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Comparative Analysis of Image Compression Techniques

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ABSTRACT
An approach to diminish the memory size of an image while retaining the optic quality of the image is termed as image compression .Generally, it is a way to dispose off unwanted bits of an image. To eliminate the non essential facts of the image is the prime target of image compression techniques. This paper covers contrastive analysis of distinct techniques of image compression by contagious toward the environment, enhancements as well as metrics like Bit Per Error (BER), Root Mean Square Error (RMSE) to figure out the efficacy of several extant feasible approaches. This analysis has manifested that Particle swarm optimization interpolate precise symbolic arrangement over the applicable approaches but due to its limited performance it also becomes barrier for other image compression approaches. This paper winds up along the appropriate destined orientation to ameliorate the extant image compression method. .

Keywords
Particle swarm optimization, image compression, PSNR, MSE, BER, RMSE, compression ratio.

1. INTRODUCTION
Image compression is the approach that enables the rapid browsing and retrieval of image from database .Image compression aims at reducing the repository range, communication period forthwith accomplish immense compression ratio [1].Predominantly, It is a significant aspect in the field of image processing due to its application. [2]Uncompressed images need large storage capacity transmission time where chances of repetition are also high. [3] There are multifarious standards for image compression such as JPEG JPEG2000, MPEG and CCITT. Different functions such as entropy encoding, color space conversion are included by these compression standards. The overall objective of image compression is to eliminate the non essential information while confining the quality of the image. [4]Multifarious performance metrics in image compression are used to assay the quality of rebuild image. [5]

2. CLASSIFICATION OF IMAGE COMPRESSION

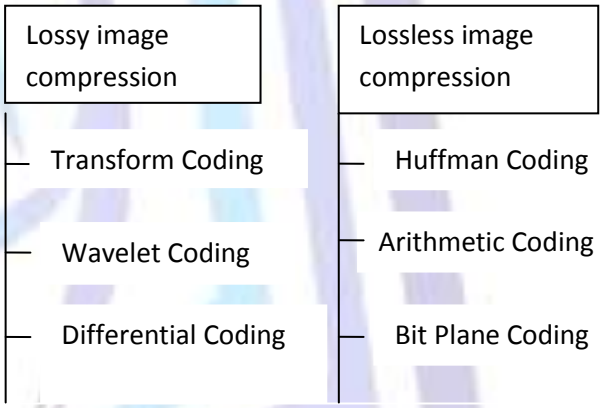

Figure 1: Two broad categories of image compression

2.1 Lossy Image compression
If the reduction of non essential information causes the loss of fine details of the image is termed as lossy image compression. It constrict on the size contraction rather than details of the image. Videoconferencing, Xerox, broadcast television are the main aspects where lossy image compression is used. A lossy image compression allows certain extent of errors. It leads to increase the compression performance. [6]

2.2 Lossless Image compression
If apostrophe reductions do not contribute any deficit of facts in the primary image is termed as lossless image compression. Entropy encoding is another name of lossless image compression. It helps in the storage of legal or medical records. High compression ratio cannot be achieved by it. It gives exact reconstruction and also called reversible compression [6].

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3. OPTIMIZATION TECHNIQUE OF IMAGE COMPRESSION

3.1 Particle Swarm Optimization (PSO)

PSO is a probing method. It focused on the counterfeit of familiar dealing of bird congregation particles aviate in the search space to find the most favorable solution. [7] Most of the conventional optimization techniques have evaluated the first order derivatives to find the best solution. Many difficulties occur in evaluation of first order derivates. PSO can be accomplished to settle multifarious function optimization problems. Each particle aviates towards a best solution by entire swarm. The performance of each particle is measured using fitness function. [8]

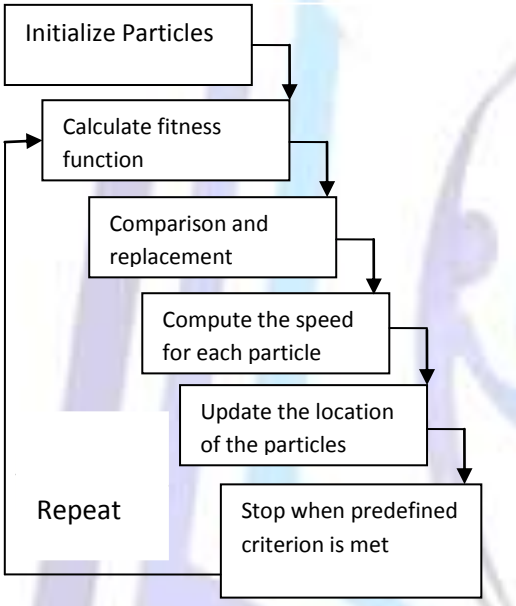


Figure 2: Particle Swarm Optimization

Brief explanation of PSO algorithm:

$$S_m^{u+1} = MS_m^u + T_2 * arb_1 * (pBest_u - ppointt_m^u) + T_2 * arb_2 * (gBest - ppoint_m^u) \quad (1)$$

$$ppoint_m^{u+1} = ppoint_m^u + S_m^{u+1} \quad (2)$$

Where

S_m^u	Particle m of velocity
S_m^{u+1}	Velocity at iteration u+1
M	inertia weight
arb_1	Arbitrary number between 0 and 1
$ppointt_m^u$	Present point of particle at iteration u
$ppoint_m^{u+1}$	Location of particle at iteration u+1
$pBest_u$	Finest location of particle m
$gBest$	Location of finest particle in a swarm
T_2 And T_2	Acceleration with coefficients.

3.1.1 Multifarious applications based on PSO

Travelling salesman, Data mining, Telecommunication, Combinatorial optimization, Signal processing, Image processing and pattern recognition problem Mobile networking.

Table 1: Variants of PSO

Year	Variant	Author
1998	Inertia Weight	Shi
2002	Constriction Factor	Clrec
2007	Initialization	Nguyen et al.
2007	Mutation Operators	Wang et al.

3.2 Genetic Algorithm (GA)

GA is a speculative algorithm that acts as a process of natural evolution. [7] GA is very effective to finding new favorable solutions in extreme large search space in a definite time.[11] Genetic Algorithms are built on the work of predictable select. GA is considered to be flexible method. In the case of evolution, alter the one population of chromosomes to a new population by applying natural selection. [7][10]

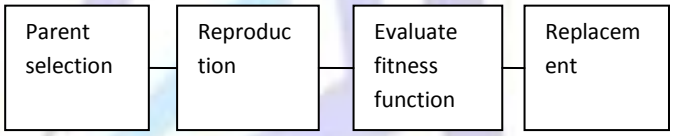


Figure 3: Block diagram of GA

3.2.1 Multifarious applications based on GA

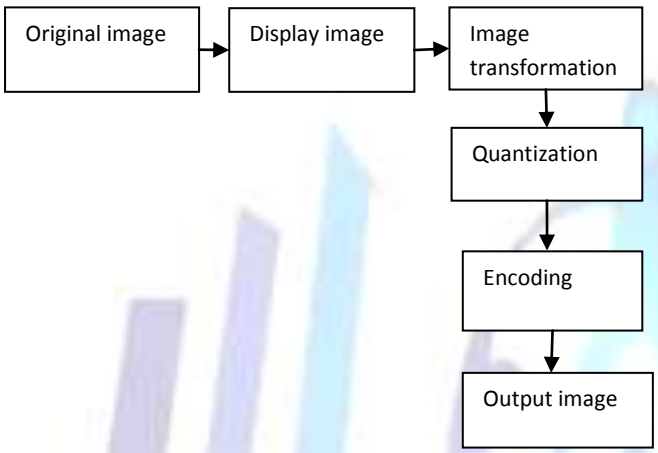
Signal processing, finding shape of protein molecule, Travelling salesman, Strategy planning, Graph coloring

Table 2: Variants of GA

Year	Variant	Author
1970	Chromosomes Representation	John Henry Holland
1993	Elitism	Horn et al.
1195	Adaptive GA	Horn et al.

3.3 Discrete Wavelet Transform(DWT)

DWT accomplish multi resolution of signals and depend upon time and frequency representation. Discrete Wavelet Transform breaks down the signals into low resolutions. [9] DWT can be distinguish as High pass filter and low pass filter In DWT, primitive image crumble into four wavelet coefficients that symbolize as approximation sub band, angled sub band, upright sub band and horizontal subband.[6]



Fi gure 4: Block diagram of DWT

3.3.1 Multifarious applications based on DWT

Video and Signal coding, Signal processing, Numerical analysis, Computer graphics, Radar target distinguishing multimedia

3.4 Huffman coding (HC)

HC is a lossless image compression technique. HC is broadly used to maximize the coding efficacy. In Huffman coding small count of bits used to encrypt the facts take place repeatedly. [3]

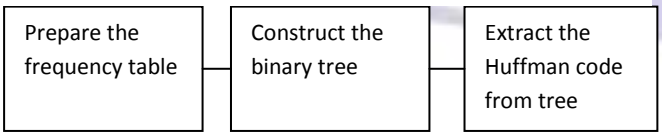


Figure 5: Huffman coding technique

3.4.1 Multifarious applications based on HC

Streganography, JPEG, MPEG, ZIP file types used

Table 3: Variants of HC

Year	Variant	Author
1959	Length Limited HC	Gilbert
1959	Huffman Template HC	Gilbert & Moore
1973	Adaptive Huffman coding	Faller

3.4 Ant Colony Optimization (ACO)

ACO is a model for resolving computational complications. The vital characteristic of ACO is the aggregate of earlier facts about the order of promising solution with rear facts about the order of former acquire good solutions.[7] To resolve the adversity as the analyze for least cost route in a graph is the prime target of Ant Colony Optimization

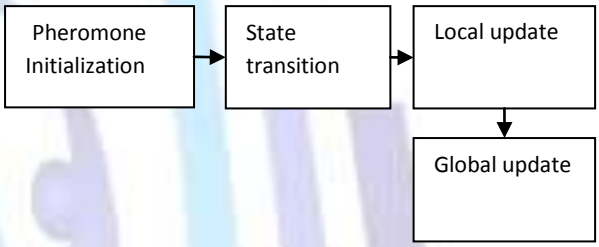


Figure 6: Steps of ACO

3.4.1 Multifarious applications based on ACO

Travelling salesman problem (TSP), stochastic problem Network routing

Table 4: Variants of ACO

Year	Variant	Author
1991	Ant System	Dorigo et al.
1996	MAX-MIN	Hoos et al.
1996	Ant Colony System	Dorigo
2001	NNS1,NNS2,NNS3	Hoos et al.

4. RELATED WORK

Diminish the nonessential wavelet coefficients that directed to considerable compression ratio while keeping the quality of an image. [1] Image compression has multifarious applications. It needs to reduce communication time and bandwidth utilization. [2] In HC, coding redundancy can be discarded by electing an appropriate method of appointing the codes and principal component analysis builds up the image.

[3] Unified the particle swarm optimization and genetic algorithm compression techniques in wavelet transform diminish the blocking artifacts in images. Particle swarm optimization gives poor result when particles unfairly picked and genetic algorithm do not assured the global optimized results. [4] Developed Three KG versions of image compression termed as KG1, KG2, and KG3. The techniques have dissimilar way to compress the image. [5] Proposed new compression approach using discrete wavelet transform which provides less computational complexity. Several performance metrics like peak signal to noise, mean square error used to figure out the quality of an image. [6]To overwhelmed the flaws of fractal image compression by applying optimization technique diminish the seeking time. Ant colony optimization technique gives best result as contrast to others. [7]Consolidate Image compression algorithms that endow a new episodic method named as SRG-PSO. This method decrease the encoding time and provide good compression ratio. [8] Discussion of image compression approaches employing Huffman coding and discrete wavelet transform. Discrete performance metrics are enforced on these algorithms to get the result that fractal algorithm proficient image compression technique. [9] Fractal image compression of lossy compression is mainly used due to its easy way of quantizing sub-frames in the image. Genetic algorithm raises the search time to acquire more appropriate rational numbers with reduced form. [10] Proposed genetic algorithm with ranking select mechanism to reduce the encoding time and maintain the image quality. [11] Concatenate the image compression method with arithmetic and Huffman lossy approaches to emend the compression ratio. [12] Symbolic amount of correlation present in the medical images to attain good compression ratio. Memory assisted compression technique to compress recent image from identical family. This technique also acquiesce each image to be treated unrestrictedly of other image and hence acquiesce individual image route and communication. [13] Mammography and country wide screening are two diagnostic tools for prior exposure of breast cancer. Both requires large amount of storage to reserve mammograms. Lossless image compression of mammograms will diminish the storage capacity and faster the communication time. [15]Three versions KG techniques termed as KG1, KG2, KG3 to compress image in dissimilar way. Compression ratio of image in KG techniques is dissimilar and excellent to each other which rely on what type of image is used for compression. [16] A new approach termed as pseudo distance technique in lossless compression is used for parallelization of pseudo distance technique and for diminishes compression time. [17] Contrastive study of particle swarm optimization and ant colony optimization to increase the performance. More potentiality for vigorous concluding the most excellent target done by ACO and to embellish PSO with robust function to check out either PSO helps in embellishing performance or not.[18] new fractal coding algorithm using ant colony algorithm has improved performance metrics and acquires identical compression ratio of the blocked based system. But the compression time is diminished greatly. [19] Hybrid fractal algorithm with ant colony algorithm which diminishes the fractal coding time extremely and acquires better compression ratio. [20] [21]

Table 5. Comparison of image compression techniques

Technique Name	Ref. No.	Year	Enhancement	Benefits	Limitations	Metrics
Particle Swarm Optimization	[4]	2015	PSO-GA	Reduction of blocking artifacts	PSO gives poor results if initial particles length is small and GA do not guarantee global optimal solution	MSE,PSNR, BER,RMSE
	[8]	2010	PSO-SRG	Reduced compression ratio	Segmented image compression method do not give lowest compression ratio	Compression ratio
	[7]	2011	PSO-GA-ACO	reduce encoding time while retaining image quality	Compression ratio high	Compression ratio
	[18]	2011	PSO-ACO	Fitness sharing Easy	Probability distribution changes by iteration in ACO	Compression ratio

(PSO)	[2]	2015	PSO-DWT	Reduce source entropy	If length of initial particles is small then gives poor result	PSNR ,MSE
Genetic algorithm (GA)	[10]	2015	GAO	the rational numbers with shorter reduced form	Do not guarantee global optimization	Compression ratio
	[11]	2015	GA-RSM	Encoding time reduced while retaining the quality of image	Complex in nature	PSNR,MSE
Discrete Wavelet Transform (DWT)	[1]	2015	DWT-TH	Better compression ratio	Not suitable for JPEG format images	-
	[6]	2014	DWT survey	Reduce computational complexities	Not suitable for JPEG format	compression ratio
Huffman coding (HC)	[3]	2014	HC-PCA	Remove coding redundancy	Compression ratio is limited	PSNR compression ratio, MSE
	[9]	2015	HC-DWT-FC	HC remove coding redundancy DWT improve quality of image FC gives better compression ratio	Huffman coding gives limited compression ratio	Compression ratio, MSE,BER,SNR
Ant Colony Optimization (ACO)	[19]	2008	ACO- FC	Compression time reduced	Time to convergence uncertain	PSNR compression ratio
	[20]	2014	Hybrid ACO-FA	Fractal coding time decrease	Higher compression time	Compression ratio

4. GAPS IN LITERATURE

1. The performance of PSO is restricted to primary set of particles. Therefore, it may produce poor results, if primary particles length is small or they wrongly selected
2. The genetic algorithm does not assure the global optimal solution
3. The hybridization of PSO-GA do not consider the effect of ringing artifacts in digital image

5. CONCLUSION

Distinguish between the multifarious image compression techniques results that PSO relinquish better results as compare to other techniques. Particle Swarm Optimization assure the global optimal solution.PSO relinquish suitable compression with limited distortion.PSO also abate the encoding time. But PSO gives indigent results if particle range is too small or large.

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