

FRACTAL IMAGE COMPRESSION USING GENETIC ALGORITHM WITH VARIANTS OF CROSSOVER

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Abstract— *Fractal image compression techniques are developed due to recognition that fractals may describe natural scenes greater than shapes of regular geometry. One of the very efficient fractal methods is based on iterated function system (IFS), and may be developed by Bamsley and Jacquin. New techniques for image compression while using the theory of fractal. The fractal codes are made assuming self likeness property of pictures. Fractal image compression explores the self similarity property of your natural image and utilizes the partitioned iterated function system (PIFS) for you to encode it. This system is of excellent interest both in theory and application. On the other hand, it is time-consuming within the encoding process and such drawback makes it Impractical for real-time applications. The time is primarily spent on the look for the best-match block within a large domain swimming pool. In particular, to generate the fractal rules, Genetic Algorithm are utilized which greatly decreases the look for finding self similarity's within the given image. With this paper the means of Genetic Algorithm (GA) is tried for Fractal Image Data compression (FIC). With assistance from this evolutionary algorithm effort was created to reduce the seek complexity of coordinating between range prohibit and domain prohibit.*

Keywords— *Fractal Image compression, Genetic Algorithm, self similarity, crossover, mutation.*

I. INTRODUCTION

Compression and decompression technology of digital image happens to be an important aspect in the storing and switching of digital graphic in information culture. Most of the ones in use can be classified under the top of lossy data compression. This implies that the reconstructed image is actually an approximation from the original image. Fractal image code introduced by Barnsley and Jacquin [1-4] will be the outcome of the study of the iterated operates system developed within the last few decades. Because regarding its high data compression ratio and basic decompression method, many researchers have done a lot of research on the item. But the main drawback with their work can be linked to large computational time for image data compression. At present, researchers focus mainly on how to select and optimize the classification from the range blocks, balance the speed

regarding compression, increase the data compression ratio and improve the products image after decompression [5]. Image compression is just about the most active grounds of research given it can reduce the prices of storage and transmission of images on the internet. Image or data compression, in normal, is an optimization problem the location where the aim is to find the shortest description regarding some given data that satisfies certain quality constraints. Fractal graphic compression, based on fractal geometry, has been observed to be one of the most promising compression approaches. In fractal data compression, an "object" can be regarded as the attractor of (iterating) an accumulation of contractive maps defined on the complete metric space. Several approaches are already used to find iterated function devices (IFS) to encode images, or more precisely, to search for the parameters that outline such maps. GA is really a search and optimization method manufactured by mimicking the evolutionary ideas and chromosomal finalizing in natural genes. GAs are normal purpose optimization techniques depending on principles inspired through the biological evolution employing metaphors of mechanisms including natural selection, genetic recombination and survival from the fittest. They are person in a wider people of algorithm, Evolutionary Protocol (EA). His idea was then manufactured by other researchers. Genetic Algorithm (GA) was invented by David Holland and Thereafter numbers of his students and also other researchers have contributed in developing this field. With the advent from the GA, many non-linear, large-scale combinatorial optimization problems in power systems are already resolved using your genetic computing structure. The genetic algorithms usually are principally destined to help complex problems, were being no exact alternative exist, and an exhaustive brows from the related search space lead to an NP-Hard trouble, or high calculation time. Our goal is to accelerate the data compression process, by improving the conventional compression algorithm using a genetic search process. This idea was exploited by some authors in numerous ways, because the optimization can be looked at from different angles, and be utilized on different details. Our approach is by using genetic algorithm to help optimize the sleek of similarities in the target image, the conventional optimization methods are sufficient for the calculation of related parameters once the similarity is discovered.

II. RELATED WORK

Y. Chakrapani and K. Soundara Rajan [6] introduce the thought of GA is put on FIC. Instead of global searching within FIC the evolutionary computational strategy like GA can be implemented which shortens the actual search space. Experimental results show the GA gives far better performance over conventional exhaustive search regarding fractal image compression. Normally the PSNR ratio for any decoded image should be very high to get a better image. Based on Table-2 it can be seen that the actual PSNR and Compression ratio are better regarding decoded image using GA over the one obtained simply by exhaustive search strategy. The performance of GA can be further improved by introducing the thought of elitism which copies the most beneficial string in one generation in to the second generation. Xiangjian He, Huaqing Wang, Qiang Wu, Tom Hintz and Namho Hur [7] have reviewed the analysis work for FIC in SA. The investigation accomplished and the efficiency analyses show why people love the FIC algorithms in SA. By inheriting the normal FIC method right from square construction (SQ) to SA, it gives much more accurate compression results (higher PSNR at the same compression proportions as on SQ) for many testing images. The FIC algorithms also provide flexible range block sizes so your compression ratio can be adjustable. There are many ways to improve FIC in SA for future work. In order to enhance the quality for image display and representation on VHS, a greater image interpolation method should be developed to transform images represented in SQ and SA. An adaptive FIC method that uses unique sizes for unique range blocks (and site blocks) is a different research direction to help expand enhance the compression performance. For real-time web-based software, it will be interested to take into account progressive FIC coding and decoding [8], which could more efficiently use network bandwidth and increase image transmitting speed. Parallel processing can be another potential method of increase the computation speed and this can be performed through the actual uniform image separating on SA by using a spiral multiplication.

Ali Nodehi, Mohamad Tayarani, Fariborz Mahmoudi [9] proposes a functional Sized population QEA for fractal image compression. The proposed practical sized population QEA has some parameters and also this paper finds the most beneficial parameters for the actual proposed algorithm. Since fractal image compression is usually a time consuming formula, and finding the most beneficial parameters needs various run of algorithm for many times, some benchmark functions are used to discover the best parameters with the proposed FSQEA. Finally the experimental results on Lena picture show a noticeable difference on fractal picture compression. The time complexity on the proposed FSQEA is adequate to original version of QEA since the average size on the population for FSQEA is adequate to QEA and the quantity of function evaluations for both of algorithms can be equal.

K. Uma, G. Geetha palanisamy, G. Geetha poornachandran[10] uncover Fractal image compression has good robustness against the outliers caused simply by salt and spice up noise. Also, The Optimization method can effectively

slow up the encoding time while retaining the grade of the retrieved picture. The main downside of FIC can be high computational price. To overcome this kind of drawback using optimization techniques is useful to reduced the searching time plus can effectively retrieved the grade of the image. With this paper I include compared different optimization techniques in Fractal picture compression methods and I've got shown comparison results. Here ACO has become produced the best Results compared to other optimization tactics like GA, PSO.

III. FRACTAL IMAGE COMPRESSION

Fractal compression is often a lossy compression means for digital images, determined by fractals. The method is best suited for textures in addition to natural images, relying on the truth that parts of a graphic often resemble other regions of the very same image. Fractal algorithms change these parts directly into mathematical data named "fractal codes" which are used to repeat the encoded image.

A. Collage theorem

This theorem states how to get the set connected with transformations that represent a great approximation of settled image. Let w_1, w_2, \dots, w_n a couple of contractive affine changes, defining an IFS. Let A really do the attractor of this IFS. Let I be a graphic (i. e. set of points), then

Wherever

And d would be the Hausdroff distance. This theorem says the subsequent:

- The closer the transformed image $W(I)$ covers the initial image I , the closer the image I is through the attractor A of the IFS code (W).
- Furthermore, there're especially closer if the transformations are incredibly contractive (i. at the. s is incredibly small).

B. Encoding procedure

The encoding procedure follows your next steps

- Partitioning of the original image directly into N non-overlapping range blocks $\{R_i\}_{i=1}^N$
- Tiling of the image into Mirielle (possibly overlapping) domain blocks $\{D_i\}_{i=1}^M$
- Number of the set connected with allowed transformations W_{ij} .

Then repeat the subsequent procedure for all range block.

- Go with a range block R ,
- From all combinations of shift and domain stop, select the pair (W_{ij}, D_j) that minimizes the gap $d(R_i, W_{ij}(D_j))$.

If the best pair has been found, store the transformation only. This transformation contains specifics of the positional

description of the domain block D, associated with settled range, the volume of rotation operation, scaling and offset boundaries.

C. Decoding method

The decompression course of action starts by assigning memory for two main equal-size images state S and SR. The length of these images may be smaller or larger than that of the initial image before compression. Summary of the reconstruction procedure:

1. A preliminary image, S, is chosen at random (usually a consistent gray image). Any transformed image, SR, is made from the transformation the following:
For each selection block, the intensity valuations of SR are calculated through the intensity values of S in the domain block. That is done from the code, the mapping w., corresponding to your range block.
2. When all selection block (and limitations wij) are worn out, the resulting image will secure the transformed version of the starting image.
3. Within the next step we may transform SR, yet again.
4. Due to the contractility of the mappings, the resulting image will converge towards any image after a few iterations.

According to the Collage Theorem, how close the reconstructed image is usually to the original image depends upon the accuracy of the mapping from site blocks to range blocks for the encoding stage.

IV. GENETIC ALGORITHM

The genetic algorithm can be a process pertaining to solving both constrained along with unconstrained optimization Circumstances It is According to natural selection [8]. This can be categorized like a stochastic algorithm. GA is usually especially efficient When the search space of an problem features very rough landscape riddled throughout numerous local optima [9]. This overcomes your own Disorders occur inside different search algorithms including Hill Climbing. Reaching a Flat place may be the many common problem inside the algorithm and also related ones. your most clicks components connected with GA tend to be Equally follow:

Variation operators: these operators create new sole (solution) through selecting solitary or perhaps additional solitary by population.

Fitness function: That defines what improvement means as well as assigns a great quality measure to a great chromosome AND evaluates it. Initial population: it's role is to help hold (represent) possible solutions.

Selection: This can be performed within a couple of ways: Fitness proportional menu as well as rank-based selection. on the primary solitary your selection probability depends towards the absolute fitness code of any individual(solution) compare to help some other one

as well as with the latter The item preserve your constant pressure coming from sorting your current population towards bases associated with fitness then allocating menu probability In accordance with rank [8].

Crossover: can be a program whereby a new single product or service can be formulated by the points contained inside 3 or added parent merchandise [8].

Mutation: the particular operator USE single one parent along with produce sole son coming from employing a series of kind associated with randomized change to the representation.

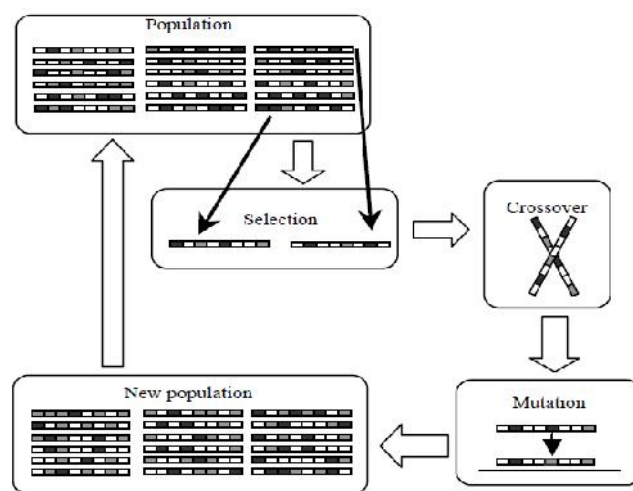


Figure 1: Genetic Process

A. Crossover

Crossover is often a genetic operator This combines (mates) two chromosomes (parents) to be able to Create a new chromosome (offspring). The idea behind crossover is actually that the new chromosome might be greater than both of a parents whether It takes your Easiest features coming from all the parents. Crossover occurs in the course of evolution As outlined by an user-definable crossover probability.[10]

The Cross over operators that we are used in our work is following :

a. One Point :

A crossover operator that randomly selects a crossover point within a chromosome then interchanges the two parent chromosomes at this point to produce two new offspring. Consider the following 2 parents which have been selected for crossover. The “|” symbol indicates the randomly chosen crossover point.

Parent 1: 11001|010

Parent 2: 00100|111

After interchanging the parent chromosomes at the crossover point, the following offspring are produced:

Offspring1: 11001|111
Offspring2: 00100|010

b. Two Point

A crossover operator that randomly selects two crossover points within a chromosome then interchanges the two parent chromosomes between these points to produce two new offspring. Consider the following 2 parents which have been selected for crossover. The “|” symbols indicate the randomly chosen crossover points.[11]

Parent 1: 110|010|10
Parent 2: 001|001|11

After interchanging the parent chromosomes between the crossover points, the following offspring are produced:

Offspring1: 110|001|10
Offspring2: 001|010|11

B. Mutation

After an crossover is performed, mutation takes place. Mutation is a genetic operator supposed to maintain genetic diversity through population connected with chromosomes to the next. Mutation occurs through evolution In line with an user-definable mutation probability, usually set to fairly low value, say 0.01 a good initial choice. Mutation can be a genetic operator designed to maintain genetic diversity through one generation associated with Population connected with genetic algorithm chromosomes on the next. This is analogous to be able to biological mutation. Mutation alters sole as well as added gene values in a great chromosome through their primary state. Mutation alters solitary or even additional gene values throughout a great chromosome by it is primary state. This can result inside entirely new gene values being excess towards gene pool. With the new gene values, ones genetic algorithm might possibly arrive with much better product or service than are previous possible. Mutation is usually a great keys to press area of the genetic search, helps to prevent your population via stagnating on virtually any local optima. Mutation will be meant to prevent ones search falling into an local optimum of an state space.[10]

The Mutation operators are generally regarding quite a few types.

- One quick way is, Flip Bit.
- The others usually are Boundary, Non-Uniform, Uniform, and Gaussian.

The operators are selected based towards the way chromosomes are encoded.

- **Flip Bit**

The mutation operator simply inverts the value of the chosen gene.i.e. **0** goes to **1** and **1** goes to **0**. This mutation operator can only be used for binary genes. Consider the two original off-springs selected for mutation.[12]

Original offspring 1
1101111000011110
Original offspring 2
1101100100110110

Invert the value of the chosen gene as **0** to **1** and **1** to **0** The Mutated Off-spring produced are :

Mutated offspring 1
1100111000011110
Mutated offspring 2
1101101100110100

V. METHODOLOGY

Throughout our proposed function we tend to be while using Fractal image compression with the genetic algorithm. Fractal image compression approaches are being formulated for its identification The idea fractals will probably describe natural scenes greater compared to shapes involving traditional geometry. Individual of any almost all efficient fractal ways is usually In line with iterated perform systems (IFS). Fractal image compression explores your own self similarity property of any natural graphic as well as has ones partitioned iterated work process (PIFS) in order to encode it. The particular system is usually of great interest both throughout theory along with application. This is time-consuming with the encoding system as well as these types of drawback renders This Impractical pertaining to real day applications. your own date can be mainly spent for the search due to the best-match block with a good large domain pool. the goal is actually for you to accelerate ones compression process, through improving your own official compression algorithm using a genetic search technique. this idea feel exploited from a few authors in different ways, since optimization is actually viewed coming from additional angles, and end up being applied from different parameters. The approach will be to work with genetic algorithm to be able to optimize the search regarding similarities on the target image, your own standard optimization methods are sufficient due to the calculation of related parameters Any time your own similarity can be detected. for the before run there is quite a few genetic technique consumed when i additional manner within MY proposed perform when i are use the variant of crossover operator to help enhance your own search speed along with in order to reduce the consumption connected with day find out self similarity for the targeted image.

Chromosomes codification

A chromosome in our algorithm is constituted by 6 genes, from which all 6 genes are submitted to genetic modification,

to generate the new child chromosomes for the better fitness Function. We have the genes:

- $X_{Dom}, Y_{Dom}, X_{DT}, Y_{DT}, \text{rotation } (\Theta), \text{ scale}(s)$

This will improve both compression speed and reconstruction quality, the following figure show our chromosomal representation of the IFS

X_{dom}	Y_{dom}	X_{DT}	Y_{DT}	Rotation (Θ)	Scale (s)
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Figure 2: Chromosomal Representation of an Individual IFS

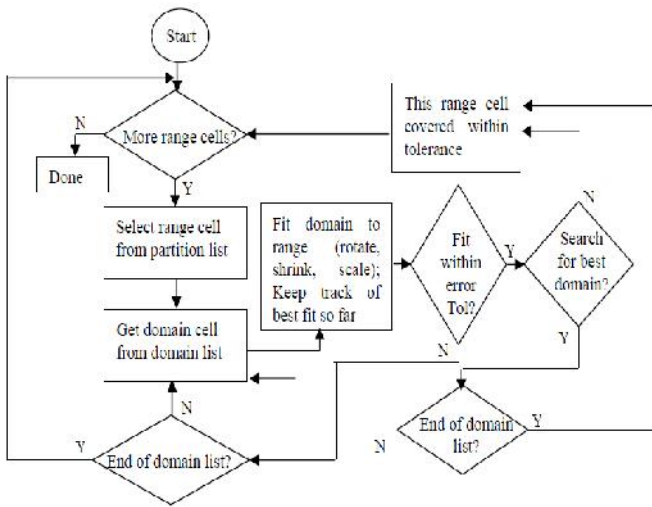


Figure 3: Flow Chart for Fractal Image Compression [13]

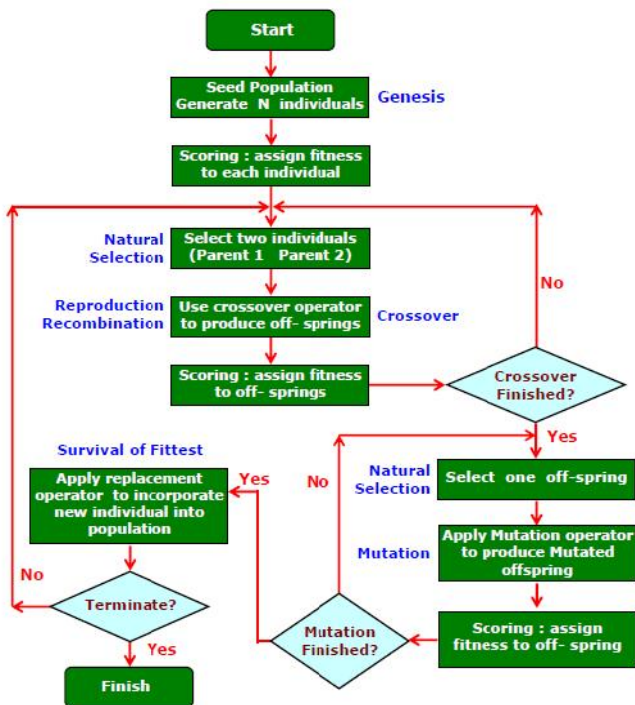


Figure 4: Genetic Algorithm –Program Flow Chart

VI. RESULT AND DISCUSSION

This all below table are shows the different reading of all parameters for the various iteration table 1.1 shows the Encoding time, decoding time and the fitness reading for the fractal image compression with the one point crossover operator of genetic algorithm.

One – Point			
	Encoding Time	Decoding Time	fitness
64*64	3.26E+03	2.98E+03	0.09
128*128	3.78E+03	3.02E+03	0.15
256*256	4.25E+03	3.12E+03	0.25

Table 1.1: Parameter Table for one point crossover

Two Point			
	Encoding Time	Decoding Time	fitness
64*64	3.27E+03	2.43E+03	0.11
128*128	3.71E+03	2.56E+03	0.35
256*256	4.15E+03	2.72E+03	0.34

Table 1.2: Parameters Table for Two point crossover

One-Point						
	a	b	c	d	e	f
w1	0.024	0.42	0.12	0.017	0.34	0.36
w2	0.035	0.65	0.32	0.12	0.14	0.14
w3	0.14	0.45	0.45	0.147	0.24	0.35
w4	0.25	0.034	0.12	0.65	0.26	0.24
w5	0.36	0.015	0.25	0.35	0.24	0.14

Table 1.3: Chromosome for one point crossover

Two – Point						
	a	b	c	D	e	f
w1	0.8147	0.0975	0.1576	0.1419	0.6557	0.7577
w2	0.9058	0.2785	0.9706	0.4218	0.0357	0.7431
w3	0.1270	0.5469	0.9572	0.9157	0.8491	0.3922
w4	0.9134	0.9575	0.4854	0.7922	0.9340	0.6555
w5	0.6324	0.9649	0.8003	0.9595	0.6787	0.1712

Table 1.4: Chromosome For Two point crossover

Iteration	one- point	Two Point
10000	0.432	0.369
20000	0.486	0.394
30000	0.398	0.421
40000	0.427	0.369
50000	0.438	0.432

Table1.5: Iteration Vs Fitness Table

Table 1.2 shows the Encoding time, decoding time and the fitness reading for the fractal image compression with the two point crossover operator of genetic algorithm.

Table 1.3 and 1.4 shows the calculated value of the different parameter of the chromosome block for the different iteration.

Table 1.5 shows our final result which shows the comparisons of the one point and two point crossover applied with the fractal image compression and shows the which one is the better in respect to fitness function reading for the different number of iteration. We show a graph below for show the comparisons result.



VII. CONCLUSION

Fractal image compression has good robustness against the outliers caused by salt and pepper noise. Also, The Optimization method can effectively reduce the encoding time while retaining the quality of the retrieved image. The main drawback of FIC is high computational cost. To overcome this drawback using optimization techniques is utilized to reduced the searching time and also can effectively retrieved the quality of the image. By looking in detail at all the features of Fractal Image Compression using Genetic Algorithm, it is Concluded with the following points:

- Genetic Algorithm finds the best IFS such that decoded image is generated with good PSNR.
- A variable length genotype is used to represent a solution.

In this paper we give a solution for the image compression using fractal image compression technique with the genetic algorithm in our we use the two point crossover operator for the genetic. And our research and simulation shows that in fractal image compression with genetic algorithm and the two point crossover operator gives the better result over one point crossover in same scheme.

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