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Adaptive Genetic Algorithm Based on Chaotic Intelligent Algorithm to Image Restoration Research

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Abstract

As an important subject of image processing, image restoration is a kind of degeneration by establishing the mathematical model of reverse deduction arithmetic, and the image processing technology of the original image is obtained.Traditional image restoration algorithm by image dimension is low, the method of single factors such as limit, image restoration effect is limited.Combined with adaptive chaotic genetic algorithm, this paper proposes an improved image restoration intelligent algorithm.Through analysis and experiment comparison, the new algorithm can get better effect of image restoration.

Keywords*: Chaos optimization; Genetic algorithm; Image restoration*

1. Introduction

With the development of the computer, we ushered in the real information age, information influence in our life, study and work more and more important, which is the most direct information of image information.Rapid development of digital image processing, are widely used in various fields.Image has become a psychology, physiology and so on various effective tool for the study of visual perception;Image, on the other hand, in scientific research, industrial production, medical and health care plays an important role in large-scale application, along with the widespread application of multimedia technology, image is closely related to human life more [1-2].

In the process of scene imaging, is influenced by many factors, so we get through different means to the quality of the image will be reduced to some extent.This kind of image degradation process called degradation of the image.Atmospheric turbulence effect, for example, the difference of optical system, image quality caused by camera shake down in nissan life, sensor characteristics of nonlinear and difference of the optical system.The human visual system for noise sensitivity than auditory system, we know that the voice in the process of transmission also has problems such as lower quality, but it is often not feel.Scene image noise, however, such as images and photographs of fuzzy, even small escapes keen vision system.

Image restoration process in a certain sense also to improve the quality of the image, but there is a obvious difference between this and image enhancement, image enhancement is basically a process of exploring the process of psychological state of choose and employ persons and the visual system to control the quality of the image using a variety of people enhancement method to improve the quality of the image until the system of people's vision to meet.Image restoration is a prior knowledge of degraded image is used, a mathematic model of the degradation phenomenon, then according to the model of reverse inference operation, in order to recover the original image scene image.Image

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restoration is always in the field of image processing and computer vision is an important research topic.

2.Related Works

2.1. Image Restoration

Image restoration is always an important in image processing and computer vision research subject, over the past few years is gaining widespread attention.The main purpose of image restoration is to improve the quality of a given image, the degraded images or there is a noise of images, using the degradation phenomenon of some kind of a priori knowledge to reconstruct or recover the original image.It is image processing, machine vision, pattern recognition and so on research in the field of the foundation.

In the process of scene imaging, is influenced by many factors, the quality of the image will be reduced.This process called image degradation image quality decline.An image in the system have more than one source of degradation, degradation image can be divided into space degradation, degradation and deterioration or degradation factors affect only individual point in an image gray level;Space degradation degradation factors can make the image blur a space in the area.For the actual problem, of course, the monitor, color and some chemistry will also cause the degradation of the image, such as remote sensing, astronomy and investigation in the photo, its degradation may be due to atmospheric disturbances, the aberration of optical system, the relative motion between the camera and the object.Before making image restoration, must make clear and certain knowledge of degradation phenomenon, a priori or a posteriori, USES in the corresponding methods to deal with, is to the image of metamorphic mechanism for detailed understanding and analysis, establish the mathematical model of degraded images [3-5].

Image restoration is the process of the inverse direction along the image degradation, after knowing the image degradation model, using the reverse process of image processing, is the effect of image is improved, the traditional image restoration is to design a filter process, quality, and the image of the restored image is obtained by calculation from the drop estimates, make its maximum and close to the real images.

2.2. The Basic Theory of Genetic Algorithm

Genetic algorithm is a kind of abstract in the process of biological evolution based on natural selection and genetic mechanism of the intelligent optimization algorithm, to solve the problem as the environment, from the generation of random individuals to form groups, and the whole optimization process is the process of finding the optimal solution, through the selection, crossover and mutation finally reach the purpose of a kind of optimization algorithm.In the genetic algorithm is used in many natural genetic evolution of the term, such as chromosome, gene, individual, population, *etc*.The chromosome is the corresponding data, the data in the traditional genetic algorithm is usually a string structure of the data.On the corresponding position of genes, namely the data characteristics of each component, genetic algorithm for chromosome also known as individuals.A certain number of individuals, make up the population, the size of the population is called the population size.Each individual how to adapt to the environment is called fitness.

Genetic algorithm includes two data conversion operations, one is the phenotype to genotype, the other one is genotype to phenotype.Genetic algorithm for the first thing to do is to process data from the actual problem, usually through some kind of coding technology calculated, make it become a chromosome in the algorithm to the optimal solution is obtained by algorithm of inverse process, pass before encoding, the decoding phase back into the actual problem, get the phenotype of task requires information.

Genetic algorithm includes three basic operations, *i.e*., selection, crossover and

mutation, it is because of the three interaction makes genetic algorithm is a kind of high robustness, global optimal intelligent optimization algorithm [6-10].

(a) Choose. Selective replication is also called, is choose the strong vitality of individuals in a group to create new group, the process of genetic algorithm selection operator for the selection of the individuals in the population evolution, which the individual is determined by calculating the fitness of before good, its spread to the next generation probability of population is big, low fitness of individuals are chosen probability is relatively small, it is because of this, the cycle of population is to seek the optimal process, makes the individual fitness is close to the optimal solution of our prayer.So the choice of selection operator for genetic algorithm is a vital, directly affect the calculation results of the algorithm.Common choice operator including roulette wheel selection, random competition, the best preserved, determine the type selection and most save selection method.

(b) Cross. Crossover concept derived from biological genetics, in biological evolution, two homologous chromosomes by mating and restructuring, to form a new chromosome, so as to produce new individual and the species, the process is of great importance for the evolution of the biological function, using the crossover operator in genetic algorithm to generate new individual, mainly from groups of individual choice, exchange their one or a few genes, a new individual, crossover operator to generate offspring inherited the basic characteristics of the parent.Crossover operation is the important feature of the genetic algorithm is distinguished from other evolutionary algorithms, which is a key link in the process of producing individuals.Crossover operator varies according to the condition of practical problems of coding, common crossover operator, such as single point crossover and multipoint crossover, with crossover and arithmetic crossover, *etc*.

(c) Mutation. Creatures in the genetic and evolutionary process, some accidental factors will lead to genetic variation, thus generating new chromosomes and then get new phenotypes, genetic algorithms mimic variation process of biological evolution, with smaller probability by gene mutation of the individual, the process is completed by mutation operator.Variation in itself is a kind of random algorithm, but together with the selection and crossover to can avoid occurring in the process of selection and crossover information loss problem.Crossover operator to ensure the global search ability of the algorithm, the mutation operator to ensure the local search ability of the algorithm, both fit is what makes the genetic algorithm to the optimization problem is solved effectively.Common mutation operator including basic variation, with variations, boundary variation and gaussian approximation, *etc*.

In addition to the three basic operations described above, also includes coding genetic algorithm, the generation of initial population, fitness function setting, parameter selection, *etc*.

1) Coding. Coding belongs to the data preprocessing stage, we need to be the real problem abstraction into a language that the computer can read, genetic algorithm is usually not deal directly with the data, rather than through the coding process will be problem for genetic makeup of individuals for operation.After get the optimal solution in the final work to decode the information back to the actual problem.

2)the initial population is generated. Genetic algorithm can run effectively, you first need to have a starting point, the algorithm with initial population as a starting point for each subsequent generation of evolution and breeding, finally get the optimal solution.Commonly used in the generation of initial population to mainly is randomly generated, but this method will produce a series of problems, the subsequent we will introduce the improved genetic algorithm to do effective improvement.

3)the fitness function. Fitness individuals in the group (Fitness) is to measure in optimization calculation can reach or close to or help to find the optimal solution of the fine degree of indicators.High fitness individuals through the probability of selection operator is introduced into the next generation is large;Low fitness of the individual to the

next generation of probability is small.Genetic algorithm USES the Fitness Function (Fitness Function) to calculate the Fitness of the individual.Fitness function is sometimes referred to as the evaluation function, is a driving force of evolution algorithm, the algorithm selection is the only basis.

3.The Intelligence of Adaptive Genetic Algorithm Based on Chaotic Image Restoration Algorithm is Proposed

We known genetic algorithm has stronger robustness than other algorithm, but the genetic algorithm is good at tend to global search and local search result is bad, this leads to algorithm in close to slow the global optimal solution.The researchers found that genetic algorithm can achieve the optimal solution with faster speed of 90%, but in order to get the final result is often take a long time.A genetic algorithm based on chaos optimization theory to solve the problem to a certain extent, but the algorithm for the crossover rate and mutation rate are inherent value, combining the adaptive theory and chaos theory, from the generation of initial population and crossover mutation probability of the two aspects of dynamic change, put forward a kind of image restoration algorithm based on adaptive chaotic genetic algorithm, because this improvement in view of the link is different, so the improved algorithm won't produce conflict, only in their own link optimize the settlement space, the algorithm is efficient and accurate.We first introduce based on chaos theory basis and implementation of the improved genetic algorithm, adaptive chaotic genetic algorithm is proposed based on image restoration method, experiment proves that algorithm can get better effect.

Chaos phenomenon is widespread in nature a kind of nonlinear phenomenon, fully embodies the complexity of the system.Chaos can within a certain range according to its own characteristic not repeatedly after all state, have ergodicity;The change of the initial condition is extremely weak will cause great changes of chaotic system behavior, with extreme sensitivity to initial conditions.The properties of chaotic motion as optimization search mechanism of avoid falling into local minimum, just can make up for the genetic algorithm easily fall into local optimum, the defects of slow convergence speed.

Genetic algorithm based on chaos theory is mainly used in the generation of initial population and excellent individual optimization.First of all, we know that the traditional genetic algorithm in often use randomly generated when the generation of initial population, but so could a considerable number of individuals from the optimal solution, causes the algorithm solving efficiency is not high, the iteration time is too long.So the use of the ergodicity of chaos for global search for initial population than the randomly generated initial population for subsequent optimization algorithm has better efficiency.Secondly using chaotic local search and improve the precision of solution.Selected individuals fitness higher part of the population after genetic operation, choose commonly 10%, for this part more excellent individuals, small chaos perturbation and disturbance amplitude was adjusted as the search process, to further optimize the quality of the excellent individual, guide the population evolve rapidly [11-12].

Commonly used chaos model for one-dimensional logical mapping, the mathematical expression is as follows:

$$x_{k+1} = \mu x_k (1 - x_k) \tag{1}$$

μ of them as the control parameter, to formula (1), can be arbitrary initial value $x_0 \in [0,1]$iteration of a certain time series $x_1, x_2, ..., x_k$. The choice of μdetermines the system was stable solution properties

Here are intelligent image restoration algorithm based on chaos genetic algorithm of specific steps:

1. Chromosome coding, we use the integer encoding grayscale level 256

two-dimensional gray image, the chromosome coding for each pixel gray value of the two-dimensional matrix elements.The benefits of using integer coding is avoiding the tedious coding, decoding process, improve the efficiency of search.

2. Initialization of population, in order to avoid the randomly generated initial population, the shortcomings of here we embedded chaotic sequence to generate the initial population.

(1) The random initial value x_0, x_0 as a matrix, its element represents the grey value, if the image gray level 256, grey value of the matrix in [0,255] interval.

(2) To map the elements in the x_0 to [0, 1] interval:

$$x_0(i, j) = \frac{x_0(i, j) - 0}{256} \tag{2}$$

(3) For the initial value x_0, obtained by type (1) the logical mapping equation of sequence $x_k(k = 1, 2, ..., M)$;

4) Will be inverse mapping sequence $X_k(k = 1, 2, ..., M), X_k = 0 + (256 - 0)x_k$, $x_k(k = 1, 2, ..., M)$

(5) Computing the fitness of each individual for sequence $X_k(k = 1, 2, ..., M)$, selecting the best n individuals initial population;

3. The selection of fitness function, the image restoration algorithm based on chaos genetic algorithm on the choice of fitness function and the traditional genetic algorithm to deal with image restoration problem is essentially the same;

4. Selection, crossover and mutation operation, the genetic operators and section on the use of genetic operators;

5. Individual chaos optimization, select individuals fitness higher part of the population after genetic operation, usually, 10% of these individuals are tiny chaos disturbance and as the search process of the disturbance amplitude was adjusted adaptively, further optimize the quality of the excellent individual, guide the rapid evolution of population,

6. If the results meet the termination conditions are output optimal solution, otherwise go to step 4.

Through the above research, we learned that the genetic algorithm will appear the phenomenon of premature convergence and unsatisfactory time complexity, causes of the problem mainly exist in the two areas, namely population initialization time randomly generated individuals far from the ideal optimal solution algorithm running time is too long;And algorithms for the setting of crossover probability and mutation probability is fixed, greatly reduces the diversity of samples, leading to premature convergence.Researchers respectively for the two problems is given, based on the predecessors' research, it is concluded that a integration of genetic algorithm, based on the theory of the adaptive chaos algorithm from two aspects to improve the traditional genetic algorithm, and makes the algorithm in a relatively short period of time to get satisfactory results.Algorithm by using chaos theory, first of all, to optimize the generation of initial population, the optimized initial population is effective to protect the species diversity and reduces the search time.For the crossover and mutation process of genetic algorithm, by dynamically changing the value of crossover probability and mutation probability to complete chromosomal crossover and mutation operation;And then of the new population of chaos optimization iteration as the next generation of population, until meet the termination conditions [13-15].

Chaotic adaptive genetic algorithm steps are as follows:

1) The actual problem coding, the algorithm parameters, including the crossover probability and mutation probability;

2) Embedded chaotic sequence generated initial population ;

3) Fitness function is given, and choose according to fitness function was introduced into the next generation of the individual;

4) According to the dynamic change of crossover probability formula of adaptive parameter chromosomes crossover operation;

5) According to the dynamic change of mutation probability formula of adaptive parameter mutation chromosome;

6) The individual crossover and mutation of a new group composed of chaos optimization, get the optimized for the next generation of population;

7) The termination condition decision, if meet the termination conditions, go to step 8, otherwise go to step 3;

8) Get the optimal solution, decoding return to practical problems.

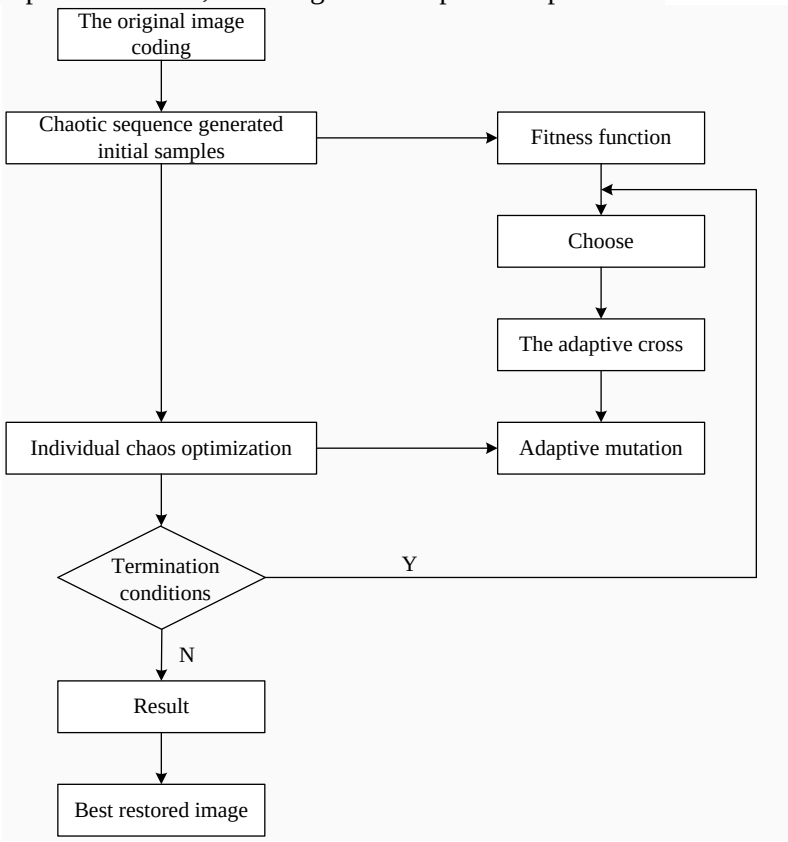

Figure 1. Flow Chart of Chaos Adaptive Genetic Algorithm

4. The Simulation Experiment and Result Analysis

In order to compare the effect of genetic algorithm and its improved algorithm, this chapter to add 5x5 fuzzy operator image data experiment "Lena" as the experimental object, contrast image restoration method based on traditional genetic algorithm and image restoration method based on chaos genetic algorithm, the improved genetic algorithm based on simulated annealing image restoration, image restoration based on adaptive genetic algorithm and adaptive chaotic genetic algorithm such as image restoration method.

(a) The original image

(b) Degraded image

(c) The traditional genetic algorithm

(d) Chaos genetic algorithm

(e) Adaptive chaos genetic algorithm

Figure 2. The Results of Different Improved Genetic Algorithm for Image "Lena" Restoration

Table 1 the objective evaluation standard of different algorithms finally restored image comparison, using the peak signal-to-noise ratio and mean absolute error to evaluate:

Table 1. Lena Image Different Algorithms Peak Signal-to-Noise Ratio and the Average Absolute Error Comparison

Method to choose	Peak signal to noise ratio(db)	Mean absolute error	Time(s)
Traditional genetic algorithm	26.128	5.12	2.97
Chaos genetic algorithm	30.354	3.98	2.13
Chaos adaptive genetic algorithm	32.146	2.56	1.87

By the results of table 1 we can see that the proposed adaptive chaotic genetic algorithm for image restoration experiment, the effect is better than traditional genetic algorithm and several kinds of improved genetic algorithm, and the time complexity is also in the middle of the range, only slightly slower than the chaos algorithm, the reason for this is that due to the chaotic algorithm for the generation of initial population used the chaos optimization, that are not present in the initial population and the original image of the individual, the deflection corresponding shortened the algorithm running time.The change of the adaptive genetic algorithm can be adaptive crossover rate and mutation rate, protect the diversity of population and global search ability, so the algorithm has more ideal results, but it is because of the addition of adaptive operation, makes the algorithm running time has increased to a certain extent.Based on chaos theory of the adaptive algorithm not only has the best quality of image restoration, and time complexity than the algorithm also have to reduce it to a certain extent, shows that the combination algorithm of this paper is feasible, through the chaos theory on the initial population and the next generation of individual optimization, makes the algorithm running time is reduced, and because the application of adaptive theory makes integration algorithm also has good effect.

5.Conclusion

Genetic algorithm is a kind of excellent global optimization algorithm, algorithm without too many constraints, can solve the problems as environment, compared with other optimization algorithms have multisple search point search information, with remarkable parallelism, and the genetic algorithm has strong robustness.But the genetic algorithm itself there is premature convergence and low efficiency of disadvantages, this chapter analyzes the genetic algorithm and its improved variety, put forward a kind of improved genetic algorithm based on adaptive chaos theory, and through experiment verify its good recovery effect to traditional methods of improvement.

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