

The Application research of Genetic Algorithm in Image Processing

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Abstract: Genetic algorithm is an algorithm that searches for the optimal solution by simulating the natural evolution process. In the process of image processing, a lot of optimization calculation is needed, and the global optimization of genetic algorithm can solve this problem well. Therefore, this article introduces the basic idea of genetic algorithm and the specific process of genetic algorithm in the application of image processing is studied, and the genetic algorithm is used to determine the weights of characteristic value and image enhancement in the application of image retrieval, and finally it points out the problems existing in genetic algorithm.

Keywords: Genetic Algorithm; Image Processing; image search; Eigenvalue weight; Image enhancement

1. INTRODUCTION

Genetic Algorithm^[1] (GA) was designed and proposed by Professor^[1] J. Holland and his students in the United States in the 1970s according to the laws of biological evolution in nature. It is an Algorithm that searches for the optimal solution by simulating the process of natural evolution. When solving complex combinatorial optimization problems, genetic algorithm can usually get the optimal solution or approximate solution quickly, which has strong robustness and self-adaptability.

Image processing is a technology that uses computers to process images to meet people's specific needs. It is a process of image enhancement, segmentation, restoration, coding, recognition^[2],^[2] compression and other processing^[2]. Under the impetus of the development of information technology, image processing technology has provided help for the improvement and development of many industries. People's demand for image processing continues to expand, so the research on image processing is becoming more and more important.

Because the process of image processing needs to carry on a lot of optimization calculation to the whole image, and genetic algorithm has better global optimization characteristics, it can quickly get the optimal solution in the process of image processing, and at the same time reduce the error in the process of image processing.

2. The basic principles of genetic algorithms

The specific process^[3] of genetic algorithm^[3] are as follows:

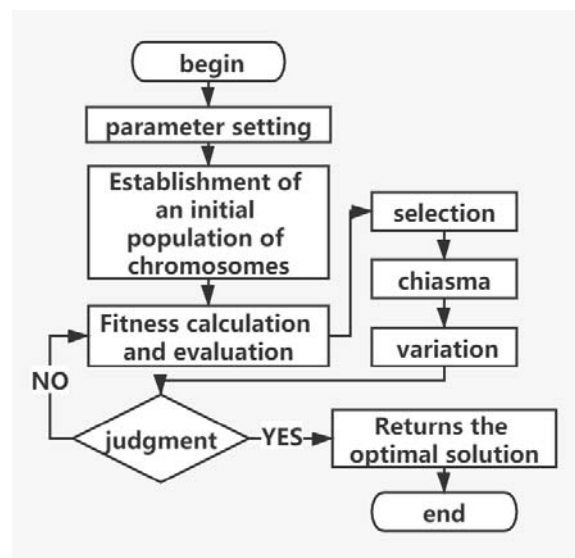
First, a population of N chromosomes is randomly generated, each of which corresponds to an initial solution to the problem and is represented by the same code. Then set some fitness function to calculate the fitness of each chromosome, and select the individual with the highest fitness in the population as the parents of the next generation population.

After that, two chromosomes of the selected chromosome group were selected in a certain way for crossover operation to generate two new chromosomes, and then a number of chromosomes were randomly selected according to

the set probability for mutation operation. When the mutation operation is completed, the fitness of the new generation population is calculated again, and the set convergence conditions are judged. If it is satisfied, the evolution is stopped and the optimal solution in the current population is returned. If not, the above steps are continued.

In essence, genetic algorithm is the continuous optimization of chromosome with bigger fitness generation by generation, and the individual fitness value is constantly increased, until the individual fitness value is close to the approximate solution that people need.

The algorithm flow^[4] is shown in the following figure.



3. Application of genetic algorithm in image processing

3.1 Application analysis for determining eigenvalue weights in image retrieval based on genetic algorithms

In content-based image retrieval, the accuracy of retrieval is low because the manual setting of eigenvalues is subjective and arbitrary^[5]. The adaptive performance of genetic algorithm is better to make up for this shortcoming. Therefore, genetic algorithm can be used to automatically assign the weight of multi-feature combination in image retrieval so as to obtain higher image accuracy.

The feature values of image retrieval^[6] mainly include color feature^[7] and texture feature.^[6] The main N feature sequences were extracted from the feature combination set including color feature and texture feature, and normalized processing was carried out to binary code the chromosomes required by the genetic algorithm.^[7] The number 1 represents the selection of the feature sequence^[8], and 0 represents the unselection of the feature sequence. Each chromosome corresponds to a unique set of characteristic sequences.

To determine the fitness function of the genetic algorithm, the sum of precision and recall can be used to improve the efficiency. Where, the precision is the ratio of the number of relevant images retrieved to the number of images retrieved; The recall rate is the ratio of the number of related images retrieved to the total number of related images.

For the selection algorithm, the adaptive proportion method or roulette algorithm can be used. The former will copy the excellent individuals in the population, eliminate the unsuitable individuals, and retain the best individuals, and select the weight that can produce excellent results. The latter means that the greater the fitness of the individual, the greater the chance of being selected will be, and the selected individual will enter the next generation population.

For crossover algorithm, a single point crossover method can be used to generate new individuals according to specific crossover probability. The crossover probability is usually selected from 0.45 to 0.99.

For the mutation algorithm, random bit mutation can be carried out on the individuals in the population. The

original is 1, the mutation is 0; where it was 0, it mutates to 1. The variation probability is generally 0.001-0.1.

There are various termination conditions for the algorithm, such as the accuracy of the solution or the maximum running time of the algorithm or the maximum iteration number of the solution.

The application process of genetic algorithm is as follow:

Step 1: select a certain database and a certain number of images of the same amount of each type as the query images, and set the appropriate number of images returned by search.

Step 2: Generate N bits of binary numbers randomly as individual codes, and a certain number of individual codes generated will be used as the initial population. The number of the initial population is generally 30-100.

Step 3: The fitness function is used to calculate the fitness of the individual and determine whether it meets the termination conditions of the algorithm. If so, the optimal individual and its optimal solution are output, that is, the optimal feature weight corresponding to each feature is obtained and the calculation is terminated. Otherwise, the process proceeds to step four.

Step 4: Chromosome selection, crossover and mutation through a certain algorithm to generate a new generation of population, and return to Step 3, until the termination conditions are met.

Through the above process, we can get the best feature weight corresponding to each feature and improve the efficiency of image retrieval. However, there are still many inadequacies, and there are still many places to be further improved. For example, the retrieval process only adopts the color feature and texture feature, but does not adopt the shape feature and spatial relation feature to further improve the retrieval accuracy. It can be seen from Jiang Xue's experiment^[9] that different databases use different eigenvalues, and the combination of eigenvalues obtained by using the genetic algorithm is corresponding to the database used in the process of the genetic algorithm, that is to say, the combination of eigenvalues is only applicable to the database relative to it.^[9]As the database is constantly updated and the number of images is increasing, the accuracy of the combination of eigenvalues will also decrease.

3.2 Application analysis of genetic algorithm in image enhancement

Image enhancement is a key research direction of image processing. On the one hand, it can effectively improve image quality, eliminate image noise and improve the overall quality of image. On the other hand, it can highlight the key part of the image, strengthen the image interpretation and recognition effect, and meet the needs of some special analysis. Image enhancement can be divided into two categories: frequency domain method and spatial domain method. The former adopts the low-pass filtering method to remove the noise in the image or the high-pass filtering method to enhance the high-frequency signal such as the edge, which is used to make the fuzzy picture clear. The latter adopts the local average method or median filtering method to remove or weaken the noise.

Image enhancement requires user intervention and cannot be performed adaptively. However, in the study of Lu Limin and Zhou Haiyin^[10], image enhancement process is regarded as an optimization process of image sequence, and image enhancement is transformed into parameter optimization, which is in line with the basic idea of genetic algorithm optimization, and the problem can be effectively solved through the strong adaptability of genetic algorithm. In this paper, the image parameter model proposed by J.S. Lee is used to transform the enhancement process of digital image into the process of seeking the optimal parameter k, and the binary coding, small population, large crossover rate and large mutation rate are adopted to improve the operation speed of the algorithm. The SNR and absolute mean error were used as fitness functions, and the maximum number of iterations was set as termination conditions. Through the commonly used genetic algorithm of survival of the fittest, the automatic image enhancement based on genetic algorithm is successfully realized, and the signal-to-noise ratio and absolute mean error is obviously better than the traditional image enhancement methods.

4 CONCLUSION

To sum up, genetic algorithm has a good application in the process of image processing, which solves the problems

of low efficiency and low accuracy of traditional algorithm to a certain extent, and provides a better optimization method for image processing.

But even so, there is still plenty of room for improvement. Genetic algorithm itself also has a lot of problems, for example, most of the genetic algorithm used in the application of the code is binary code, which limits the application of genetic algorithm through other ways of coding. Genetic algorithm can select and improve its code appropriately based on different application situation; Secondly, the parameters of genetic algorithm need to be selected at the beginning of its application. The selection of different parameters will greatly affect the performance of genetic algorithm. Moreover, the current theoretical research can not fundamentally solve the two most prominent problems of precocious convergence and poor local search ability.

In a word, genetic algorithm still has a lot of room for development in theoretical development and practical application. In the future, due to the development of mathematical methods and computer performance, the research of genetic algorithm will get greater progress, and the application of genetic algorithm will be more extensive.

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