each point is between 0-255. The larger the index value, the greater the brightness at this point. By converting it to an index image, it will play a key role in the subsequent processing. After processing the results shown in Figure 2.



Figure 2. Electron microscope image zoom and grayscale

2.3 Image Identification

The material's pores are bright and regularly closed, allowing the image to be screened for the final location of the pores and marked in the image matrix. The following figure3 is the algorithm design flow.

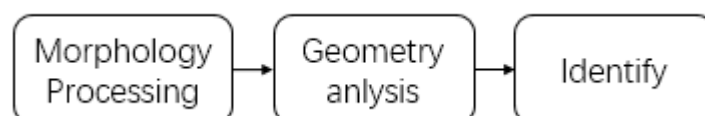


Figure 3. Concrete pore recognition algorithm

Brightness value filter. For different parts of materials, take different brightness screening principles. The digital image is set as a matrix $Q(i, j)$, and the matrix $Q(i, j)$ is reduced to the row vector $K'(I, j)$. The prototype is used instead of the sorting algorithm to process all the pixels Ascending order, to be sorted after the row vector $K'(I, j)$, set the brightness coefficient, you need to set the specific characteristics of the image brightness constant J , the matrix image brightness screening:

$$S(i, j) = J \cdot \sum_{i=1}^k K(i, j) \quad (1)$$

$$J = \begin{cases} 0, & K(i, j) < \text{const} \\ 1, & K(i, j) < \text{const} \end{cases} \quad (2)$$

Using Matlab platform, the program traverses each value inside, can filter out the brightest point. For the part can not be filtered through the brightness of the part, through the morphological processing related algorithms. The image needs to be binarized before it can be processed. Generally, there are many methods for binarization, such as the maximum entropy method, the method of moment preserving, etc. In this paper, automatic thresholding method is used. The method uses the gray level difference between images Larger, manual thresholding is not applicable; therefore, comparative studies are often conducted to examine the possibility of using automatic (instead of manual) thresholds and to determine the appropriate type of automatic threshold for a particular situation, such as a particular sample preparation and microscopy technique. The digital matrix $S'(i, j)$ obtained from the first step in Figure 1 is stored as a logical type data matrix $S'(i, j)$. Morphological analysis of the image, first remove the small objects in the image, then set the threshold set by the image, the image morphological open operation, the first expansion and then erosion, the operation can be used to eliminate small objects, the slender Detail of the object will do not significantly change its area while smoothing the boundaries of larger objects.

Define $S'(i, j)$ as an element in set A , and set the kernel functions $g_1(x), g_2(x)$ as kernel functions under erosion and expansion respectively. Therefore, the following morphological operations are performed:

$$B = \{z | (z \cap A) \neq \emptyset\} \quad (\text{Corrosion operation})$$

$$C = \{z | (B \cap A) \neq \emptyset\} \quad (\text{Expansion operation})$$

the corresponding convolution operation:

$$T_1 = \int_{-\infty}^{\infty} f(\omega) g_1(x - \omega) d\omega \quad (3)$$

$$T_2 = \int_{-\infty}^{\infty} f(\omega) g_2(x - \omega) d\omega \quad (4)$$

The matrix T_2 obtained is the image matrix obtained by morphological opening operation, and the image is shown in the figure.

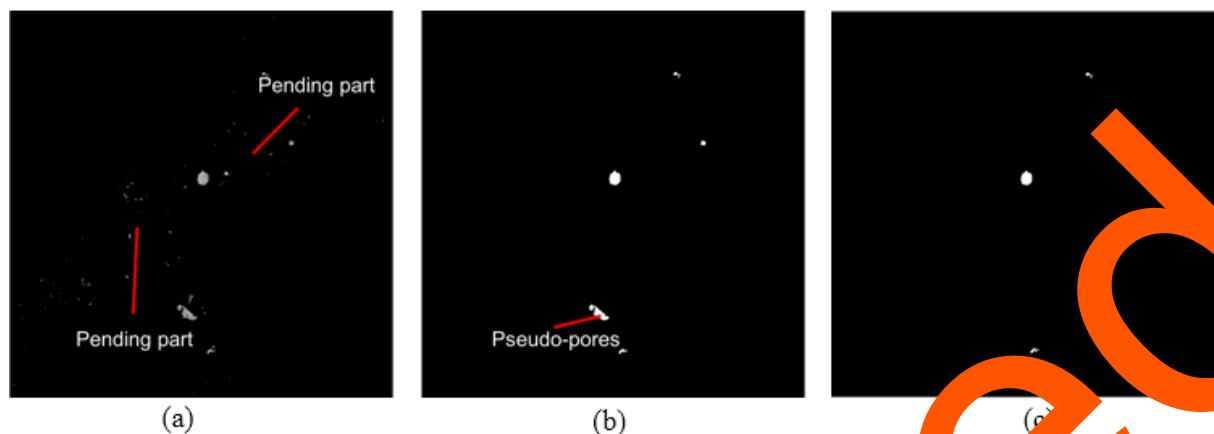


Figure 4. Pore identification process

(a) Brightness value filter; (b) Morphology open operation; (c) Morphological filling

As can be seen from Figure 4b, the morphological treatment largely removes the small spots from the corresponding small areas, and further morphological processing is required for the 'pseudo-pores' at the lower left corner.

Filling in Figure 4b, in the corresponding matrix is not in the area, the white is filled, making the white area into a closed convex polygon. Therefore, after the 'pseudo-pore' in the lower part is filled, it can be removed by obtaining the corresponding area attribute and deleting the area with too large area. Finally, the result is still a matrix of 8047×9263 . The yellow part of the graph is marked with some index value. Make it easy to combine the last results into the same graph.

The final identification results shown in Figure 5,

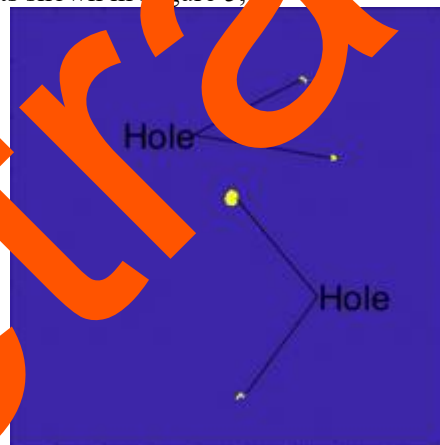


Figure 5. The final identification results

3 Conclusion

- Based on the above steps, the digital images can be identified. Each time the resulting matrix is added linearly, the characteristics of each part can be reflected in a graph.
- In the process of digital image inspection of other building materials, the above algorithm only needs to modify a few corresponding threshold parameters to reduce the influence brought by the picture itself, and also can obtain good results.
- In view of the portability of the algorithm, based on the matlab2017a platform, material electron microscopy image recognition software can be developed. In the later work, corresponding intelligent algorithms are designed to adaptively modify the threshold parameters to obtain the required structure of the material Characteristics.

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