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Research on the Improvement of Image Enhancement Algorithm in Real Time Digital Image Processing

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Abstract: In real-time digital image processing, image enhancement is one of the main techniques. Efficient image enhancement can improve the effect of image processing and lay a good foundation for subsequent image processing. This paper mainly studies the improvement scheme of image enhancement algorithm in real-time digital image processing, which focuses on the image sharpening, and puts forward the algorithm improvement scheme of image sharpening. At the same time, it also studies the feasible scheme of image saturation adjustment and brightness contrast transformation.

Keywords: Digital Image; Image Enhancement; Sharpening

Digital image processing is a computer image processing technology, which refers to the process of image processing by computer and converting it into digital signal. Image enhancement is a technology of digital image processing. Its purpose is to improve the visual effect and lay a good foundation for the subsequent image analysis. Real time digital image processing requires high efficiency of image enhancement technology. In the practical application of image processing, it is often necessary to improve the image enhancement algorithm to ensure the effect of image processing and improve its the efficiency.

1. Image sharpening

Image sharpening, also known as edge enhancement, is used to compensate the image contour and make it clearer. High pass filter and differential method are commonly used image sharpening algorithms. In practical application, the Laplacian operator in differential algorithm is common.

1.1 Laplacian

Laplacian is defined as a second-order differential operator in n-dimensional Euclidean space, which is the second-order derivative of the same kind. After the Laplace operator is digitized, the second-order difference approximation is used

$$\Delta^2 f = \Delta_x{}^2 f(x,y) + \Delta y^2 f(x,y) = \left[f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1) \right] - 4f(x,y)$$

Sharpening the image, that is, image edge enhancement, can reduce or eliminate the low frequency components, enhance the blurred image target edge and some details, and increase the contrast of the image. Therefore, the image can be inversed by a differential operation or the like. As a differential operator, Laplace operator can weaken the region of slow gray change in the image, and enhance the region of abrupt gray change in the image. So, in real-time digital image processing, when sharpening the image, the original image is usually processed by Laplace operator to describe the gray mutation of the image and generate a new image, and then the original image and the new image are superimposed to sharpen the image.

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1.2 Algorithm improvement

Laplace algorithm can sharpen the image, but this algorithm also has some problems. Laplace algorithm enhances every pixel in the image. Although the edge is enhanced to make the target clearer, the noise of the image is also enhanced. In the practical application of image processing, the image often has different degrees of noise. This Laplacian algorithm will make the original smooth part of the image appear speckle due to noise enhancement, which makes image processing more difficult. This algorithm can get better results only in the ideal digital image processing with little noise.

The method to overcome the problems caused by the above algorithm is to enhance the edge of the object instead of the smooth part of the image. If the image is a static image, the recognition algorithm can be used to recognize the image, and then only enhance the edge of the target. But in real-time digital image, it is difficult to achieve the effect. Therefore, according to the characteristics of real-time image, two improvement schemes are proposed.

1.2.1 Noise domain method

Set the noise intensity of the original image as u, calculate the travel value in the edge enhancement operation, and compare the two values, The formula is

$$I' = I \qquad I-(A+B+C+D)/4 \le U$$
$$I' = I + r*(I-(A+B+C+D)/4) \qquad I-(A+B+C+D)/4 > U$$

The noise range method can basically avoid the noise of the smooth part of the enlarged image in the real-time digital image, but this improvement scheme is only applicable to the image with fixed u value, that is, the image with relatively fixed ambient light and camera exposure. Because the u value in most cases will change with the environment and exposure conditions, it is impossible to determine the specific u value. Therefore, the noise range method can only be applied when the u value is determined, such as fingerprint recognition.

1.2.2 Exponential curve method

Exponential curve method is to set an exponential curve in advance and use it to deal with the difference, which can reduce the smaller difference and basically ignore the larger difference. Most of the edges of the image observed by human eyes are recognizable changes, while the image noise is relatively small. That is, in the difference calculation, the difference of image edge area is relatively large, while the difference of image smooth part is relatively small. Therefore, the exponential curve method can enhance the image edge and weaken the noise enhancement in the smooth region of the image. The excessive noise enhancement in each region of the image becomes smoother through the mapping of the curve. Exponential curve method can solve the problem of image sharpening in real-time digital image processing, and it can enhance image edge and suppress image noise.

2. Image saturation adjustment

2.1 Image saturation adjustment principle

Image saturation refers to the brightness of the color in the image, and the transformation of color chroma in the image is the basis of image saturation adjustment. It is difficult to adjust image saturation, especially for color images. Different from gray image, color image is multi-channel information, and its algorithm transformation is more complex. In the real-time digital image processing which requires high efficiency of image processing, the adjustment of image saturation is more complex and inefficient if the traditional algorithm is used. Therefore, the improvement scheme is put forward.

2.2 Algorithm improvement

Let the tricolor values of a color pixel in the image be R, G and B, the formula is

$$R' = R + r*(R-(G+B)/2)$$
$$G' = G + r*(G-(R+B)/2)$$
$$B' = B + r*(B-(G+R)/2)$$

In the saturation adjustment formula, r represents the enhanced intensity coefficient. The higher the r value is, the greater the saturation is.

3. Adjustment of image brightness and contrast

3.1 Adjustment principle of image brightness and contrast

The brightness of an image refers to the brightness of the image. Image contrast refers to the size of image gray contrast, that is, the measurement of the brightness level between the brightest white and the darkest black in an image. When the difference is larger, the contrast of the representative image is larger, and the difference is smaller, the contrast of the representative image is smaller. Good brightness and contrast can make the image rich in color, improve the image clarity and make the image more vivid. The contrast broadening of point operation is the principle of image brightness contrast transformation. Let g be the gray level of the new image and f be the gray level of the old image, the relationship is:

$$g=G(f)$$

The range of g and f is set to [0, L]

3.2 Algorithm improvement

The exponential curve is used to enhance the continuity of image brightness and contrast.

3.2.1 Image brightness

If an exponential curve is applied and Brightness is the exponential variable of the curve, the brightness transformation formula is as follows:

$$g=L*pow(f/L, \text{Brightness})$$

In the formula, when brightness=1, $g=F$.

4.2.2 Image contrast

Two exponential curves are used to synthesize one. Let Contrast be the exponential variable of the curve, the formula of contrast transformation is:

$$g=(L/2)*\exp(f/(L/2), \text{Contrast}) \qquad f \leqslant L/2$$

$$g=L-(L/2)*\exp((L-f)/(L/2), \text{Contrast}) \qquad f>L/2$$

In the formula, when contrast=1, $g=F$.

In the algorithm improvement scheme, we can use the transformation formula to superimpose the brightness and contrast transformation to establish a table. In the process of real-time digital image processing, if the brightness contrast transformation is carried out, the table can be queried once to complete two operations. When the parameter changes, you only need to update the table. Therefore, in the process of image brightness contrast transformation, we can use the look-up table method to simplify the transformation formula.

4. Conclusion

This paper mainly studies the improvement scheme of common image algorithms in the process of real-time digital image processing, and focuses on the analysis of the algorithm improvement scheme of image sharpening. Because the traditional image sharpening algorithm will lead to image noise enhancement, so starting from this problem, the noise range method and exponential curve method are proposed. At the same time, this paper also studies the improvement of image saturation adjustment and image brightness, contrast transformation. Image enhancement is the basis of image understanding and analysis. Efficient image enhancement can effectively guarantee the efficiency and effect of real-time digital image processing.

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