Research on Image Deblurring Processing Technology Based on Genetic Algorithm

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Abstract. Image deblurring, which is an important branch of digital image processing, is one of the difficulties in digital image processing. The main goal of image deblurring is to improve the quality of the given image, and to reconstruct or restore the original image using the relevant prior knowledge. Genetic algorithm (GA) is a global optimization search algorithm, which can quickly and effectively calculate complex multidimensional data area and indirectly. Now, genetic algorithm is slowly showing its excellent performance in the field of image processing. Therefore, based on the fuzzy features of the image, this paper uses the image enhancement algorithm to realize the image deblurring by capturing the gray value of the pixels in the image, and the improved genetic algorithm is used to better select the image threshold. The experimental results show that the new algorithm obtains higher definition than the traditional image deblurring method, and the improved genetic operator algorithm improves the degree of noise reduction.

Keywords: Image deblurring, Digital image processing, Genetic algorithm, Image enhancement algorithm

1. Introduction
There are many reasons for image blur, including radiation, atmospheric factors, human factors, technical factors and so on [1-3]. In order to obtain better treatment effect, image blur caused by various reasons often needs a variety of image deblurring processing technologies to restore the image, because different image blur methods need different processing technology [4]. From the technical point of view, image deblurring technology can be divided into three categories: image enhancement, image restoration and super-resolution reconstruction [5].

The goal of image enhancement is to improve the attention to the visual effect of the algorithm by applying it to a given image, so as to deliberately emphasize the general features or locality of the image [6]. The clarity of the image after processing, which emphasizes some aspects that people pay
attention to, increases the contrast of different elements in the image, suppresses the characteristics of
not attracting attention, improves the image quality, enriches the information, and improves the ability
of image interpretation and recognition. Image enhancement can be divided into frequency domain
method and spatial region method [7,8]. Frequency domain method is to take the image as a
two-dimensional image, and Fourier transform the image [9]. For example, the edge information of an
image can also be enhanced by edge filtering to make the blurred image clearer [10]. The method of
spatial domain is to obtain the pixel average value of the image to achieve the function of removing
the noise in the image.

Genetic algorithm operates the process of chromosome gene mutation and gene crossover in the
process of biological evolution through mathematical and computer simulation. Compared with some
traditional optimization algorithms, genetic algorithm can get better optimization results quickly.
Therefore, this paper is based on the genetic algorithm image deblurring processing technology, this
paper uses the improved genetic algorithm can quickly find the best threshold, to achieve image
deblurring processing. The experimental results show that compared with the traditional image
deblurring method, the improved genetic algorithm has a higher definition in image deblurring
processing function.

2. Image Deblurring and Genetic Algorithm

2.1 Image Deblurring Algorithm

Generally, two methods can be used to restore blurred images. One method is that if there is no
relevant image information, in this case, the noise model can be established properly to eliminate or
weaken the noise. On the other hand, if there are a lot of pixel information of the original image, we
can establish a mathematical model of the image and optimize the damaged image based on the model,
which will get more effective results. There are many other options for image optimization. Firstly, the
problem of image restoration can be solved by continuous mathematics or discrete mathematics.
Secondly, the image can be processed in spatial domain or frequency domain. In addition, when the
image is restored by mathematical method, the process can be realized by changing the convolution in
the spatial domain and multiplying it with the frequency domain.

2.2 Genetic Algorithm

Genetic algorithm is a computational model used to calculate Darwin's genetic selection and biological
evolution. In this paper, the global optimization tool is used to automatically search the genetic cutting
technology and reference parallel objects to select the optimal threshold value of the image. The basic
process of standard genetic algorithm is as follows: according to the individual length of the first
generation organism, the population, the probability of propagation and mutation are fixed, the first
population is randomly generated, then the parent population is calculated, and then whether the
termination is complete is determined. If the conditions are met, the best individual is output. When
the conditions are not met, the selection, crossover and mutation of chromosome genes will continue
to be carried out to establish the population of offspring. The offspring will be regarded as the parent
population of the next generation, and finally the individual will produce the best result.

Let the population size be $n$, where the fitness value of individual $i$ in the population is $f$, then
the probability $P$ of $i$ being selected is:

$$p(f_i) = \frac{f_i}{\sum_{i=1}^{n} f_i}$$  \hspace{1cm} (1)

In order to evaluate the image quality quantitatively, the fuzzy ratio $D(x)$ is used to evaluate the
image enhancement effect.
Among them, the dimension of gray image is $M \times N$, $p_{\text{min}}$ represents the fuzzy feature of the original image.

If the fuzzy ratio of the original image is $d(x)$ and the fuzzy ratio of the enhanced image is $D(x)$, the fuzzy degree of the image is reduced after the fuzzy enhancement, and the contrast is enhanced, so $d(x) > D(x)$. $E(x)$ is used to represent the relative error between the original image and the enhanced image. The smaller $E(x)$ is, the closer the enhanced image is to the original image in shape and gray level. Therefore, $E(x)$ is taken as the fitness function. The gray threshold corresponding to the minimum $E(x)$ is the best gray threshold.

$$E(x) = \frac{d(x) - D(x)}{d(x)}$$

(3)

### 2.3 Improved Genetic Algorithm

Aiming at the problems of slow optimization speed and premature convergence of traditional genetic operator algorithm, this paper improves the traditional genetic operator algorithm. In this paper, the hybrid probability is dynamically adjusted. When the population diversity decreases, the hybrid probability $P_c$ will be increased, and more new individuals will be introduced to increase the population diversity; otherwise, when the population diversity is too high, the hybridization probability $P_c$ will be reduced to make full use of the information provided by the current region.

At the beginning of the algorithm, the population diversity $D_0$ is calculated, and the hybridization rate $P_c$ is set as 40%. In the $i$-th generation of evolution, if the population diversity is $D_i$, then $P_c$ is modified according to the following formula:

$$P_c = P_c + \left[\frac{D_{i-1} - D_i}{D_0} \times 0.4\right]$$

(4)

The main starting point of the improved genetic algorithm is to ensure the population diversity by dynamically adjusting the hybridization probability.

### 3. Experimental Background and Parameter Setting

In this paper, the genetic algorithm is applied to the common search strategy, and the genetic operator is applied to the image deblurring process. In the last chapter, we introduced the basic principle of genetic algorithm, and showed how to select the best threshold to improve the image quality, and understood the general characteristics of genetic algorithm. This paper mainly focuses on the application of the improved genetic algorithm in image deblurring processing technology. The improved genetic algorithm, that is, by dynamically modifying the probability of hybridization and aiming at the genetic algorithm, finds the genetic algorithm with slow threshold speed and premature convergence. Experimental results show that the improved genetic algorithm can improve the quality of image deblurring. In the experiment, the parameters are set as shown in Table 1.
Table 1. Parameter setting

| Parameter name       | numerical value |
|----------------------|-----------------|
| Experimental tools   | PyCharm         |
| $M$                  | 256             |
| $N$                  | 256             |
| $G$                  | 0.1             |
| $\rho_{\min}$       | 0.001           |
| Initial population   | 30              |

4. Discussion

4.1 Restoration of Actual Image

In order to verify the restoration effect of genetic algorithm on the actual image, the actual blurred image taken in two cases was restored. Four pictures were taken with a digital camera, and the images were blurred due to deliberate out of focusing. In this paper, the improved genetic algorithm is used to deblur the image, and the traditional genetic algorithm is selected to deblur the image. The experimental results are shown in the following figure.

![Figure 1](image1.png)

**Figure 1.** Comparison of recovery degree between two algorithms

It can be seen from the data in Figure 1 that both algorithms have certain effect on image restoration, but the recovery degree of the improved genetic operator algorithm is 20% higher than that of the traditional genetic operator algorithm. The improved genetic operator algorithm can restore 80% of the pixels in the blurred image, and can remove the blur degree of the image more effectively, so that the image can be restored to a better and clearer quality.

4.2 Restoration of Convolution Blurred Image

The next group of pictures is convolution blur image restoration. In this paper, the selected images were taken with digital camera, and four images were blurred due to inaccurate focusing. In this paper,
the image is still de blurred. The experimental group uses the improved genetic operator algorithm used in this paper, while the control experiment still selects the traditional genetic operator algorithm. The experimental results are as follows:

![Figure 2. Error comparison of two algorithms](image)

It can be seen from the data in Figure 2 that the improved genetic operator algorithm reduces the noise error to less than 5.5dB in terms of error reduction. The traditional genetic algorithm reduces the image noise error to 8dB. It can be seen that the improved genetic algorithm simplifies the calculation space and effectively shortens the time of image restoration. If a certain amount of noise is added to the degraded image, the inverse filtering will be unstable due to the general ill condition of the degraded image. At the same time, when the signal-to-noise ratio (SNR) is higher than 30 dB, the inverse filter can get better recovery. However, if the degradation is serious and the signal-to-noise ratio is low, the image restored by inverse filtering will be completely submerged by the amplified noise and oscillation fringes. Due to its inherent robustness, the genetic algorithm has no such limitation and can get ideal restoration. According to the comparison of the two algorithms, the improved genetic algorithm can reduce the noise error, make the edge information of the image clearer, and the image treatment after deblurring is clearer. It can be seen that the improved genetic algorithm improves the degree of noise reduction.

4.3 Characteristics of Image Deblurring Technology and Genetic Algorithm

(1) Principle of image deblurring

As the digital deblurring processing technology has been a basic problem of digital image processing specialty, with the continuous development of digital image processing technology, digital deblurring processing technology is also gradually developing. Historically, most of the research on digital image processing focuses on image distortion, including algorithm research and compilation of image processing programs for specific problems. The so-called image distortion is an important branch of digital image processing, which means to eliminate or reduce the image noise during the acquisition of digital image, so as to improve the image quality. The general image noise mainly includes the influence of illumination and the image blur caused by the change of relative motion. Image distortion means spectral distortion, so the imaging process involves repairing damaged image tissue. This can be done using spatial filters or point-to-point image processing during image generation. Image restoration technology is considered to be the most effective method to eliminate all kinds of noise and blur in image processing, and has been widely used in many research fields.

When capturing the images of plane or three-dimensional objects, they may be affected by the defects of the actual capture equipment, the medium of image transmission and the blur caused by relative motion, which makes the photos taken and the actual objects have a very big difference, that is,
the so-called image damage event. The purpose of this paper is to eliminate or minimize the influence of image blur and restore the original image as much as possible. However, there are many reasons and characteristics of image blur, so there is no agreed restoration method so far, but there are different effective restoration methods for different blurred images.

There are many reasons for image blurring, such as the influence of optical illumination, the nonlinearity of sensor, the influence of optical system, the uneven photo, atmospheric interference, relative motion blur and geometric distortion caused by abnormal scanning of camera. To sum up, in general, there are two main reasons for image blur: deterministic and random. In order to effectively design the digital image restoration system, the most important thing is to quantify the image. According to the actual image system in the display system, the image is digitized and the clarity of the restored image is restored. Basically, the characterization process is to record the result of image corruption and then perform operations to restore the model to its original state. It should be emphasized that the correct image blur model is usually the key to effective image restoration.

(2) Characteristics of genetic algorithm
First of all, genetic algorithm starts not only with one solution, but also with multiple solutions. This is a huge difference between genetic algorithm and traditional optimization algorithm. Traditional optimization algorithms provide an optimal solution from one data source. The solution is easy to interpret as an environment-friendly solution. Genetic algorithm starts from the string set and has a large coverage area suitable for global selection. Secondly, genetic algorithm uses little information to solve specific problems, and the general algorithm is easy to develop. Because genetic algorithm is used to search the physical value information, it does not need the information directly related to the problem as the source of the problem. Genetic algorithms only need general information such as fitness values and string codes, so they can handle any problem. Thirdly, genetic algorithm has a very strong ability to contain errors. The first string itself of the genetic algorithm itself contains a lot of information from the best solution. Genetic algorithm can quickly delete very different strings from the best solution through selection, transition and mutation operations, which is a powerful filtering process and parallel filtering method. Therefore, genetic algorithm has a high tolerance for errors. Fourth, the selection, transmission and mutation in genetic algorithm are random behaviors rather than real laws. Genetic algorithms use random methods to find the best solution. Selection reflects the best solution, cross reflects the generation of the best solution, and variation covers the overall solution.

Genetic algorithm has been applied in many fields, which shows its great potential in image deblurring. The most important problems in the application of genetic algorithm include the following three aspects. First, string encoding method. There is a problem with the content of the string encoding method. Usually, you set the various parameters of the problem to form a substitute with real or binary code, and then create a pair of chromosomes. Second, determine the fitness function. Fitness function is also called object function, which can solve the quality problem in the process of image deblurring, which is usually called "environment". Generally, the problem model can be regarded as an object function, but it needs to be constructed separately in the process of image deblurring. Thirdly, genetic algorithm needs to have its own set of parameters. Genetic algorithm has three dimensions: population size $n$, lateral probability $P_c$ and mutation probability $P_m$. When the population size $n$ is very small, it is difficult to find a good solution, and it will take a long time. For a priori opportunity, if $P_c$ is too small, it is difficult to search forward; if $P_c$ is too large, it is easy to break the high adaptive value structure, which is generally between 0.25 and 0.75. If $P_m$ is too small, it is difficult to produce new gene structure mutation. If $P_m$ is too large, genetic algorithm becomes a pure random search, generally between 0.01 and 0.2.

5. Conclusions
In reality, there are many fuzzy images caused by photographing or other reasons. When the image is blurred seriously, it will affect the image segmentation, recognition and understanding. Therefore,
Image deblurring processing technology has important practical significance. There are many methods for image deblurring, among which threshold denoising has always been the focus of scholars, and genetic algorithm as an optimization tool has attracted more and more attention of relevant researchers. Based on the theory of improved genetic algorithm, this paper makes a deep research on image deblurring. The experimental results show that the improved genetic algorithm can restore 80% of the pixels of the blurred image, and can remove the blur degree of the image more effectively, so that the image can be restored to a better and clearer quality. At the same time, the improved genetic operator algorithm improves the degree of noise reduction, makes the image smoother and has better visual effect in the process of image restoration.

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