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Research on adaptive image denoising technology

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Abstract

In the process of image generation and transmission, there will be a lot of noise pollution, which makes the quality of the image suffer certain damage. This will not only make people feel the difference in vision, but also adversely affect the subsequent processing of the image. Therefore, in the pre-processing stage of image, image denoising is very necessary to improve the signal-to-noise ratio of the image. This paper uses MATLAB to build four GUI interfaces, and uses its own callback function to adjust the pop-up sequence, which includes picture reading, adding noise, dray-reducing processing and image saving window, and draws experimental conclusions by comparing effect pictures and peak signal-to-noise ratio. Finally, by comparing the denoising effect of adaptive denoising with that of other algorithms, it is concluded that adaptive parallel filter denoising is not necessarily the best in removing image noise, but it is superior to other algorithms in preserving image edge features.

Keywords

Edge features, Adaptive image denoising, Peak signal to noise ratio, Frequency domain.

1. Introduction

Image noise is mainly generated in image acquisition and image transmission. The operation of camera components is affected by a variety of external and internal variables, including the environmental conditions of image shooting and the internal quality of camera sensor components that will cause noise to the image. The common noise mainly includes Gaussian noise, salt and pepper noise and Poisson noise [1].

Image denoising is mainly carried out in spatial domain and frequency domain. The denoising methods of image spatial domain mainly include mean filtering denoising, median filtering denoising and linear filtering denoising. In fact, it is to calculate the signal neighborhood of the image to achieve the purpose of denoising. The other image denoising technology is to change the digital image from the spatial domain to the frequency domain, then transform the signal in the frequency domain, and finally reverse transform the image, transform it from the frequency domain to the spatial domain to achieve the effect of denoising frequency domain. Among them, there are many ways to convert space domain and frequency domain, Fourier transform and wavelet transform are commonly used.

Adaptive Morphology [2] is a kind of new method of image processing and phase to puts forward some improvements on the traditional mathematical morphology, the traditional artificial selected invariable updated structural element that is in front of the image processing, through analyzing on the overall characteristics of the original image adaptive choose to suit the characteristics of the local processing of structural elements. Through the selection of structural elements, adaptive morphology increases objectivity in the subjective sense. The selected structural elements are no longer immutable, but change accordingly according to the characteristics of the original image. In the aspect of image processing, it is superior to the traditional mathematical morphology and can achieve satisfactory results in image processing.

2. Principle of adaptive denoising and other denoising methods

2.1. Median filter

Median filtering is a kind of median selection based on the statistics of selected pixels in a certain order, which can effectively suppress noise. It is also a nonlinear smoothing technique. The basic principle of median filtering is to replace the pixel value of a certain point in the digital image with the median value of each point value in the neighborhood of the point, so that the surrounding pixel value tends to the true value, so as to remove noise points. The method is to use a two-dimensional sliding template of some construction, and the two-dimensional median filter output is as follows:$g(x,y) = med\{\mathrm{f(x-k, y-l), (k, l \in W)}\}$. In this formula, $f(x,y)$ and $g(x,y)$ are the original image and the processed image respectively. W is a two-dimensional template, generally 3*3, 5*5 odd square template, can also be different templates, such as circle, line, circle, cross and so on. The pixels in the template are sorted according to the size of pixel value to generate monotonic number as two-dimensional data sequence. Its filtering is also the filtering of two-dimensional data sequence. Since digital image is described by two-dimensional image, this two-dimensional sequence is equivalent to a two-dimensional matrix, and the value of elements in it is the pixel of each pixel point. Median filtering is to sort the gray values in the window, using a sliding window with an odd number of points, replace the gray value of the center point with the median gray value of the window, and then assign the median value to the center point.

2.2. Mean filter

In fact, mean filtering is a linear filtering and the neighborhood average method is adopted. Its basic principle is to use around the mean value of each pixel to replace the original pixel values of pixels, which is the current pixel (x,y), choose a odd template, this template is composed of the neighbor number of pixels, strives for the average of all pixels in the template, and then gives the mean to the current pixel (x,y), as a grayscale image at that point in $g(x,y)$. Expressed by the formula is as follows:

$$g(x,y) = \frac{1}{m}\sum f(x,y) \tag{2-1}$$

m is the total number of pixels in the template including the current pixel. The general output of mean filtering is:

$$Z_i = \frac{(f_{i-v}+f_{i-v+1}+\cdots+f_i+\cdots+f_{i+v})}{m} \tag{2-2}$$

2.3. Gaussian smoothing filter

Most of the image noise is Gaussian noise, so gaussian filter is widely used. Gaussian filter is a linear smoothing filter, suitable for eliminating gaussian noise, widely used in image denoising. It can be simply understood that Gaussian filtering denoising is the weighted average of the pixel value of the whole image. The value of each pixel point is obtained by the weighted average of its own value and the value of other pixels in the neighborhood.

The specific operation of Gaussian filtering is to use a user-specified template (convolution or mask) to scan every pixel in the image, and replace the value of the central pixel of the template with the weighted average gray value of the neighborhood pixels determined by the template[3].

One-dimensional Gaussian distribution:

$$G(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}} \tag{2-3}$$

Two-dimensional Gaussian distribution:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \tag{2-4}$$

2.4. Adaptive morphological image denoising

In the process of mathematical image denoising by mathematical morphological filtering, the structural elements are arranged according to the order of dimension, so as to filter out different noises. The geometric features of digital images can be preserved more by using multiple structural elements of mathematical morphology. Therefore, multiple structural elements are connected in series to form series denoising, which is to arrange the structural elements with the same shape from small to large in dimension to denoise the original image, which is similar to the design flow chart of series circuit.

In order to simplify the steps of the algorithm experiment, in the concrete implementation process, we can choose the way of calculating the difference between the series processing results and the original image as the weight vector, and then calculate by the way of weighted sum of the series results. Therefore, in order to carry out the simulation of mathematical morphology filter cascade filtering denoising of digital images, this experiment selects a neural network image, adds salt and pepper noise, and constructs different series filters and parallel filters to carry out the filtering denoising experiment.

Series 4	Series 3	Series 2
Series 1	Pixel	Series 1
Series 2	Series 3	Series 4

Figure 1 Adaptive denoising pixel module

As shown in Figure 1, the selection of adaptive denoising pixels is illustrated. We select an odd pixel template, and after selecting intermediate pixels, we respectively conduct series filtering denoising of three pixels in the horizontal direction, which is the denoising processing result of Series 1. The Series 2, 3 and 4 are filtered vertically and diagonally respectively. Parallel denoising is to carry out parallel filtering to denoise the above series denoising.

3. Comparison between adaptive denoising and other methods

3.1. Comparison between adaptive image denoising and median denoising

Through the comparison of different noise we found that the adding gaussian noise adaptive denoising effect under the condition of parallel denoising the peak signal to noise ratio of the maximum, and 3 * 3 median filter window filtering effect is the most significant, cross like contrast than the adaptive median filter to remove noise much better but on image edge retention, adaptive image median filtering is not good. After adding salt and pepper noise and pine noise, the median denoising effect is also better.

3.2. Comparison between adaptive image denoising and mean denoising

The mean filtering denoising uses n*n, square window denoising, in 7*7 square window peak signal to noise ratio is the largest, the more square window points, the greater the peak signal to noise ratio, the more obvious denoising effect. However, in the adaptive image denoising, the PSNR is in the middle, and the PSNR of parallel denoising is the largest, and the denoising effect is not as good as that of mean filtering.

3.3. Comparison between adaptive image denoising and Gaussian denoising

After adding three kinds of noise, the PSNR value of gaussian smoothing denoising is greater than that of adaptive denoising, so the effect of adaptive denoising is worse. By adding three kinds of noise to the picture, adaptive noise reduction in parallel is the best. Gauss is not good

enough to retain the details of the image features, on the contrary, adaptive edge retention is much better. Therefore, adaptive image denoising and Gaussian algorithms have their own advantages and disadvantages, and the selection should be made according to different requirements and situations.

4. Conclusion

Mathematical morphology is an image processing discipline in its infancy, which has attracted much attention from scientists since its infancy. Moreover, it has the most basic set as the theoretical basis, and it is simple to operate. It is not only used in the image processing neighborhood, but also widely used in other disciplines. With the development of mathematical morphology, it is used in grayscale image processing, and it was initially used in binary images. The selection of structural elements is the premise of image processing operation in mathematical morphology, and the shape and dimension of the selected structural elements are fixed, so there are some corresponding disadvantages in the operation of the selected structural elements. In the selection of structural elements, adaptive matching can also be carried out according to the shape characteristics of the original image to select structural elements, so that the selected structural elements can adaptively change the shape and dimension according to the image characteristics, which is called adaptive morphology method.

Gray image processing in this respect, in view of the characters of noise, this paper proposes a adaptive morphology denoising method in series, in parallel, on the adaptive morphological denoising experiment, through the experiment of effect and peak signal to noise ratio figure this kind of method and the other four methods of denoising effect is compared, show that this method is better than that of other several denoising methods in terms of denoising. It is proved that the parallel filter proposed in this paper has the best effect in image denoising, and the series filter is better than other denoising methods, and the adaptive morphology has better retention ability in image features and details.

In this paper, on the basis of the adaptive morphological image denoising, and the denoising effect of the weight calculation, the calculated value of the corresponding draw a line chart, better adaptive morphology denoising effect, the larger the value, the closer to the original image, but still exists in the relevant local corresponding deficiency, remains to be perfect.

Morphological image processing in the process, is the most important part of the selection of structural elements, which is the key part of the morphological operation, however, the adaptive selection of structural elements on the subjective judgment increased the objective cause, this article only targeted denoising using adaptive weighting algorithm, is better than the method of denoising method still have a lot of, The selected structural elements will be more flexible and efficient in morphological operation, and these methods still need to be explored.

In fact, after more than 50 years of development, although mathematical morphology is a new method of image processing, but its development is relatively perfect, the theoretical basis is relatively good, in the field of image processing is also relatively significant for research and development, and has been skillfully used in many disciplines. Not only that, in computer language identification, data processing, calculation method, the computer shows that the micro images, medical image processing, image coding and compression, industry in food detection and circuit testing, materials science, robot visual imaging, motor sports, and other areas of the many aspects and are widely used. However, mathematical morphology is used in many aspects of life, such as infrared fingerprint detection and iris detection on door locks, mountain images in geography, musicians processing music and tomography imaging, and many other fields have good prospects for development. In the field of image processing, the development of mathematical morphology has a good prospect, and many technicians prefer

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related image processing methods. At present, the research, development and application of adaptive morphology are still in progress.

References

[1]Sun Haiying. Research on image gaussian noise and salt-and-pepper noise denoising algorithm [D].Shanghai: Fudan University, 2012.
[2]Shao Qianqian. An adaptive correction method for image denoising [D].Hunan University, 2013.
[3]Yu Shengwei, Ding Jianmin, Wu Ting, Wei Jianlan. MATLAB image filtering denoising analysis and its application: Beihang University Press,2015.09.