International Journal of Electrical, Electronics and Computer Engineering **4**(1): 73-81(2015)

ISSN No. (Online): 2277-2626

Fractal Image Compression using Genetic Algorithm with Variants of Crossover

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(Received 10 January, 2015 Accepted 04 February, 2015)

(Published by Research Trend, Website: *www.researchtrend.net)*

ABSTRACT: The use of social media, handheld devices like smart phones etc and other areas of computer world are generating huge and further increasing amount of information in digital form. In addition to existing schemes, still there has been a great demand on providing good quality of digital image compression techniques and its optimization. Therefore, the advanced Image compression methods are not only desired but necessary too. Digital image compression algorithms also utilize the redundancy in an image so that it can be represented using lesser number of bits while still maintaining acceptable image quality. The literature reveals, several schemes are appeared but are not to be effective enough, on controlling all aspects of image quality. This work investigates fractal image compression technique and also proposes a novel image compression scheme based upon Genetic Algorithm (GA). On examining image compression, a global mechanism that can be combined GA and other image compression schemes to succeed parameter alleviation and along with to accomplish application requirement on the other hand. This may be achieved by implementing the GA processes for discovering best possible optimization during Compression process using the different different crossovers methods. The main objective of this thesis is to quantitatively analyze existing and proposed Image Compression Schemes on basis of few parameters including different crossovers. The technique is implemented and simulated with (i) Fractal Image Compression with various images and (ii) Same with proposed Adaptive Genetic Algorithm technique using variants of Crossover. Then, performance of these two techniques were compared on few famous images in various scenarios and also by varying parameters. The result shows that the proposed mechanism outperformed.

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

Chakrapani and 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 noticable 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. Uma *et al.,* [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.

A. 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.

Collage theorem: This theorem states how to get the set connected with transformations that represent a great approximation of settled image. Let wl, w2,..., wn 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:

(i) The closer the transformed image W(1) covers the initial image I, the closer the image I is through the attractor A of the IFS code (W).
(ii) Furthermore, there're especially closer if the transformations are incredibly contractive (i. at the. s is incredibly small).
Encoding procedure: The encoding procedure follows your next steps
(i) Partitioning of the original image directly into N non-overlapping range blocks $\{Ri\}^{N}_{K=1}$
(ii) Tiling of the image into Mirielle (possibly overlapping) domain blocks $\{Di\}^{M}_{i=1}$
(iii) Number of the set connected with allowed transformations Wij.
Then repeat the subsequent procedure for all range block.
(i) Go with a range block R,
(ii) From all combinations of shift and domain stop, select the pair (Wij, Dj) that minimizes the gap d(Ri, Wij(Dj)).

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.
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.

B. 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.

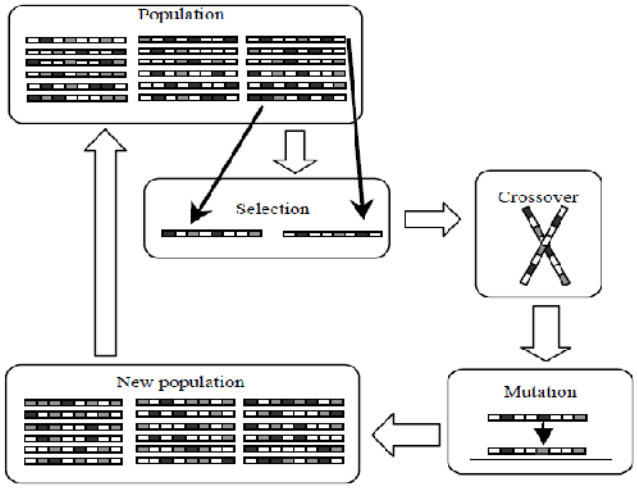

Fig. 1. Genetic Process.

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 where by 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.

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 :

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.

Parent1:11001|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

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]

Parent1:110|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

III. METHODOLOGY

This proposal investigates the Genetic Algorithm based Compression techniques in Image. The breadth of study involves proposal and implementation of Adaptive Genetic Algorithm based Compression technique in Fractal image compression, simulations of these algorithms, collection of simulation data and assessment of the merits of new algorithms and lastly analysis for them. The complete research work was done in IV Phases involving 9-steps including input and output. The phases are shown in Fig. 2.

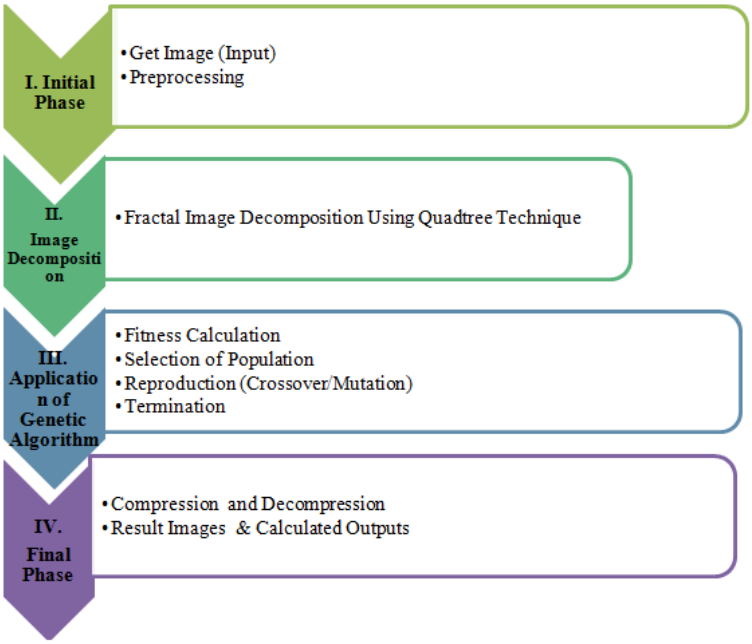

Fig. 2. Phases in Proposed Image Compression.

A. Initial Phase

This phase involves 2 steps: 1. Getting input Image 2. Pre-processing. For the first step two famous images are chosen i.e. Lena image and Cameraman image. The decision of choosing images is based on previous research works. Both the images are easily available on internet in different image formats and dimensions. The RGB and Gray Scale format of images are also available. For this work jpg image file format on Gray Scale is used. Any size of RGB or Gray Scale image can be taken as the tool has some pre-processing tools / commands. To pre-process the images it must be read by the tool. The Pre-processing involves 3 sub-processes:

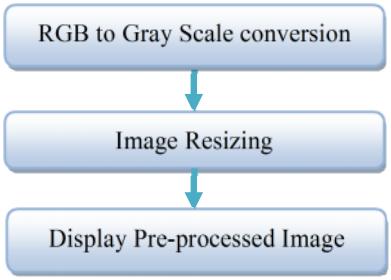

Fig. 3. Pre-processing Steps.

B. Image Decomposition

In this work decomposition and portioning are used in same sense and for this work Quad-tree decomposition technique is used for Fractal decomposition. A general structure for FIC follows the same steps. A sample general structure for FIC and brief description of Quad-tree decomposition is given below:

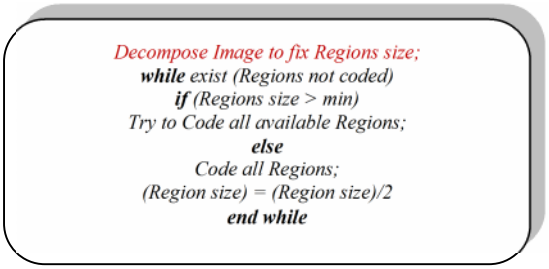

Fig. 4. General Structure for FIC.

C. Application of Genetic Algorithm

This category of algorithm is based upon the natural evolutionary concept through distribution of genome or chromosomes based upon the fundamentals of natural selection & survival of the fittest principal. Genetic Algorithms can be applied to search & optimization problems. The flowchart and algorithm for GA is represented.

D. Final Phase

To significantly improve the performance of simulation programs by converting loops into array operations. The process of conversion is called vectorization. A vector not only runs faster, it is also shorter, and simpler to understand and change. Our Adaptive Genetic Algorithms that are implemented typically uses multiple vectors. As nested loops runs very slowly, many of the nested loops found in a typical GA implementation have been removed from AGA. The proposed code is short, fast and simple.

(i) The proposed algorithm runs many test images and it is found that following set of optimal values of all the algorithm parameters which ensure compromise between execution time and solutions optimality : Population Size=500 ; Maximum generations = 100 ; Genome length = 640; Crossover probability = 1 ;Mutation probability = 0.003.

E. Calculated Outputs

The measures: compression ratio (CR), compression and decompression time, mean square error (MSE) and peak signal-to-noise ratio (PSNR) measured in decibels (dB) were used as performance indicators. Image having same PSNR value may have different perceptual quality. The quality of reconstructed images can be evaluated in terms of objective and subjective measure. In objective evaluation, statistical properties are considered whereas, in subjective evaluation, viewers perceive and inspect image directly to determine the image quality.

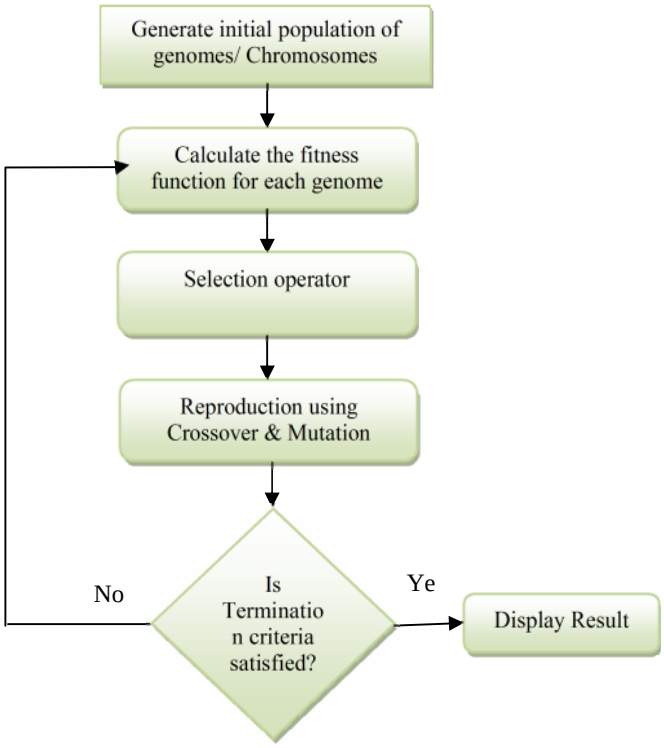

Fig. 4. Flow chart of Genetic Algorithm.

(i) Compression ratio (CR) is a measure of the reduction of the detailed coefficient of the data. CR is defined as number of bits of the original image (B_{org}) per one bit of the compressed image (B_{comp}). Compression ratio can be expressed as:

$$CR = \frac{B_{ORG}}{B_{COMP}}$$

(ii) Compression & Decompression Time. Compression can be either lossy or lossless. Lossless compression reduces bits by identifying and removing statistical redundancy. The process of reducing the size of a data file is referred to as data compression, and time taken for such compression or reductions is compression time. Conversely, the time taken to reconstruct and restore the image is Image Decompression time.

(iii) Signal To Noise Ratio (SNR). Signal-to-noise ratio (often abbreviated SNR or S/N) is a measure used in engineering to quantify how much a signal has been corrupted by noise. It is defined as the ratio of signal power to the noise power corrupting the signal. Signal-to-noise ratio is defined as the power ratio between a signal (meaningful information) and the background noise (unwanted signal):

$$SNR = \frac{P_{SIGNAL}}{P_{NOISE}}$$

(iv) Mean Square Error (MSE). The MSE is the cumulative squared error among the compressed and the original image. A lower value of MSE means lesser error.

$$MSE = \frac{1}{mXn} \sum_{y=1}^{m} \sum_{x=1}^{n} [I(x,y) - I'(x,y)]2$$

Where, I(x, y) is the original image and I‘(x, y) is the reconstructed image and m, n are the dimensions of the image. The lower value of MSE represents lower the error and better picture quality.

(v) Peak Signal to Noise Ratio (PSNR). PSNR is a measure of the peak error. Many signals have very extensive dynamic range, because of that reason PSNR is generally expressed in terms of the logarithmic decibel scale in (dB). The PSNR is defined as:

$$PSNR = 10 * \log_{10}\{\frac{MAX_{I^2}}{MSE}\} = 20 * \log_{10}\{\frac{MAX_I}{\sqrt{MSE}}\}$$

IV. RESULT AND DISCUSSION

These all below Figures and Tables are shown the different readings of all performance parameters for the fractal image compression with the one point crossover operator and two point crossover operator of genetic algorithm.

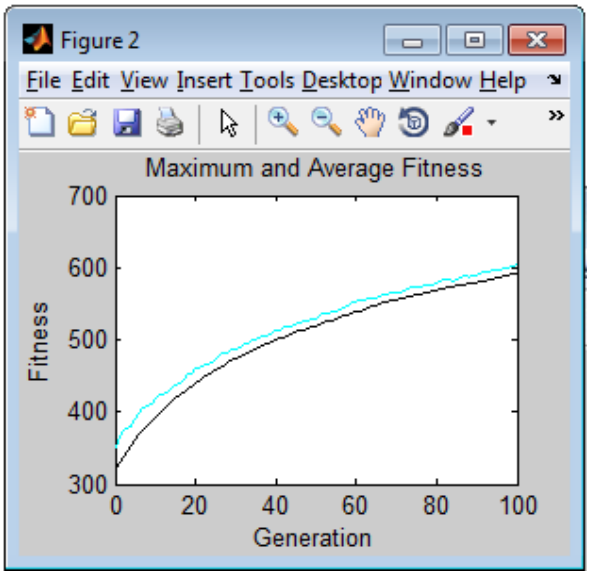

Fig. 5. Number of generations v/s Fitness function with One-Point Crossover.

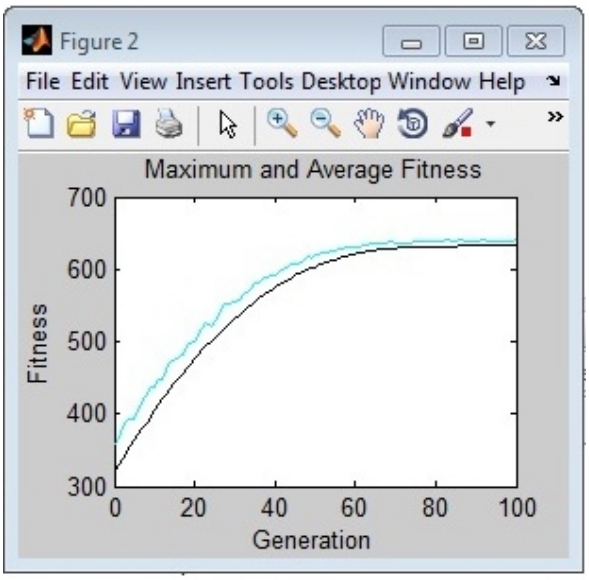

Fig. 6. Number of generations v/s Fitness function with One-Point Crossover.

To see the effectiveness of proposed AGA when applied with traditional technique an important aspect recorded between "Numbers of generations" v/s "Fitness function" using One-point and Two-point Crossover. The graph is shown in Fig. 5 and Fig. 6. The results recorded two types of Fitness values: Maximum and Average. In our results, the average fitness function value achieved is 638, which is in close approximation with Maximum value (640) of fitness function. The numbers of generations (iterations) taken are 100. Fitness Values were found close to maximum values but more in two point crossover than one point crossover as evidenced by the results.

Table 1 : Comparisons using variants of Crossover.

Image Name	**Objective Parameters**	**F I Compression**	**Proposed AGA-F I Compression**	
			1- point Crossover	**2-point point Crossover**
Lena.jpg	CR	13.51	22.07	24.06
	Compression Time	1.78 s	1.39 s	1.11 s
	Decompression Time	17.64 s	8.39 s	8.15 s
	SNR	16.53	13.96	14.97
	MSE	577.13	398.7	499.73
	PSNR	21. 34	22.99	24.43
Cameraman.jpg	CR	14.85	34.75	36.75
	Compression Time	1.70 s	0.79 s	0.79
	Decompression Time	14.81	4.69 s	4.72 s
	SNR	18.73	16.6	15.22
	MSE	237.90	174.38	134.47
	PSNR	20.78	21.49	24.29

The results as shown in Table 1 can be summarized as under-

(i) Appreciable compressions were noticed as Compression ratio (CR) in one-point crossover and two-point crossover were 63.35% and 77.6% respectively, in case of image of Lena whereas 1.4 times and 1.5 times in the image of Cameraman.

(ii) Compression time and decompression time were recognizably reduced in both the crossovers and in both the test images.

(ii) Signal to Noise Ration needs to be optimized with increased Compression ratio

(iii) The reduction in Mean Squared Error (MSE) were noticed to a perceptible level in all the test images and in both types of crossovers

(iv) In both the crossovers and test images and, an increase trend were observed in Peak Signal To Noise Ratio (PSNR) were observed

V. CONCLUSION AND FUTURE SCOPE OF WORK

The present work can be concluded as under-

(i) An Adaptive Genetic Algorithm based Compression Technique was successfully presented

(ii) Existing techniques with new "Adaptive Genetic Algorithm based Compression Mechanism" to improve the quality of digital image

(iii) It demonstrates how Compression Mechanism influence image quality and how various Objective evaluation parameters affect image compression techniques

(iv) The impact of compression and decompression on image has been demonstrated

(v) The evaluation and comparison were examined for performance parameter in proposed approach (technique) with the existing approach via simulation.

Early results given by the simulations and tests of the Thesis are very promising and encourage us to investigate toward the proposed mechanism even further. Based on obtained results the proposed work can be considered a good basis to build upon for further research in the direction of Image Compression. This can include the following:

(i) The suggested mechanism can be evaluated for other quantitative metrics and qualitative metrics in future

(ii) A huge scope of development of the Adaptive Genetic Algorithm based Compression Mechanism

(iii) Formal analysis and evaluation of the proposed framework

REFFERENCE

[1]. A.E. Jacquin. (1992). Image coding Based on a Fractal theory of Iterated contractive Image Transformations. *IEEE Transactions on Image Processing*. Vol. **1**. pp. 18-30.

[2]. A.E. Jacquin. (1993). Fractal Image coding: A *Review Proc. IEEE*. Vol. **81**. pp. 1451-1465.

[3]. M.F. Barnsley. (1988). Fractals Everywhere. New York: Academic.

[4]. M.F Barnsley and A.E Jacquin. (1998). Application of recurrent iterative function systems to images. *Proc. SPIE*. **1001**(3): 122-131.

[5]. I. Rechenberg (1973). Evolutionsstrategie: Optimierung Technischer Systeme nach Prinzipien der biol- gischen Evolution. Frommann-Holzboog Verlag, Stuttgart, 1973.

[6]. Y. Chakrapani and K. Soundara Rajan (2009). "Genetic algorithm applied to fractal image compression"ARPN Journal of Engineering and Applied Sciences Vol. **4**, NO. 1, FEBRUARY (2009).

[7]. Xiangjian He, Huaqing Wang, Qiang Wu, Tom Hintz and Namho Hur, (2006). Fractal Image Compression on Spiral Architecture, *Proceedings of the International Conference on Computer Graphics, Imaging and Visualisation (CGIV'06).*

[8]. H. Wang, Q. Wu, X. He and T. Hintz, (2006). "A novel interactive progressive decoding method for fractal image compression", *International Conference on Innovative Computing, Information and Control (IEEE ICICIC2006).*

[9]. Ali Nodehi, Mohamad Tayarani, Fariborz Mahmoudi (2009). A Novel Functional Sized Population Quantum evolutionary Algorithm for Fractal Image Compression *Proceedings of the 14th International CSI Computer Conference (CSICC'09).*

[10]. K. Uma, P.Geetha palanisamy, P.Geetha poornachandran (2011). "Comparison of Image Compression using GA, ACO and PSO techniques**"** IEEE-International Conference on Recent Trends in Information Technology, ICRTIT 2011 978-1-4577-0590-8/11/$26.00 ©2011 *IEEE MIT, Anna University, Chennai*. June 3-5, 2011.

[11]. *Fundamentals* of Genetic Algorithms : AI Course Lecture 39 – 40, notes, slides www.myreaders.info/ , RC Chakraborty, e-mail rcchak@gmail.com , June 01, 2010 www.myreaders.info/html/artificial_intelligence.html.

[12]. Faraoun Kamel Mohamed BOUKELIF Aoued (2005). "Optimization Of Fractal Image Compression Based On Genetic Algorithms" *3rd International Conference: Sciences of Electronic, Technologies of Information and Telecommunications,* March 17-21, 2005 – TUNISIA

[13]. Wen-Yang Lin,Wen-Yuan Lee And Tzung-Pei Hong (2003). "Adapting Crossover And Mutation Rates In Genetic Algorithms*" Journal Of Information Science And Engineering* **19**, 889-903 (2003).