Research on fast segmentation and correction algorithm of object surface damage image based on machine vision

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Abstract: As an important field of image processing, traditional image interpolation algorithm is widely used at present. Compared with the learning based image interpolation algorithm, the traditional image interpolation algorithm has the advantages of low algorithm complexity and fast processing speed. Many commercial software, such as Microsoft office and Adobe Photoshop, integrate traditional image interpolation algorithms such as nearest neighbor interpolation, bilinear interpolation and bicubic interpolation for image scaling. In addition, this technology is also widely used by many printer drivers. The research goal of this paper is how to further improve the interpolation accuracy and improve the quality of interpolated image while maintaining the processing speed advantage of traditional image interpolation algorithm. This paper mainly studies the bicubic interpolation algorithm, which is the most widely used in the traditional interpolation algorithm. There are two implementation methods of bicubic interpolation algorithm in application, which are 16 point ordinary bicubic interpolation algorithm and 16 point convolution bicubic interpolation algorithm. The difference between them is that they solve the interpolation kernel in different ways.

1. Introduction

As the main single frame image reconstruction technology, image interpolation algorithm is widely used in computer vision, especially in the field of medical image processing. Classical linear interpolation methods include nearest neighbor interpolation, bilinear interpolation, cubic convolution interpolation and so on. However, in the processing of image edge pixels, these classical interpolation methods do not consider edge pixels alone, but consider them equally with non edge pixels, which affect the interpolation effect of edge pixels. Therefore, researchers introduce nonlinear interpolation methods to better maintain the edge information of the image, such as gradient based interpolation algorithm. The edge information of the image corresponds to its high-frequency information, which is where the gray level changes more violently. The low-pass effect of the classical linear interpolation method will insert new values where the gray level changes more violently, so that the image edge becomes gentle.[1] Therefore, what we need to do is that the interpolation point should be as close to the low-frequency region as possible. In this paper, an edge preserving interpolation algorithm based on inverse gradient weight is proposed, which can quickly obtain high-quality interpolated images.

2. Algorithm modeling

Firstly, the digital image is collected and the sample set is established. Secondly, the collected sample images are represented and preprocessed. The main purpose of image preprocessing is to eliminate irrelevant information in the image, restore useful real information, enhance the detectability of relevant information and simplify the data to the greatest extent, so as to improve the reliability of feature extraction, image segmentation, matching and recognition. Then, understand the algorithm of image segmentation using different methods to select the threshold. For this subject, it focuses on the iterative method and watershed method. Iterative method, also known as rolling

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method, is a process of constantly using the old value of variables to deduce new values. Iterative method is divided into accurate iteration and approximate iteration. "Dichotomy" and "Newton iterative method" belong to approximate iterative method. Watershed segmentation method is a mathematical morphology segmentation method based on topology theory. Its basic idea is to regard the image as a topological landform in geodesy. The gray value of each pixel in the image represents the altitude of the point.[2] Each local minimum and its affected area are called catchment basin, and the boundary of catchment basin forms watershed. The calculation process of watershed is an iterative labeling process. Finally, Matlab is used to write programs to realize the algorithms, and these algorithms are evaluated. Image segmentation evaluation aims to optimize segmentation by studying the performance of image segmentation algorithm. This topic will compare the performance of the two algorithms to segment a given image, so as to help select the appropriate algorithm in the specific segmentation application.[3]

3. Algorithm description

In this paper, the idea of non-uniform interpolation is adopted. Firstly, a pair of low resolution image is defined as s, and the high-resolution image I is obtained after interpolation. The pixels of image I are divided into four categories according to their coordinate positions: odd odd, odd even, even odd, even even. As shown in Fig. 1, the low resolution image s is projected to the odd odd position of image I to obtain: i2i-1, 2j-1 = m (Si, J).

As shown in Fig. 1, suppose i2i-1, 2j-1, i2i-1, 2J + 1, i2i + 1, 2j-1, i2i + 1, 2J + 1 respectively correspond to the four adjacent pixels on the low resolution image, (LS1, Ls2) and (LD1, LD2) respectively represent the sum and difference of the pixel values on the diagonal of the four adjacent pixels: LS1 = i2i-1, 2j-1 + i2i + 1, 2J + 1, Ls2 = i2i-1, 2J + 1, 2j-1; LD1=I2i-1,2j-1+I2i+1,2j+1,LD2=I2i-1,2j+1+I2i+1,2j-1. The interpolation of even even position is calculated by using the inverse gradient weight, where W is the inverse gradient weight. For the interpolation calculation of odd even and even odd position, since the place with large gradient value reflected in the gradient diagram is the edge, the absolute value of gradient value between i2i-1, 2j-1 and i2i-1, 2J + 1, i2i + 1, 2j-1 and i2i + 1, 2J + 1 is required during interpolation operation. Grad1 = ABS (i2i-1, 2J + 1-i2i-1, 2j-1), grad2 = ABS (i2i + 1, 2j-1-i2i-1, 2j-1). When interpolating, it should be as close to the place with small gray value as possible to maintain the edge of the interpolated image, where R is the value-added coefficient. I2i-1,2j=(I2i-1,2j-1-I2i-1,2j+1) +grad1*r,I2i,2j-1=(I2i-1,2j-1-I2i+1,2j-1)+grad2*r.

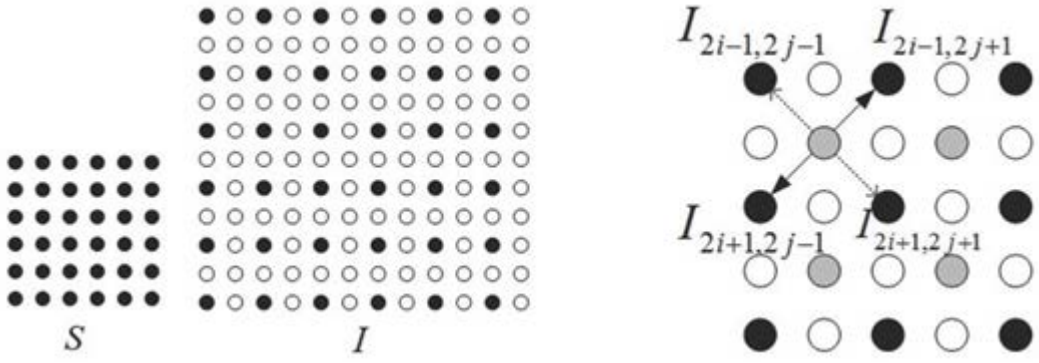

Figure 1 Four to sixteen pixels

4. Bicube interpolation method

Bicubic interpolation improves the problem of image blur in bilinear. It refers to the gray value of 16 pixels with 4 * 4 around the source image matrix, and uses the weight function H (T) approximation to optimize the interpolation function $Sa(t) = \frac{\sin(t)}{t}$.

Define function

$$h_3^1(t) = \begin{cases} 1-2|t|^2 + |t|^3 & \text{if } |t| < 1 \\ 4-8|t|+5|t|^2 - |t|^3 & \text{if } 1 \le |t| < 2 \\ 0 & \text{other} \end{cases}$$

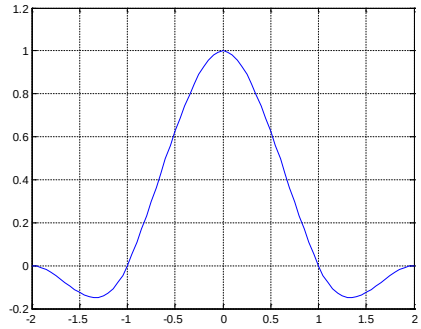

Figure 2 Effects of transfering

For the pixel point P (x, y) of the corresponding source matrix of interpolation, take the 4x4 neighborhood point P (Xi, YJ) near it, I, j = 1,2,3,4. The interpolation calculation is carried out according to the following formula:

$$i(x,y) = \sum_{i=1}^{4}\sum_{i=1}^{4} p(x_i, y_j)h(x-x_i)h(y-y_j)$$

Take the above 4 * 4 color matrix as an example.

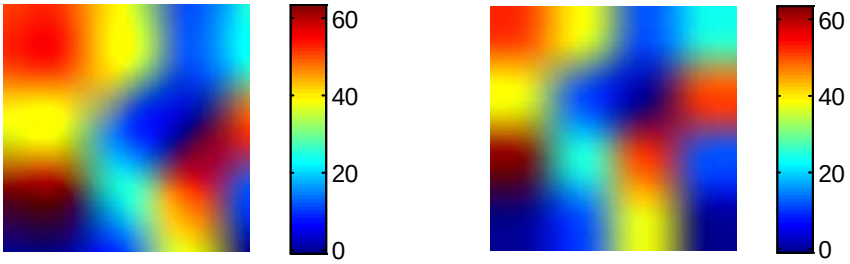

Figure 3 Enlarged image

Bicube interpolation algorithm not only takes into account the value of interpolated adjacent pixels, but also introduces the surrounding gray value to sharpen the image. The obtained enlarged image has less distortion and restores the details of the image itself.[4]

5. Conclusion

In essence, the nearest neighbor interpolation only uses the gray information closest to the pixel. The operation method is simple and fast, but there will be obvious step change at the gray change of the image, resulting in the distortion of "mosaic" and poor overall restoration; Bilinear interpolation is to calculate the weighted average of the surrounding four pixels, the overall distortion is small, it can be regarded as a low-pass filter in the frequency domain, and the phenomenon of blur can be observed in the image color gradient or image edge; Bicube interpolation algorithm not only takes into account the value of adjacent pixels, but also introduces the gray value of 16 surrounding pixels to sharpen the image. [5]The amplified image has less distortion and restores the details of the image itself, but its operation is complex and the time cost is high. In practical application, it should be used flexibly according to the system resources, operation environment and requirements, so as to achieve the best scale transformation effect.

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