Comparative Analysis of Lossless Image Compression: A Review

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Abstract

Lossless flag & image compression is essential for some applications where immaculate exactness is required. The proficient stockpiling & correspondence of medicinal images is one of the fundamental uses of lossless image compression. In this work we propose another wavelet-based lossless image coder that depends on a cutting edge calculation, to be specific SPIHT (set apportioning in progressive trees). An algorithmic adjustment is acquainted all together with increment its effectiveness. An enhanced lossless coding technique for the notable wavelet change based calculation SPIHT is introduced named ESPIHT. This strategy keeps up the capacity of dynamic transmission & produces a completely implanted piece stream. The outcomes acquired on various dark scales & shading images demonstrate noteworthy enhancements of the proposed coder over the traditional SPIHT.

Key words : Lossless Image Compression, SPIHT , PSNR , Compression Ratio

I. Introduction

Advanced picture might be lossless or lossy relying on the nature of pictures. For restorative picture, funnies and specialized illustration, lossless picture pressure is utilized. These strategies are utilized extraordinarily for high piece rate exchange of a picture. The most widely recognized nature of a computerized picture is that area pixels are tangled to the primary pixels. Henceforth, neighborhood pixels have repetitive data [1]. Picture pressure has two segments, one is excess and another is Irrelevancy. The duplication of a picture is evacuated by the repetitive part. A flag created by human visual framework by the utilization of unimportance part. Since the constraint of transmission capacity and rapid information exchange picture pressure method is utilized. There are two procedure include amid the transmission of information. One is information encoding and another information translating. Encoding, known as pressure include decrease of bits from the first message or picture. It implies decrease the extent of information because of band impediment of channel.

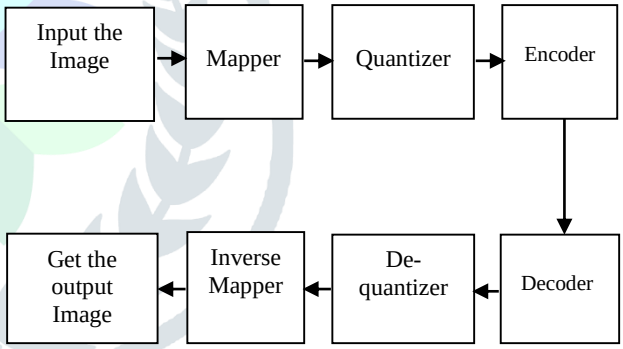

Figure 1: Steps of Image Compression and Decompression [2]

In the collector end, invert process happen. That procedure is known as decompression or disentangling. It intends to recuperate the uncompressed information from the packed information. The lossless pressure is otherwise called reversible pressure, on the grounds that in lossless pressure strategy we get the last yield precisely same as the info [1]. Figure 1 demonstrates the means for Image pressure and decompression.

As shown in Figure 1, first of all input image is taken from the data set. Then image is fed to the Mapper. Mapper convert the input image into inter pixel coefficients. Quantizer reduced these inter pixel coefficients into small values or we can say Quantizer convert large values into small values so it results some kind of data loss. Entropy encoder compressed these Quantized values and improves the compression.

Image compression may be lossy or lossless. Lossless compression is favored for recorded purposes and routinely for helpful imaging, particular outlines, cut workmanship, or funnies. Lossy pressure systems, especially when used at low piece rates, present pressure antiquated rarities. Lossy systems are especially suitable for standard pictures, for instance, photographs in applications where minor loss of unwaveringness is qualified to achieve a liberal decline in bit rate. Lossy pressure that produces irrelevant complexities may be called ostensibly lossless.

The rest of research paper is design as follows. The overall previous work is described in Section II. Section III describes problem formulation. Performance parameter describe in section IV. Finally, Section V describes the conclusion of paper.

II. LITERATURE REVIEW

Many researchers have adopted different methods for lossless image compression and described in following section.

Saif alZahir, *et.al.* in 2011 introduced a novel calculation for packing literary pictures is exhibited. As of late, an unparalleled volume of printed data was transported over the Internet through email, visiting, blogging, twittering, computerized libraries, and data recovery frameworks. As the volume of content information has surpassed 40% of the all out volume of traffic on the Internet, compacting printed information winds up objective. Numerous calculations were presented and utilized for this reason including Huffman encoding, math encoding, the Ziv-Lempel family, Dynamic Markov Compression, and Burrow-Wheeler Transform. The calculation includes two sections: (I) a fixed– to– variable codebook; and (ii) line and segment decrease coding plan, RCRC. Reproduction results on countless literary pictures demonstrate that this calculation has a pressure proportion of roughly 87%, which surpasses distributed outcomes including those of JBIG2.[1]

Suny Fredonia, *et.al*. in 2012 proposed another strategy, an altered pseudo-remove procedure, for shading mapped picture pressure. There are a few systems that yield preferable pressure results over GIF and PNG; nonetheless, a few calculations require two passes on the picture information, while some don't keep running in direct time. In contrast to these strategies, the pseudo distance procedure requires one pass and keeps running in straight time. Likewise, understood 2-D pressure plans, for example, JPEG-LS and CALIC neglect to yield preferable pressure over GIF or PNG, because of the way that the pixel esteems speak to files that point to shading esteems in a gaze upward table.[2]

Rasha Adel Ibrahim, *et. al*. in 2015 presented an improved model coordinating quantized quad trees and Entropy coding utilized for fractal picture pressure. Fractal pressure is a lossy pressure strategy for advanced pictures dependent on fractals as opposed to pixels, which are most appropriate for surfaces and common pictures. It takes a shot at self - similitude property in different

divisions of pictures, depending on the way that pieces of a picture frequently look like different pieces of a similar picture. It requires Long encoding investment and influences the picture quality. Quantized quad tree technique separates the quantized unique dim dimension picture into different squares relying upon an edge esteem other than the properties of the highlights exhibited in picture. Entropy coding is connected for improving the pressure quality. Recreation results demonstrate that the quantized quad trees and entropy coding improved pressure proportions and quality got from the fractal picture pressure with range square and emphases method. Distinctive quantitative measures can be found by passing pictures of various arrangement and dimensions [3]

Thafseela Koya, *et. al.* in 2016 thought about between two most recent works in the picture pressure in particular, An Efficient DCT-Based Image Compression System Based on Laplacian Transparent Composite Model and An Innovative Lossless Compression Method for Discrete-Color Images. The primary target of picture pressure is to reduce the quantity of bits required to speak to a picture by disposing of the spatial and phantom redundancies. Picture pressure is named lossy and lossless pressure. An Efficient DCT-Based Image Compression System Based on Laplacian Transparent Composite Model lessens the pressure rate by 25% on account of pictures, contrasted with JBIG2. It is additionally seen that this methodology is more qualified for customary pictures like Lena and Goldhill while An Innovative Lossless Compression Method for Discrete-Color Images is more qualified for outlines and maps [4]

Chuanmin Jia, *et. al.* in 2016 contributed a novel picture quality upgrade calculation dependent on convolutional arrange is proposed for low piece rate picture pressure. Specifically, a down example technique is performed to create lower goals picture for low piece rate pressure. While the decoder side, up test is to be performed firstly to the first goals. Picture quality is additionally improved by the proposed convolutional profound system. Specifically, a discretionary picture quality improvement system can be used for further upgrade after the first organize. With the assistance of profound system, progressively point by point and high-recurrence data can be recouped while keeping up the consistency of form territory, prompting better visual quality. Another benefit of this methodology lies in that the proposed methodology is completely perfect with all outsider picture codec pipeline. Test result demonstrates that the proposed plan significantly outflanks JPEG in low piece rate picture compression[5]

Ahmed A. Nashat, *et.al*. in 2016 utilized Haar wavelets as the premise of change capacities. Haar wavelet change is made out of a succession of low pass and high pass channels, known as channel bank. The repetition of the DWT detail coefficients are diminished through thresholding and further through Huffman encoding. The proposed limit calculation depends on the measurements of the DWT coefficients. The nature of the compacted pictures has been assessed utilizing a few variables like Compression Ratio, (CR), and Peak Signal to Noise Ratio, (PSNR). Test results exhibit that the proposed procedure gives adequate higher pressure proportion contrasted with other pressure thresholding strategies. Discrete Wavelet Transform, (DWT), is known to be a standout amongst the best pressure strategies. It gives a scientific method for encoding data so that it is

layered by dimension of detail [6]

Ryan Rey M. Daga, *et.al.* in 2017 proposed to improve KTS-BTC by actualizing adjustments: (1) usage of Huffman Coding, and (2) encoding RGB values utilizing shaved piece strings speaking to numbers that are separable by a pre-characterized intensity of 2. Transmitting and putting away advanced pictures have data transmission and plate space necessities. Lessening the document size of these pictures empowers quicker transmission of information and expands the quantity of pictures that can be put away in a similar measure of circle space. Block truncation coding (BTC), one class of pressure method, is regularly utilized for its low computational multifaceted nature which make it reasonable for various applications. An as of late proposed pressure strategy, alluded to as *k*-d Tree-Segmented BTC (KTS-BTC), had the capacity to lessen the bit rate of the compacted picture while keeping up picture quality[7]

Lu Yu, *et. al.* in 2017 proposed a novel strategy for the lossless pressure of the interferometer hyperspectral instrument Large Aperture Static Imaging Spectrometer (LASIS) information is displayed. This plan settles upon the blend of information improvement and band requesting of LASIS 3-D picture and the as of late displayed CCSDS-123 lossless multispectral and Hyperspectral picture pressure standard. Right off the bat, the LASIS information is revamped from the photograph procurement arrange to the optical way contrast (OPD)image organize by the improve way to deal with evacuate the impedance data superimposed on the picture. At that point the OPD band is reordered by the interferogram trademark to improve the connection between's neighboring groups. At long last, the reordered OPD band information is prepared utilizing the CCSDS-123 standard[8]

Devee Darshani Panda, *et.al*.in 2017 exhibited a vital report on various picture pressure procedures with their subjective and quantitative examination. Because of the information transmission and capacity requirements it is fundamental to pack the pictures before transmission. While the picture quality gets debased because of the decreased size and data misfortune. So the recuperated pictures suffer with the ruined picture quality and high pressure proportion. The execution assessment of various lossy and lossless pressure procedures are done through a test picture with various execution estimating parameters like PSNR , MSE, CR and BPP[9]

Qingyu Zhnag, *et. al*. makes starter contemplates on a profound system based picture coding plan in this paper. Pictures on the Internet are more often than not as packed bitstream to spare stockpiling. To fulfill content-based picture re-trifling (CBIR), picture highlights are additionally required to be put away in parallel structure. The first train a profound system for compacting pictures into bitstream, and after that train another profound system for extricating picture includes as paired vector. Their trial results demonstrate that the proposed plan accomplishes a pressure of 5.3 for 32×32 thumbnails, beats JPEG at comparable pressure proportions, and the subsequent code is straightforwardly accessible for CBIR. Their work shows a promising heading of synchronous picture pressure and retrieval[10]

Yuzhang Lin, *et. al*. in 2018 proposed an assignment based picture pressure metric, inside the JPEG 2000 system, which safeguards the data that is most important for a given undertaking. Conventional picture pressure techniques

essentially center around augmenting a picture quality-based measurement of the packed picture, which are appropriate for human onlookers yet not really for machine eyewitnesses, for example computerized picture abuse calculations that understand undertakings, for example, classification. The assignment specific data (TSI) is determined as the shared data between information (X) and class name (C) in the wavelet area for each sub-band. A heuristic TSI-based rate portion calculation is created to decide quantization step estimate for each sub-band with the end goal that the complete file measure is limited, while safeguarding much TSI as could be allowed. Our proposed strategy delivers a JPEG 2000 consistent compacted code stream, which can be decoded by any JPEG 2000 agreeable decoder[11]

Uthayakumar J, *et. al*. in 2018 has utilized a satellite picture dataset which comprises of 2800 pictures of boats in satellite symbolism with ship or no-deliver order. Satellite pictures are bigger in size and it needs high measure of storage room and transmission time. There is a more prominent test to store or transmit the satellite pictures from the satellite to earth station. Picture pressure methods have developed to viably process the pictures with mediocre or no misfortune in quality. The satellite pictures can be compacted to deal with the storage room and correspondence data transfer capacity. In spite of the fact that few explores have been done on pressure of characteristic pictures, just few have focused on satellite pictures. The idea of satellite pictures represents a more prominent test to pack satellite pictures. To do this work, the current picture pressure procedures, for example, Lempel Ziv Markov chain Algorithm (LZMA), Burrows Wheeler Transform (BWT), Deflate and LZ77 are contrasted with each other. The examination results suggest that LZMA accomplish preferred pressure over different techniques with the pressure proportion, pressure factor and pressure time of 0.5666, 1.765 and 53 seconds respectively[12]

Table1. Literature Review Table

Ref	Research Methodology used	Major Findings	Advantages	Disadvantages
[1]	Huffman codes The Codebook Model The Row and Column Reduction Coding scheme	Compression Percentage Huffman Code : 95.00%. JBIG2 : 95.10 %	It has a compression ratio of approximately 87%, which exceeds published results including those of JBIG2	Cannot compress their font size
[2]	Modified pseudo-distance technique color-mapped image compression	Improvement GIF : 64% PNG : 12%	Pass and run in linear time	Not suitable for GIF and PNG
[3]	Fractal Image Compression Followed by 1. Affine Transformation 2. Contractive Transformation	PSNR Satellite Rural Image:33.01 Satellite Urban Image : 29.05 Encoding Time Satellite Rural	Improved compression ratios and quality of images	Does not work on different-similarity property

		Image: 16.90 sec Satellite Urban Image : 12.73 sec		
[4]	Laplacian Transparent Composite Model Proposed CALBIC	compression rate reduce by 25% Compression Rate JBIG2:20616 CALBIC: 14739 BPP JBIG2:0.029 CALBIC:0.019	Diminish the number of bits required to represent an image by eliminating the spatial and spectral redundancies	reduces the compression rate by only 25% in the case of images, compared to JBIG2.
[5]	Caffe Package Dataset Artifact Reduction convolutional neural network Method	BPP Rate For Code Rate CR= 0.15 :26.84 CR=0.2 :28.27 CR=0.25 : 29.03 CR=0.3 :29.67 CR=0.35 :30.31	Fully compatible with all third-party image codec pipeline	Cannot outperforms JPEG in high bit rate image compression.
[6]	Haar transform DWT & Huffman Coding	RMSE:6.45 Wavelet CR :6.52 W&H CR :37.69 PSNR :31.94	Provides sufficient higher compression ratio compared to other compression thresholding techniques	Does not provide the redundancy of the DWT detail coefficients.
[7]	1. Block Truncation Coding 2. Absolute Moment Block Truncation Coding 3. K-d Tree-Segmented Block Truncation Coding	PSNR Image 1 : 31.80 Image 2 : 34.52 Image 3 : 34.18 Image 4 : 32.05 BPP Image 1 : 2.76 Image 2 : 1.81 Image 3 : 2.99 Image 4 : 4.24	Reduce the bit rate of the compressed image while maintaining image quality	increase in MSE was small and bounded, there is also small reduction in the image quality.
[8]	1. Data Rearrangement 2. OPD Band Ordering 3. Prediction 4. Encoding	Compression Ratio: 3.21 Improvement : 31%	The interference information superimposed on the spatial images LASIS data can be separated using the proposed rearrange method.	Cannot obtain the band ordering at the Ground station based on the proposed compression scheme.
[9]	DPCM Huffman SPHIT	PSNR DPCM:48.07 Huffman:26.13 SPHIT:30.99 MSE	Compress the images before transmission	Image quality gets degraded due to the reduced size and information

		DPCM:4.09 Huffman:2.85 SPHIT:51.70 CR DPCM:0.25 Huffman: 27.89 SPHIT:2.58		loss.
[10]	UK Bench dataset Deep network-based image coding scheme VGG-2 network Combined Network and Fine tuning	Average file size : 576 Average compression ratio :5.3 Average PSNR :23.39	Achieves a compression of 5.3 for 32×32 thumbnails, outperforms JPEG at similar compression ratios	Effect of errors in transmission
[11]	Task-based image compression	Compression Ratio : 40%	Preserves the information that is most relevant for a given task	Produces image quality which is not suitable for machine observers.
[12]	Satellite imagery dataset LZMA Technique	Compression Ratio :0.5666 Compression Factor:1.765 Compression Time :53sec	Inage can be compressed to manage the storage space and communication bandwidth	Added complications

III. Problem Formulation

Lossless & close lossless compression are commonly done by methods for forecast based methodologies, i.e., the information are decorrelated by methods for a straight or nonlinear indicator, & the expectation blunder tests are then bolstered to an entropy coder. Since these examples commonly show some remaining relationship, setting based entropy coding is normally completed. In this setting, the examples are characterized into a predefined number of measurably homogeneous classes dependent on their spatial or unearthly setting; as an outcome, the entropy of the setting molded model will be lower than that of the stationary memory-less one, & the entropy coder will give enhanced compression. It merits seeing that, in lossy or close lossless compression, the decoder must make indistinguishable characterizations from the encoder; this necessitates the settings are registered on the quantized & not the first information. Grouped versatile expectation has appeared to give great outcomes versatile choice of versatile indicators & versatile mix of versatile has been connected to images.

IV. Performance Measurement

The performance parameters are measured in relations of CR, PSNR & MSE.

A. Compression Ratio (CR)

CR is the ratio between post compression file size and pre compression file size. For any algorithm compression Ratio (CR) should be higher [14].

$$\text{Compression Ratio} = \frac{\text{Size after Compression}}{\text{Size before Compression}}$$

B. Peak Signal to Noise Ratio (PSNR)

It is the ratio between max signal power to noise encountered in signal. PSNR should be higher for any algorithm.

$$\text{PSNR} = 10 \log_{10} \frac{M \times N}{MSE^2} \quad |\text{db}|$$

Where M×N is the resolution of uncompressed image [14].

C. Mean Square Error (MSE)

MSE defined Mean Squared Error between compressed image and original image. MSE should be lower for any algorithm. If MSE is 0 that's mean compressed image is similar to uncompressed image and is given by

$$MSE = \frac{1}{MN} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} [\, f'(i,j) - f\,(i,j)]^2$$

f' (i , j) is function of compressed image and f (i ,j) is the function of original image [14].

V. Conclusion

In this review paper different image compression techniques with its simulation parameters PSNR, Compression Ratio and compression time are studied. The different techniques are used to improve the performance parameter. These images are used for personal and commercial used. ESPHIT is more efficient than other image compression technique like quad tree partition technique, syntax based arithmetic coding. In context to complete survey it is clear that ESPHIT have less time complexity in comparison to RBF kernel technique.

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