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Image denosiong based on python

Rundong Shen

College of physics and Optoelectronic Engineering. foshan university, Guangdong Province, China

a11413856802156@163.com

Abstract. This paper introduces the common image restoration technology, discusses the image denoising technology based on python, and analyzes the advantages and disadvantages of this method.

Keywords: component, python, Image restoration, noise reduction.

1. Introduction

The meaning of image restoration technology is to use computers to fill in all kinds of missing images and remove the redundant parts. When we need to use different types of images, sometimes these images will have different degrees of defects for various reasons, such as some images have the problems of blurring, serious noise and low contrast. At this time, we need to use image restoration technology to process the images in order to achieve better image effects. The significance of image restoration is not only to improve the existing research methods, but also to apply it to all aspects of real life, such as object removal: remove the unwanted parts of the image and repair the missing parts; Image repair: repair defects in the image, such as yellowing, scratches, etc; Picture modification: such as the modification of character expression and appearance; Text removal: remove text, watermark and other objects that affect the image effect.

Image processing technology is widely used in many fields, including face recognition, cultural relics identification and repair, assisting doctors in diagnosis, etc., which greatly facilitates people's life and creates huge economic benefits. Therefore, the innovation of this technology is of great significance. Image denoising is an important part of image processing. Through image denoising, users can get a clearer image, which is more conducive to the extraction of image information and enhance the visual effect of the image, so that the image can be more effectively applied in specific application fields.[1]

The advantage of early image processing technology is that it can achieve good repair effect for a small area, but it performs poorly when repairing a large area. Many experts and scholars all over the world have invested in the research of image denoising, and have proposed various classical denoising algorithms, among which the commonly used filtering algorithms include mean filtering, wavelet filtering and nonlocal mean filtering.

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2. Traditional image processing

2.1. image feature acquisition principle

Image acquisition is to obtain the pixel features of multiple images with different resolutions and spectra, from which the relevant information of each image can be obtained [2]. With the continuous development of image processing technology, the requirements for obtaining image sharpness are also increasing. In order to obtain images with higher sharpness and more information, the related technology of image feature extraction has begun to be paid attention to. The specific process is as follows: using traditional methods for image processing, we need to select the key details of the image to prepare for the subsequent calculation. The method of obtaining image related feature information is as follows:

$$J = (s - h - c) \cdot 4$$
$$I = \begin{cases} sin^2(\chi) & c \le h \\ \pi + sin^2(\chi) & c > h \end{cases} \tag{1}$$
$$T = 1 + \frac{4\max(s,h,c)}{s-h-c} = \frac{J+y}{J}$$

In the above expression, J represents the brightness vector of the acquired image, I represents the wavelength vector of the acquired image, X represents the wavelength system of the acquired image, T represents the gray value of the acquired winter image, and represents the maximum value of pixel information of the acquired image. The following expression is used to describe the image quality, which can reflect the clarity of the image:

$$M = \frac{F}{\ln\left(1 - \sum_{j=2}^{p} q\,(J,I,T)\right)} \tag{2}$$

$$F = \sum_{j-2}^{p} M \frac{g_j(s,h,c)}{\ln g_j(s,h,c)} \tag{3}$$

In the above expression, M represents the number of image quality pixels, $g_j(s,h,c)$ represents the number of useless pixels in the image, f represents the number of information set samples in the integrated image, and represents the sharpness result. It can be seen from the above expression that in the process of feature extraction, there is a drawback. The acquisition environment is very bad, and the number of image pixels will deteriorate, or even be lost or damaged. According to the expression (2-2), the number of complete pixels in the image will be reduced. According to the expression (2-3), the large reduction of effective pixels in the image will lead to the smaller numerator and larger denominator in the formula (2-3), Finally, the quality of the image is reduced, and the obtained image has low definition [3], which affects some subsequent column operations.

2.2. Traditional image denoising methods

The existence of noise in the image will have a great impact on the feature extraction process, so many scholars have invested in the research of relevant image denoising technology, and also proposed many classical denoising algorithms, among which the commonly used filtering algorithms are mean filtering, wavelet filtering and non local mean filtering.[4]

2.2.1. Mean filtering

Mean filtering is also called linear filtering. The main principle is to set a filtering window centered on the target point, which is generally set to the size of or, and take the mean value of all values in this window to replace the pixel value of the target point to achieve denoising. The pixel value around the

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noise point is considered to be the actual pixel value closest to the original noise point. Therefore, the result obtained by calculating the average value of the pixels around the noise point is relatively close to the real value of the target point. The formula is as follows:

$$v(i,j) = \frac{1}{n \times n} \sum_{(x,y) \in B_n} f(x,y) \tag{4}$$

In the above formula, n x n represents the size of the filtering window, and B represents the neighborhood centered on the noise point (I, J). Mean filtering can effectively suppress linear noise, but the filtering process is equivalent to smoothing, so the resolution of the filtered image will decline, and even the image will be blurred. At the same time, the filtering effect of mean filtering on high-density noisy images is not good.

2.2.2. Local average filtering

Nonlocal mean filtering is a major breakthrough in spatial filtering. Traditional spatial filtering, such as mean filtering and median filtering, uses local neighborhood information of noise points to replace noise points according to certain rules to achieve denoising, and does not make full use of the relationship between pixels. Although the implementation is very convenient, it also faces the situation that the image is too smooth after denoising, resulting in image blur, image discontinuity, image detail information loss and so on. For a noisy image, there is always some redundant information. This algorithm can use this kind of information to eliminate noise. Compared with the algorithm that only uses local information to remove noise, this algorithm can make full use of the pixels of the whole image, and weighted average these pixels according to similarity analysis to get the result value. Compared with the traditional neighborhood filtering algorithm, NLM algorithm can achieve denoising and better protect the image details, which has also become one of the hot spots of scholars in recent years. For a noisy image, $v = \{v(i), i \in I\}$ represents the coordinate domain of the image. By arbitrarily selecting the noisy pixel I in the image, the estimated pixel value obtained after denoising by NLM algorithm can be obtained as follows:

$$NL[v](i) = \sum_{j \in I} 2(i,j)v(j) \tag{5}$$

Among them, W (i, j) represents the weight function and meets the condition of $w(i,j) \in [0,1]$. its size depends on the similarity between the image block n (i) centered on pixel i and the image block n (j) centered on pixel J. Gaussian weighted Euclidean distance is used to measure the similarity between the two neighborhood blocks. The specific formula is as follows:

$$d(i,j) = \|N(i) - N(j)\|_{2,a}^2 \tag{6}$$

Where a>0 represents the standard deviation of Gaussian function. After obtaining the neighborhood block similarity, weight distribution is carried out according to the similarity. The definition of weight function w (i, j) is:

$$w(i,j) = \frac{1}{z(i)} exp\left(-\frac{d(i,j)}{h^2}\right) \tag{7}$$

Where, h is the smoothing coefficient, which can control the speed of weight attenuation, and Z (i) is the weight normalization parameter, which is specifically expressed as:

$$z(i) = \sum_{j \in J} exp\left(-\frac{d(i,j)}{h^2}\right) \tag{8}$$

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2.2.3. Image restoration theory

Image restoration technology is a process of using the information of the undamaged area of the image to reasonably fill the damaged area from the outside to the inside according to certain rules, so that the repaired final image is as close to the original undamaged image as possible, which can maintain continuity on the whole, ensure that the repaired boundary can be naturally connected with the undamaged area, and visually conform to people's cognitive psychology as much as possible. According to this definition, an image to be repaired can be divided into two parts. One part is the area of the image to be repaired. The image information of this area has been completely lost, and the other part is the area of the image that is not damaged. The information of this area is reliable and effective. A good repair model is to make full use of the information of the undamaged area as accurately as possible to restore the information of the damaged area. The process of image restoration is very complex and requires a lot of calculation. The images processed by different restoration algorithms may be different. Finally, the restoration effects of different algorithms should be compared according to reasonable evaluation criteria.

3. Image processing based on Python

3.1. Advantages of Python image processing

Python is an interpretive language with simple syntax. It can perform numerical calculations efficiently and supports matrix and vector operations. In terms of image processing, more importantly, python has standard libraries and a large number of third-party open source extension libraries, which can be simply called according to needs, and these libraries can be used to achieve the purpose of image processing. Python also has a corresponding powerful extension library. For example, dft2 () and idft2 () in opencv can be used for fast Fourier transform and inverse transform. In this research process, opencv, plotlib, skimage and other third-party tools are mainly used for image processing.

3.2. Gaussian filtering

Gaussian filter is a kind of linear smoothing filter, which is more suitable for removing Gaussian noise and is widely used in image denoising. Generally speaking, Gaussian filtering can be obtained by calculating the weighted average value of the pixels of the whole image, that is, the weighted average value can be obtained by dividing all the pixel values in the image by the total number of pixels. Operation steps of Gaussian filtering:

(1) Use a specific template to scan all pixel values in the whole image;

(2) Calculate the weighted average pixel value;

(3) The weighted average pixel value is used to replace the central pixel of the image.

Gaussian filtering is implemented in image processing noise in two ways: window discretization, sliding window convolution and Fourier transform. Sliding window implementation is the most commonly used experimental method of denoising. When the discretized window becomes larger and larger, the amount of calculation of sliding window will become larger and larger. When this happens, the implementation method of Fourier transform should be considered. Select the weighted linear smoothing filter according to the shape of Gaussian function, which includes one-dimensional function and two-dimensional function:

$$G(x) = \frac{1}{\sqrt{2\pi}\sigma^2} e^{-\frac{x^2}{2\sigma^2}} \tag{9}$$

$$g(x) = \frac{1}{\sqrt{2\pi}\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \tag{10}$$

The height of Gaussian function depends on the size of.

We can use Python for Gaussian filtering, which uses the program module scipy.ndimage The filters filtering operation module uses the Gaussian distribution curve as the filter algorithm to blur the

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image. This module can use the fast one-dimensional separation method to calculate the convolution [5]. In addition, we can also use opencv tools for Gaussian filtering, such as Gaussian blur() function. The comparison before and after treatment can be seen in the following figure:

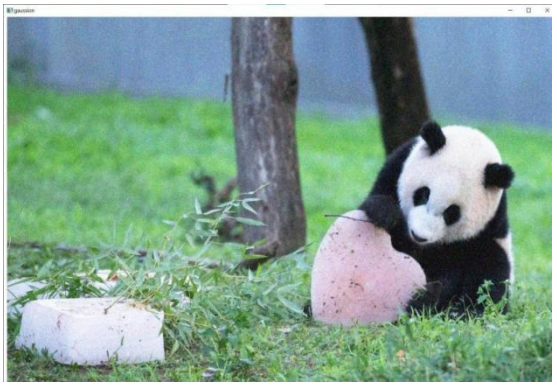

Figure 1. animal diagram before Gaussian filtering.

Figure 2. animal diagram after Gaussian filtering.

3.3. Median filtering

Median filter is a kind of nonlinear smoothing filter. The specific operation steps are to sort all the pixel values in the digital image or digital sequence from small to large, and then find the middle value in the sorted pixel values as the pixel value of the center point, and then compare it with the surrounding pixel values, and change the pixel values with large differences into values close to the pixel value of the center point, so as to eliminate isolated noise points. Gaussian filtering can deal with Gaussian noise well, while median filtering can have a good effect on salt and pepper noise. Therefore, different types of noise can be removed after median filtering and Gaussian filtering are processed twice.

As shown in Figure 3-4 and figure 3-5, the denoising method of pixel $w(x,y) \rightarrow g(x,y)$ is, Adopt a template for the image, and the center point a of the template coincides with the center point w (x, y) of the image. The remaining 8 pixel values are $w(x-1,y-1)$, $w(x-1,y)$, $w(x-1,y+1)$, $w(x,y-1)$, $w(x,y+1)$, $w(x+1,y-1)$, $w(x+1,y)$, $w(x+1,y+1)$. Suppose $s_1, s_2 \ldots s_9$, then arrange the 9 pixels in ascending order, find out the middle value and set it as the pixel value of this window, and the formula is as follows:

$$g(x,y) = demin(s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9) \tag{11}$$

The final result of image processing is as follows:

Figure 3. animals after treatment.

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4. Conclusions and deficiencies

Compared with the experimental results of image denoising, the median filter is not very effective in removing Gaussian noise, but it plays a good role in removing salt and pepper noise. According to the principle of median filter, the points in the image that are not polluted by noise are replaced by the values of noise points, so the removal effect will be significantly optimized, and the contour of the image will be clear. From this, it can be concluded that the effect of median filtering on removing salt and pepper noise is obviously better. According to the experimental results of using Gaussian filter to remove image noise, the removal effect of noise is proportional to. The larger the noise is, the more obvious the removal effect is, but the image also becomes more blurred, and the edge part also becomes blurred. Therefore, when using Gaussian filter to remove noise, we should choose a suitable value.[6]

At the same time, the project also has some shortcomings and needs to be improved. Due to the principle of Gaussian filtering, some details originally owned by the image, such as small stripes, may be filtered out when processing the image. In addition, when processing pictures with serious noise, the processing effect of the pictures is not very good, and the clarity and the preservation of picture details are not satisfactory. The processing method needs to be further improved. At the same time, other image processing methods can also be added, such as mean filtering, contour extraction, and even image processing with neural confrontation network, so as to try to further improve the effect of image processing.[7]

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