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Image Compression: A Survey

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Abstract: Image Compression is a demanding field in this era of communication. There is a need to study and analyze the literature for image compression, as the demand for images, video sequences and computer animation has increased at very high rate so that the increment is drastically over the years. Multimedia data whether graphics, audio, video data which is uncompress requires considerable transmission bandwidth and storage capacity. So this leads to the need of compression of images and all multimedia applications to save storage and transmission time. In this study we discuss different compression algorithms used to reduce size of images without quality reduction.

Keywords: Compression, image, lossless, lossy, review

INTRODUCTION

An approach of reducing the volume of graphics file in bytes without influenced image quality to unacceptable level. This minimization in size enables more images storage in an available memory space and cut down the transmission duration that is demanded by an image to be downloaded over the Internet. Compression can be classified in to two types Lossy and Lossless compression (Mudassar Raza *et al*., 2012; Naeem *et al*., 2008) technique. In Lossless compression there is no information loss and the image also retains its quality it can be remodeled exactly the same as the original. Main application is Medical imagery (Masood *et al*., 2012).

In Lossy compression loss and missed information is bearable. Application is commercial distribution (DVD). Lossless methods cannot provide enough compression ratios. In this study, a review of various lossy and lossless algorithms (Fig. 1) used so for image compression are explained, this will be helpful for researchers for further research by considering the existing work.

COMPONENTS OF COMPRESSION

Two essential and basic parts are reducing redundancy and irrelevancy. Reducing Redundancy focuses to reproduce exactly from the image. Parts of the image are omitted unnoticed by the receiver from naked eye namely Human Visual System in irrelevancy reduction.

There are several image compression algorithms some of them are lossy and some are lossless such as fractal image compression, transform-based image compression (DCT, DWT) (Sharif *et al*., 2011a, b), image compression using wavelet coding, ESPIC EBCOT, Embedded zero tree wavelet algorithm, SPIHT algorithm, Set Partitioned Embedded Block coding and Wavelet difference reduction algorithm. Recent compression methodologies successfully achieve high compression rate and maximum quality of perception relative to previous one.

RESULTS AND DISCUSSION

Fractal image compression: At first Fractal Image Compression (FIC) was recommended but major drawback of FIC was poor retrieved image quality when compression is apply on noisy or corrupted images. So, to overcome this limitation, HFIC is proposed in which contrast and brightness estimate through M-estimation. The main drawback is high computational cost which is solving through PSO which reduce time needed for searching. This technique is efficient because it retain the quality of image (Jeng *et al*., 2009). Figure 2 shows some Fractal Image Compression Techniques.

Region-based heuristic search compression: By using different transformations classes a novel algorithm that enlarges the block-based scheme. Implemented methods are not block based of fixed size square. It is region based large and irregular shaped segments of images can be used as regions. These region-based transformations used to encode images. Heuristic algorithms used to construct these transformations (Thomas and Deravi, 1995; Hartenstein *et al*., 2000). Nearest neighbor search is based on pre-

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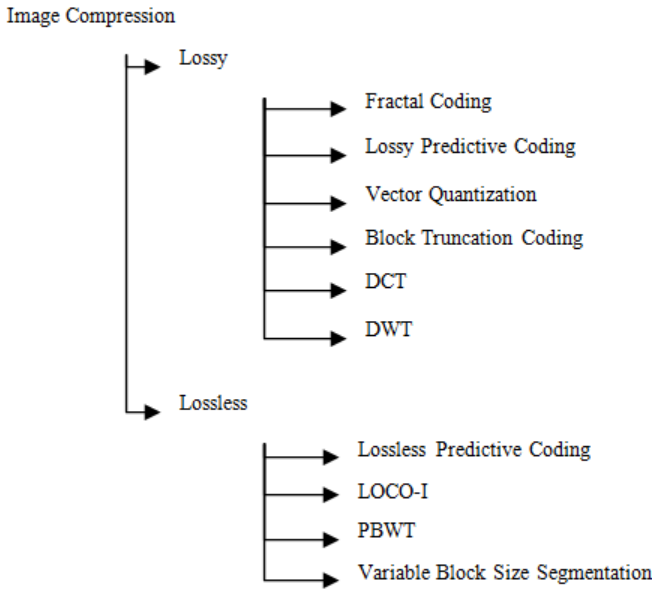

Fig. 1: Lossy and lossless image compression methods

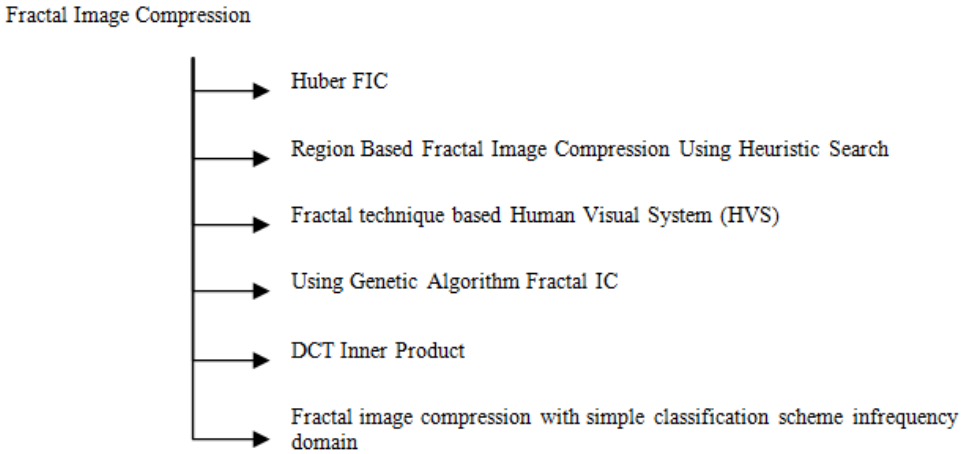

Fig. 2: Fractal image compression techniques

quantization and orthogonal projection which are parameters of fractal transform. It is shown from results that our new technique has the ability to enhance both rate of compression and fidelity thus encoding time and memory demand minimizes (Avcibas *et al*., 2002). A method for exploiting the time redundancy of region borders is proposed. The additional information improves the signal quality produced by the classified region coding scheme. The predictor used for image sequence coding is very simple. In order to achieve better results more complex predictor based on motion estimation and compensation (Sanderson and Crebbin, 1995).

Low complexity fractal-based compression: Technique based on human visual system is the method using a simple and competent 4×4 blocks is divided into perceptually shade and edge blocks. For each edge block instead of using MMSE criterion from small domain pool with respect to every 52 edge patterns Firstly it finds Same domain block using properties like mean, range, location and orientation. By guessing mean intensity correlation found in the neighborhood of a shade block can be easily decreases (Kumar and Jain, 1997). Shade region of image suitably can code by Pattern based technique is proved by simulation. Table 1 shows some Fractal Image Compression Techniques.

Proposed Scheme not only is better in term of encoding speed and compression ratios (Kumar *et al*., 1998). Region are coded corresponding to segmentation map computed already that explicit region based functionalities images (Tong and Wong, 2002).

Table 1: Fractal image compression techniques

Ref.	Technique	Features	Merits	Demerits	Application	Results
Jeng *et al*. (2009)	Huber fractal image compression	Embedded linear huber regression into encoding	Preserve image quality	High computational cost	Suitable for corrupted image compression	Due to noise in image HFIC has good robustness against the outliers PSNR>26.42 dB
Thomas and Deravi (1995)	Using heuristic search fractal image compression	Image redundancy efficiently exploited through self-transformability	Achieves a double compression ratio	The encoding takes an order longer than the decoding	Multimedia and image archiving	Compression ratios 41:1
Kumar *et al*. (1998)	Bath Fractal Transform-(BFT) based method	Focus on visual pattern with least squares approximation	Faster and better fidelity	Computational complexity	Low cost and real time consumer applications	Use of higher block size gain higher compression ratios
Kumar and Jain (1997)	Low complexity FIC	Based on human vision system	High speed encoding speed and higher compression ratios	-	Suitable for low cost consumer applications and Progressive Image Transmission (PIT)	Encode test image in 16 sec Only in 2 iterations achieves decoded image
Mitra *et al*. (1998)	Fractal image compression with genetic algorithm	Considered and exploited self transformability property of images	Computational efficiency means reducing the coding cost	Time consuming, extensive search needed	Real life images	Compression ratio is 9.97 PSNR is 31.53
Truong *et al*. (2000a)	Fractal DCT inner product	MSE calculations of the given range block is done with exploiting redundancies	Faster	-	Applicable to various enhanced algorithms	With same PSNR value encoding time six times faster than baseline method
Jeng and Shyu (2000)	classification scheme in frequency domain	Lowest frequency data is used to aid fractal image compression	Retrieved image quality is not affected	-	This algorithm helps FIC to reduce computation time	Faster ~4.7 times

Compression using genetic algorithm: Performance of the fractal based on GA comprises of 3 components total amount of search space points second number of cycles T and initial population size S. Iterations will varies from image to image for sake of near-optimal solution. Image self transformability characteristic is take into account and also reduced. Compression implements the GAs which greatly decreases the search space. It discusses practical implementation of the proposed method and classification technique (Mitra *et al*., 1998).

Progressive decoding method: Fixed point iteration approach with control parameter is progressive when we set control parameter as one Contractive transformation and particularly reverts back. Based on the new iteration procedure, a progressive decoding algorithm, which does not need any specific fractal encoder and is beneficial for low bandwidth transmission (He *et al*., 2004).

DCT inner product with FIC: In order to attain a quicker encoding, that exploits every repeated computation for the eight dihedral, a method of classification shrunken domain pool size the eight orientation measurement is still needed at each search entry. For quad tree applications with a small/large block size same calculation is also done. For better speed of the decoder the fast algorithm can be applied independently without effecting PSNR (Truong *et al*., 2000a).

Fast fractal based on one norm of normalized block: For fractal coding an accelerating scheme on normalized block is proposed. It contains ability to grab the best matched block with a reduced search. It is proved from results that it yields the same or superior quality as the baseline algorithm, while its runtime is shortened ~19 times (He *et al*., 2004).

Combination of fractal image compression and vector quantization: Fractal image compression and oriented mean shape gain VQ efficiently merged. We use two quad tree based schemes fast top down heuristic technique and with a large range multiplier method. Generation of an embedded code is not possible with it because embedded codes allow progressively transmission capability and scalability (Hamzaoui and Saupe, 2000).

Simple classification in frequency domain: Lowest frequency data is utilizes to aid fractal image compression. The overall decoding is carried out 4.7 times faster than is possible using the baseline method while the resultant image quality is not effected the quality of retrieve image is also preserved (Jeng and Shyu, 2000).

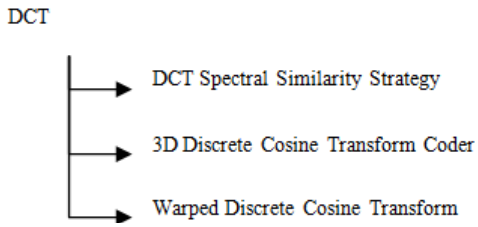

Fig. 3: Compression methods based on DCT

DISCRETE COSINE TRANSFORM

It is proposed for medical image compression. It enhances the compression output by exploiting spectra similarity and quality of image is also preserve. It involves division of n*n image into same size sub image. Unitary transform is applied on each sub image (Wu and Tai, 2001). In JPEG to retain the quality as compression ratios in average level achieved, discrete cosine transform Bit rate is reduced. For bit level reduction three main methods of band gathering matching similarity and significance selection are discussed (Nijim *et al*., 1996). In prescribed set of frequency ranges we predefine several WDCT matrices. Minimization the error of reconstruction for input block of image best WDCT matrix is searched which then compressed transform coefficients. Matrix index are send toward decoder side to reconstruct image and then corresponding WDCT inverse matrix is multiplied to coefficients (Cho and Mitra, 2000).

DCT based image compression: Benefits of various approaches are combined by DCT based compression method (Fig. 3). Firstly, Image is divided into variable size blocks using partitioning in vertical and horizontal direction. For reducing statistical redundancy by a bit plane of each image block. In decompression of images blocking artifacts can be eliminated by post filtering. Significantly better compression results are shown than JPEG and other techniques (Ponomarenko *et al*., 2007).

3D-DCT coder for medical image compression: The advancement in compression algorithms are needed by lossless medical imaging for diagnostic purposes attain high compression Ratio. In this with very high fidelity and low bit rate an adaptive 3D DCT image coder is presented. Compression ratio increases and alleviates blocky effects by this method. Decrement of blocking effects could be achievable when employed to the 3-D cuboids. As background that is darker occupy most contents of image. Due to this reason to compress medical images 3D coder is more suitable choice. In segmentation phase to generate the Huffman codes we have use a 3D zigzag scanning pattern instead of 2D zigzag scan (Tai *et al*., 2000).

Medical image compression: First we calculate and measures difference area b/w correct predicted points for deciding significant coefficients. Goal of compression is obtained instead of the whole coefficients by recording and significant coefficients transmission. To reconstruct coefficients among two sequent important coefficient equations is used on the decoder side (Belloulata and Konrad, 2002).

Table 2 shows an overview of some DCT based compression methods.

IMAGE COMPRESSION USING CODING OF WAVELET COEFFICIENTS

Embedded Zero Wavelet algorithms (EZW): This is robust image compression technique in which embedded nature of bit stream is maintained during the transmission. For this first wavelet coefficients are partition into S parts then code and quantize them one by one thus S embedded bit stream which are different from each other are created (Creusere, 1997). Coding that simultaneously offers lossless as well as lossy recovery. For optimizing the functionality of both coding methods, Division of two layers is recommended. For consumption of energy and de-correlation first coding layer is on a DWT that is produced by wavelet filter kernel choice in correct way. Using an adaptive wavelet packet integer algorithm remaining part of image is de-correlated in second layer (Marpe *et al*., 2000). Two techniques based on EZW coding were proposed to enhance the working of method. Using both methods one can make gains significant in compression performance can be highly achievable through a fixed transform. Coding resulting System outperforms a baseline system by using fully embedded EZW (Adams and Antoniou, 2000). The approach relies upon EZW. In progressive medical image transmission EZW algorithm is known as

Table 2: Discrete cosine transform compression methods

Ref.	Technique	Features	Merits	Demerits	Application	Results
Wu *et al*. (2001)	DCT spectral similarity strategy	Promote transmission or storage	Simple manipulation of images fast image transfer over large n/w	Computational burden	Medical images	PNSR 4-8 dB and max compression ratios
Tai *et al*. (2000)	3-D discrete transform	Local energy magnitude segmentation technique	Decoded images quality is better than by JPEG	Computational time	Medical images	bpp is <0.25

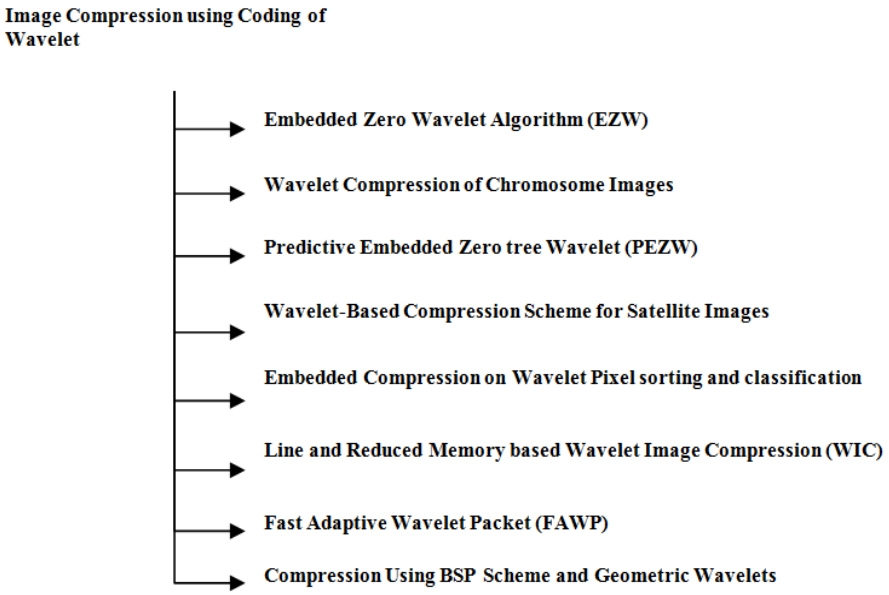

Fig. 4: Wavelets based compression

"controlled and manageable resolution constraint and rate constraint" (Dilmaghani *et al*., 2004).

Hybrid coding: A hybrid coding system that uses a hierarchy of set partition in SPIHT and vector quantization VQ for image compression is presented. To form the wavelet trees the coefficient of the input image wavelet is rearranged from all the sub-bands of the same orientation that are composed of the corresponding wavelet coefficients. Wavelet trees grouped into two classes based on the amplitude distribution a simple tree classifier has been proposed. Each class of wavelet trees is encoded using an appropriate procedure, specifically either SPIHT or VQ (Su *et al*., 2005).

Wavelet-based space frequency image compression: SFS has rate distortion criterion which suits the image representation that is a good alternative for images. Because of speckle texture especially in ultrasound image and the unique shape of scanned regions mean unusual characteristics Partition. It is more optimum representation for compressing ultrasound images in medical. To compress ultra sound images background area and ultrasound scanned region should be operated individually is an appropriate way to compress medical ultrasound images is shown in this study (Guo *et al*., 2001).

Binary space partition scheme and geometric wavelets: This algorithm uses two BSP and GW methods. BSP scheme uses a simple description of the images. In image processing and computer graphics field, it has range of applications. This method splits the convex field into two sub domains by dividing it with a hyper plane. This subdivision process is done in order to reduce the given cost. The approach repeatedly partitions image by straight lines in a stepwise way and geometric representation extraction. This method benefits in betterment of PSNR with increased bitrates (Chopra and Pal, 2011). Figure 4 shows different Wavelets based Compression methods.

Performance analysis using wavelets of image compression: Wavelet compression and decompression process are highlighted with the extent to affected image quality as well as main point and still images compression. Image quality is measured or picture quality scale by using pre-determined image quality with the help of PSNR and its comparison with a DCT is also discussed. Result provides a good reference and for application developer makes it possible and easy to make choice of good wavelet compression system. In Short performance of image compression by implementing wavelet is discussed (Grgic *et al*., 2001).

Wavelet compression of chromosome images: In this coding scheme for the chromosomes, ROIs lossless compression is mainly used during our examination and testing for comparison on the whole image. In second case with use of bit rate separately background of chromosomes are compressed lossless. Easy manageable performances for lossless compression in this section along with all results presented are described in terms of PSNR in decibel and b/p for lossy compression (Liu *et al*., 2002).

Predictive embedded zero tree wavelet: Predictive EZW wavelet coding is a zero tree based codec. The functional units for PEZW are zero trees for coding. Minimum complexity and good coding efficiency is gained by this algorithm (Liang, 1999). ECZQR in the wavelet transform domain is a unique scenario that depends on energy clustering and zero quad tree representation is proposed. To use large rectangular blocks to represent zeros it first uses Morphological dilation to extract the arbitrarily shaped clusters of significant coefficients within each sub-band (Chiu *et al*., 2001; Zhong *et al*., 2000).

For satellites images wavelet based compression scheme: We present almost lossless image compression for enhancing image's quality level. Firstly encode input image by the CCSDS recommendation. Then to produce residual image reconstructed by the code by subtracting resultant image from original image. Compressed image decode by decoder and bit plane after receiving encoded data. The proposed method is easier to implement due to low complexity (Chen *et al*., 2009).

Embedded wavelet pixel classification and sorting: In this study the embedded image compression structuring and hierarchy of working in wavelet domain is describe by using the concept of pixel sorting and classification. Pixel grouping and sorting methods for better understanding the working of previous method can also characterized implicitly or explicitly. We develop algorithm domain in wavelet not so complex explicit and suitable way to classify and sort pixel. At variable complexity modes without any post process PCAS algorithm shows efficient higher performance with quality or spatial scalability (Peng and Kieffer, 2004).

Convergent algorithms for succewith applications to wavelet image compression: In this study, we will state and prove some properties of the SAVQ algorithm and also propose and analyze a new version of it. This modified algorithm achieve more stable rate x distortion performance in the sense that its parameters can be set PSNR performance regardless of particular image coded also obtained. This is a very desirable result as finding the optimum parameters for each input image would be computationally expensive (Craizer *et al*., 1999). Global maximum entropy can be observed through three step scalar quantizer performed after discrete wavelet transform. It help us to describe minimum quantization error with entropy constrained and minimum entropy with an error bound, which are useful for applicable in real implementations (Wu and Hsu, 2000).

Multi-wavelet transform coding: Multi-wavelet decomposition algorithm on multi-scaling basis initialization phase has been shown more powerful and suitable. For this purpose different techniques have been considered. The working capability of multi-wavelet coder is matched with the scalar wavelets results and outcome. These multi-wavelets are examined to compression problem (Cotronei *et al*., 2000).

Wavelet-based color image compression: Implementation of CSF from even to local variations within decomposition sub band of spatial frequencies at max precision. Method is suitably efficient to be applicable for luminance and also color images. At beginning of study a surface over spatial frequency this directs to quantization task noise shaping under visual perception. To check modeling of CSF in constraints of a DWT based codec for achieving better compression quality which is also visually optimal for this implementation choices were also point out (Nadenau *et al*., 2003).

Reduced memory and line-based wavelet compression (LBRMBIC): Approach for line based wavelet transforms and it divides memory which is to be consumed in two different classes that is filtering memory and synchronization memory. Entropy coding algorithm that can merge with line based transform with very low memory consumption. It is also experimentally shown competitive performance with image coders. This algorithm is better with respect to memory usage and computations (Chrysafis and Ortega, 2000).

Dynamic contrast based quantization: Strategy for the purpose of visual quality restoration has been proposed at any bit rate. For every DWT sub band quantizer size is estimated. On the outcome of psychophysical experiments contrast are chooses applied by using threshold and sub band threshold targets constitute and against many natural image maskers of wavelet sub band quantization distortions presented (Chandler and Hemami, 2005).

Compression based on adaptive wavelet packet: Best wavelet algorithm implementation and discuss by basic target image construction out absurdly large amount of time requirement adapted to required image. For better performance with computational burden high speed packet coder is designed for performing better merged with a simple quantization scheme. Results are also examined on various textured images including not only PSNR.As compared to standard techniques this scheme is approximately 4 times speedy (Meyer *et al*., 2000). 9/7 filter for compression of image blocks the number of multiplications is reduced by a ratio of 5/12 and the speed of implementation of the wavelet transform increased is proposed. In comparison with its lifting-based implementation, the number of multiplications is decreases by a ratio of 5/12 and the

Table 3: Image compression using coding of wavelet coefficients

Ref.	Technique	Features	Merits	Demerits	Application	Results
Creusere (1997)	EZW algorithm	EZW algorithm divide the wavelet coefficients quantize and code each of them separately	Small amount of additional memory is required	Higher computational complexity	Multimedia application	For the lena image bpp = 1.0 with S = 256 PSNR = 35.06 db
Marpe *et al*. (2000)	Two layer wavelet based algorithm	Both lossless and lossy compression allowed Simultaneously	Fast optimal	-	Transmission of telemedical images	Similar or superior pure lossy still image methods
Liu *et al*. (2002)	Wavelet compression of chromosome images	Depending on features of ROI method for compression chromosome image	Transmission in telemedicine	-	biomedical image archiving	Compression achieved is double
Liang (1999)	Predictive embedded zero tree wavelet coder	Zero trees are the fundamental coding units for PEZW	Efficient coding wise and versatile functionality	Power consumption	Internet and multimedia Image application	Both efficient but PEZW has much low complexity
Chen *et al*. (2009)	For satellite images wavelet based compression scheme	Image compression based on lossless compression technique	high quality images with less transmission time	-	Satellite image transmission and storage system	For lunar 92% of bit rate
Peng and Kieffer (2004)	Embedded image compression	In wavelet domain method of modeling and ordering	Scalability with flexible complexity	Computational time	Transmission of digital images	1.0 bpp and PSNR = 0.45 db
Wu and Hsu (2000)	Discrete Wavelet Transforms in image compression (DWT)	Global max of an entropy function with Different decision levels	Maintain good image fidelities with high ratio of compression	-	Multi-resolution applications	-
Cotronei *et al*. (2000)	Multi wavelet transform coding	Embedded coding scheme based on successive approximation quantization	Fast transmission of image data	-	-	Compression ratio is 128:1 for lena image
Nadenau *et al*. (2003)	Wavelet-based color image compression	DWT-based codec for visually optimal compression ratio	Better visual quality	-	Medical imagery or SAR images	Compression gain of about 30%
Chrysafis and Ortega (2000)	Line based reduced memory compression	Solve low memory problem of wavelet image compression	Efficient in term of speed and memory	-	Mass market consumer products	Outperform DCT-based coders
Meyer *et al*. (2000)	Adaptive wavelet packet image compression	Fast 2D convolution algorithm	Visually pleasant images	Computational load	-	~4 time more fast than standard decimation
Adams and Antoniou (2000)	reversible EZW	Transform selection method	Simple, compatible	-	Reversible embedded image compression system	Much better than baseline system

speed of implementation of the wavelet transform is increased (Meng and Wang, 2000).

Multi wavelet packets image compression techniques: The pre exist standards of compression like JPEG algorithm wavelet transforms and quantization method has capability of surpassing. In order to perform better wavelet transform filters are required. It mixed number of desired characteristics as symmetry and orthogonally (Collins and Atkins, 2001).

Integer wavelet transform: For lossless from lossy compression difference between integer (IWT), infinite precision DWT is analyzed. Due to IWT usage structure for quality degradation is presented. Rounding operation can be changed through added white noise which is not linear based on the hypothesis. Transfer functions were measured for equivalent computation impact of few sources of noise on the reconstructed pixel. Through simulation verification is done for model. To validate theory as input, white noise (salt) is

used at beginning to validate theory. Secondly entire compression system used and natural images in framework of real applications (Zeng and Cumming, 2001). See Table 3 for Image Compression using Coding of Wavelet Coefficients.

EFFICIENT SPATIAL PREDICTION BASED IMAGE COMPRESSION

It is lossy compression technique for multimedia application and wireless transmission. Two phases of this method are Prediction and Quantization. In prediction more information convey from each sample pixel depend on hierarchical structure among pixel in image then integrate this with quantization method SPIHT to enhance compression performance (Kuo *et al*., 2002).

Image and video compression: For conjunction 2D pattern matching used that depends on range of methods with different run length encoding and adaptive distortion for image and videos lossy compression. Tree based matching search is used by basic kernel for computation with a region growing scheme. Expanded and run length encoded segments are in decompression matched patterns and requires minimal computation for simplicity (Alzina *et al*., 2002). Here Quad tree decomposing Algorithm is described. It is simple way in order to achieve representation of an image at variable resolution ranges. For variety of image processing application this representation can be use and helpful. Through quad tree decomposition with using optimal choice for quad tree decomposed here proposed way to enhance performances of compressing and equation based bit allocation procedure derived from rate distortion theory for some Gaussian field (Liu and Zhao, 2008).

The proposal use information related to original image by a non stationary model. Preservation of edges sharpening is made possible in resulting solution while the introduced artifacts are considered and discuss here reduced. The advantage is first the degradation which is undesirable such as blocking artifacts (Ozcelik *et al*., 1995). In this study purpose is to design a high quality compression system which is cost effective for the efficient transmission. Both lossless such as contour, run length and arithmetic as well as block predictive lossy compression for graphics is supported and introduce various efficient algorithms that helps and storing images locally consists of both graphical and video data at the same time and architecture of the professional communication is also described (Schaar-Mitrea, 2000). See Table 4 for Image and Video Compression based methods.

To cut down reconstruction error, it is Pre/post filtering framework to near block boundary in image and video compression based on wavelets.

EDGE-BASED INPAINTING COMPRESSION

Inpainting techniques finishes visual redundancy which is inherent in natural images. Some prominent characteristics in filtering are proposed in the removal of tilling of JPEG (Liang *et al*., 2005) at the encoder side extracted from images. Some area of image also skip in encoding process based on the features those are extracted and at the decoder side recover after using assisted inpainting method. Due to delivered assistant Information It has the capability to remove too much regions so compression ratio can be greatly increased

Table 4: Image and video compression

Ref.	Technique	Features	Merits	Demerits	Application	Results
Kumar and Jain (1997)	Two dimensional pattern matching image and video compression	Lossy data framework based on a 2D pattern matching	Good compression ratios	Space and time complexity	Image and video compression	Lena image CR = 32.01 PSNR = 27.5
Chen *et al*. (2009)	Image compression via improved quad tree	Simple technique to obtain an image representation	Better compression performances	-	Video and HDTV compressions	Better perform than transform coding or sub band
Ozcelik *et al*. (1995)	Algorithms based on recovery techniques	An iterative technique for reducing the unwanted degradations	Higher compression rates	Visually satisfying images cannot be produced	Applications ranging from video telephony to HDTV	For lena image compression ratio~ = 30:1
Schaar-Mitrea (2000)	Hybrid video compression	Cost-effective high quality compression system	Efficient video and graphics storage and transmission	Cost	TV and video images	Achieve compression factors up to 16
Liang *et al*. (2005)	Pre/post filter for wavelet image and video method	Filtering framework to reduce the reconstruction error	Simplicity and flexibility	-	Real-time applications	Compression ratio of 120:1

and at a time for better quality of visual in saving regions already loosed and remove for good visual quality efficiently at the same time (Liu *et al*., 2007). As in term of quality and edge preservation of image, it is indicated from result that proposed model is particularly suitable for images with high contrast image. It exhibits lossy compression (Hong and Bao, 2000).

LOSSLESS IMAGE COMPRESSION ALGORITHM

In this study lossless compression technique is proposed in order to obtain compression at high ratio (Fig. 5). As characteristics of image maximized local and global redundancy so it reduces redundancy at both local and global level. First divided image into blocks of different length and then depending on the characteristics of pixels in each block encode these pixels. Technique gives more efficiency with respect to other lossless algorithms and better result is achieving (Wu and Tan, 2000; Ranganathan *et al*., 1995). Lossless compression technique applied on medical imaginary redundancies in spatial and temporal domain in order to decrease size of image and it also reduces storage space without degrading image. Time needed for computation is also decrease. At first stage to exploit temporal redundancy in image data OSS is apply. Using cluster analysis redundancy in data I temporal domain is also removed. Standard technique for dynamic data (Ho *et al*., 1997). Almost same or high compression ratio is achieved by LOCO-I then provided with state of art schemes depending on arithmetic code (Weinberger *et al*., 2000). Lossless Predictive Burrows Wheeler Transformation (PBWT) and Gradient Adjusted Prediction (GAP) block sort algorithms which are useful in compression of textexual data. From implementing Gradient Adjusted Prediction predictor the performance can also be improved. From results achieved by the experiment the efficiency our proposed methods can also be checked (Ng and Cheng, 1999). The algorithm recommended is a better substitution for lossless. In case of real time imaginary obtained results are reasonable with exploitation of spatial redundancy. The implementation of the method is carried out in MATLAB. On MRI, CT scan, ultrasound and Mammogram experimental calculations are also applied. For future compression Multiple Array Technique we can use Huffman/Arithmetic coders and then transmission is done through the Wi-Fi media (Devaraj *et al*., 2005). For training template from training model Lossless novel block is presented of error diffused images. Multi- template is constructed for representing texture features (Huang and Chung, 2007). We examine approach which contain block division of the image and then from a codebook of scans each block is choose. Semi adaptive and adaptive codebooks design and use is also studied. We also match with the best obtained outcomes via standard JPEG (Memon *et al*., 1995). A direct 3D lossless compression method depending upon region growing has been introduced. Its performance is the same as that of the corresponding 2D SLIC algorithm when it is applied to the same number of slices at worst case. In most practical cases dealing with medical images and examine remarkable efficiency by proposed method (Wu and Tan, 2000).

The coding procedure consisting two passes. It groups dots of 2*2 to cell where number of black dots is used to represent each cell and the black dots location in cell. In first step encoding is done of black dots in the cell and in 2^{nd} round position is encoded. Firstly we perform lossless compression Lossless compression in

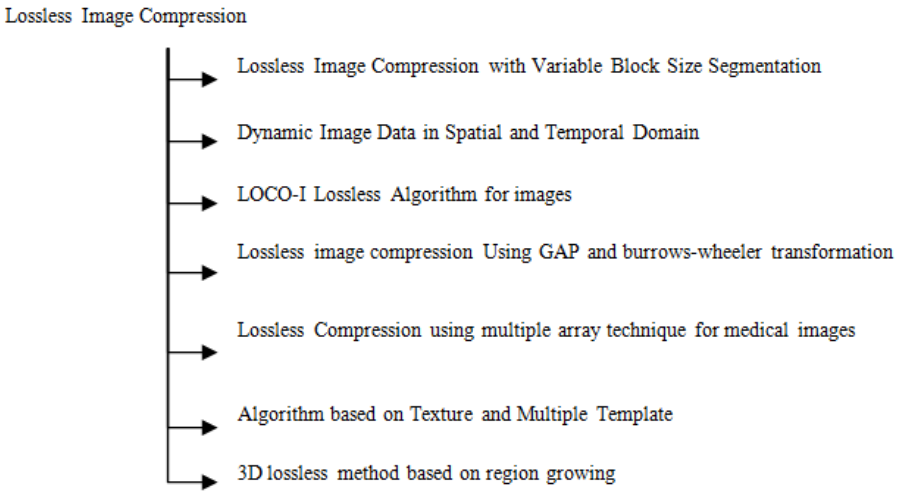

Fig. 5: Lossless image compression algorithms

Table 5: Lossless image compression algorithms

Ref.	Technique	Merits	Demerits	Application	Result
Wu and Tan (2000)	Variable block size segmentation Lossless compression	Higher compression efficiency	Time and space complexity	Medical imaging and satellite photography	Better perform than other lossless compression schemes for lena CR = 44.71
Ho *et al*. (1997)	Dynamic image data compression	Requirement of storage space is reduced more than 95% and retain quality	-	Medical image	Compression ratio >80: 1
Weinberger *et al*. (2000)	LOCO compression algorithm	Efficient performance in conjunction	Decompression is slow than compression about 10 times	Continuous-tone images	Faster than PNG
Ng and Cheng (1999)	Gradient adjusted prediction and burrows wheeler	In text compression results are excellent	Compression the result is poor if directly applied into image	Used in text compression	Better than lossless JPEG
Devaraj *et al*. (2005)	Lossless compression using multiple array technique	Reduce computational complexity and faster compressions	-	Medical and geophysical applications	Than other lossless image compression CR is same or higher standards X- ray 2.9:1
Huang and Chung (2007)	Texture- and Multiple Template Based algorithm (TMTBIC)	Low memory and transmission time requirement	-	Suitable for error-diffused images	Compression improvement ratio of proposed algorithm is 17.6% than previous schemes
Wu and Tan (2000)	3D lossless image compression based on region growing	Better performance due to exploitation of redundancies	Performance is the same as 2D SLIC algorithm when applied to the same num of slices	Medical images	-

2nd pass it can be refined to be lossless (Ng and Cheng 2003). Incorporation of Progressive and near lossless technique is presented in a single framework. Proposed coder proved to be competent as experimental performance than conventional compression schemes (Chen *et al*., 2002).

Multistate segmentation loss less compression: To manage the size and number of region tree is pruned. Overhead of rate optimization exists in coding segmented data. Image model can be implemented having pixel description present nearly region edges which are in interior is another advantage of proposed scheme (Lee and Park, 2003).

Ordered binary decision diagram: A lossless compression algorithm for images based on OBD diagrams is presented. OBDD is searched by algorithm which is helpful for representing the image and then efficiently do coding of ordered binary decision diagram. With respect to a previous study the result of this shows improvement in great aspect (Jeng *et al*., 2000).

Conditional arithmetic coding prediction and adaptive lifting: In reducing prediction mistake due to variance of stationary signal. In general dimensional case optimal predictors is first calculated of a lifting scheme. With corresponding update filters optimal predictor filter is applied by sampling and row column for lossless compression of still images. In quincunx case to improve the results for enhancing efficiency of linear predictors in nonlinear means by directional post processing (Cardinal, 2001; Boulgouris *et al*., 2001). Table 5 shows some Lossless Image Compression Algorithms.

COMPOUND REAL TIME IMAGE COMPRESSION

First recent study is reviewed on compound image compression. Then the SPEC algorithm which includes system segmentation and coding detail description is provided then experimental results are given at last stage. Two main contribution of SPEC algorithm are to separate text/graphics from pictures accurate segmentation algorithm and for compressing text and graphic lossless coding method is designed. It is validate from experimental output that SPEC is an algorithm having less complexity. Much better visual quality is provided (Lin and Hao, 2005).

LEAST-SQUARE BASED 2D FILTER

New method utilizing a two dimensional transversal filters related to disparity estimation in stereo images due mismatching effects is represented. For reconstructing the block to minimize the quantity of filter coefficients reduced ordered filtering. It is enhanced block matching scheme version. During the comparison the outcome of standard block matching methods results of this technique showed that proposed scheme is best option for the mismatching effects (Seo *et al*., 2000).

IMAGE COMPRESSION BY CELLULAR NEURAL NETWORKS (CNNUM)

In this study, various Cellular Neural N/w Universal Machine (CNNUM) algorithms were presented for the extremely fast compression of still and moving images. The key idea is to split the image into spatial sub bands storing only the subtraction of reconstruction from a lower sub-band and the original image removing spatial redundancy. This algorithm performs better in lossless compression and superior to JPEG standard with respect to compression ratio and speed (Venetianter and Roska, 1998).

TILING AND ADAPTIVE IMAGE COMPRESSION

In this study sequential probability assignment algorithm is provided which do coding of an image with a O bit length of code that is the algorithm can be called as the best tiling algorithm. The burden of computation of the algorithm is O Nn^3. Major study contribution is that in image rectangle tiling class as useful method is introduce and efficient in term of computation and exactly same computational complexity progressive transmission is also possible (Lee, 2000).

BILEVEL IMAGES COMPRESSION ALGORITHM

Suitable lossless compression focused on coding of block Arithmetic. With respect to binary source symbols probabilities P0 and p1arithmetic it parses its coding interval. Template moving approach is used across bi level by BACIC with BAC. To index probability table template is used as a 12 bit context table is constructed and adapts to each image information (Reavy and Boncelet, 2001).

TEXT IMAGE COMPRESSION WITH JBIG2

By implementing JBIG2 standard compression of text images is examined. First SPM based JBIG-2 comparison with PM and S systems based are first given according to efficiency of their coding. SPM system contains 8% much better in case of lossless. As compared to bit rate in the lossy case better control is noticed over quality of reconstructed image by SPM system. The major advantages is that it cut down time and storage almost 2-4% too much memory consumed and 2-3 times longer encoding time (Ye and Cosman, 2001).

EMBEDDED BLOCK CODING WITH OPTIMIZED TRUNCATION

It support packet decompositions also preserves edges lost by SPIHT. In this collection of sub-band organized in increasing resolution level is used to represent original image. LL sub-band is lowest resolution level. For the purpose to rebuild the image each successive resolution level comprises of the additional sub bands with double vertical and horizontal resolution. As layers increase performance decreases. This development is better for applications where remote browsing of large compressed images involves (Taubman, 2000).

COMPRESSION BASED ON FUZZY ALGORITHMS

Fuzzy vector quantization algorithms: An algorithms which perform efficiently and exploit advantage of fuzzy clustering is propose where demands of VQ problem is also fulfilled. Effective strategies are milestone on which it is based upon for transition from soft toward crisp/hard decisions during the clustering process. Measurement of the uncertainty related to training vector assignment is also done in this study with the help of several functions which contain which are implemented in fuzzy K-means algorithms. For designing codebook in compression of image based on VQ the proposed Algorithms can also used (Karayiannis and Pai, 1995). A new VQ technique is presented in study which uses FRLVQ before applying Standard VQ algorithm as a pre process. The proposed algorithm helps to design codebook in an image compression application. An improvement in resulting codebook PSNR is achieved by FRLVQ-fuzzy VQ is shown by the experimental results. In selection RL is insensitive indicated by further testing both the learning rate control parameter and of the initial codebook (Iwahashi *et al*., 2003).

Image compression based on fuzzy algorithms: System performance depends on wavelet based sub band and vector quantization decomposition. By using wavelet filters original image is decomposed in variable resolution sub band sets to separate frequency bands. Using Linde Buzo Gray algorithm the obtained bands are quantized and via unsupervised learning several

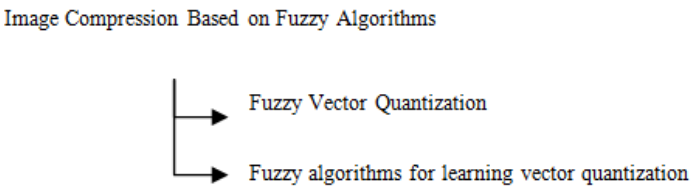

Fig. 6: Image compression schemes using fuzzy algorithms

Table 6: Compression based on fuzzy algorithm

Ref.	Technique	Features	Merits	Demerits	Results
Karayiannis and Pai (1995)	Fuzzy vector quantization	Efficient algorithm for designing vector quantize	Speed, simplicity and conceptual appeal	-	FVQ algorithm codebook design better than previous
Karayiannis *et al*. (1998)	Fuzzy Algorithms for Learning VQ (FALVQ)	Wavelet based sub band decomposition and vector quantization	Low computational requirements Better image quality	-	Compression ratio >8:1

fuzzy algorithms for learning quantization all prototypes update of neural network these algorithms perform vector quantization. These algorithms are tested on the reconstructed images to calculate quality (Karayiannis *et al*., 1998). See Fig. 6 and Table 6 for Image compression schemes using Fuzzy Algorithms.

EFFICIENT COMPRESSION ALGORITHM FOR HYPER SPECTRAL IMAGES

The proper A3D-DWT and asymmetric zero tree are effectively merged together for rate-distortion improvement in proposed lossy method of compression. It is shown by experiments that the proposed adaptive AT3DSPIHT method performs not only much good then the existing compression schemes relay on 3D-DWT and A3D-DWT for hyper spectral images but also better perform at the weakest correlated spectral bands then 2DSPIHT (Shusterman and Feder, 1994). For analyzing image which are hyper spectral in which for compression criteria target detection and classification were used. With an unsupervised learning first we identified interest target in a hyper spectral image scene. To obtain fractional abundance images the entire image cube is compressed for these targets (Du and Chang, 2004).

SPIHT ALGORITHM

Several modified SPIHT algorithms are also introduced for compressing multispectral images in the spectral dimension by implementing KLT or VQ for the purpose to take a strong interband dependency benefits that such images contains. On adaptive it is seems that 3-DSPIHT is more appropriate due to its lower complexity of design. Performance is much out class both when multispectral and hyper spectral images are considered. The comparison is also given with respect to other schemes (Luigi Dragotti *et al*., 2000). The use of pixel based error measures is our proposed method with multispectral image more likely the spectrum reconstruction accuracy according to the pixels. Usually grey level or RGB images are being compressed. For images which are multispectral are presented for measures some quantitative quality (Kaarna *et al*., 2000). The working performance of a custom hardware implementation is dramatically enhanced and with the slight adjustment in existing algorithm desired output can also achieved. With fixed order SPIHT thus the original algorithms PSNR curve is also matched (Fry and Hauck, 2005). Highly scalable SPIHT combines the features of spatial scalability through the necessary details of the original SPIHT algorithm like scalability; compression efficiency and low complexity are also kept (Danyali and Mertins, 2004). The error-tolerant SPIHT algorithm is discussed here implement simple modifications and extensions to the conventional SPIHT coder. In terms of computational complexity the ER-SPIHT organization adds little overhead to either the encoder or decoder. The use of RCPC and CRC concatenated coding does add considerably to the processing requirements, although the complexity is comparable with other error-correcting methods (Truong *et al*., 2000b). Analyzing texture mapping homogeneity and by incorporating reduction of speckle into compression scheme improvement of image compression and interpretation is gain. At start in hierarchical trees SPIHT classical set partition implements wavelet compression scheme and changes for controlling the speckle reduction rate using various schemes of encoding to homogeneous and non homogeneous scene area (Martin and Bell, 2001).

S-TREE AND SHADING APPROACH

Novel method is presented for compression of gray image Rate of bits and the quality of image shows that STC method is reliable then BTCC method. Execution cycle of proposed method is min than half than BTCC. In each block by considering noise and increasing the

execution time image's quality is also preserved in a satisfactory ways of proposed shade tree method can get improvement at very high rate (Chung and Wu, 2000; Wu and Tai, 1998).

STACK-RUN-END

An intra sub band approach based on wavelets is quite unique than method which depends on zero tree type. A small symbol set is utilize for converting the information detail of wavelet coefficient which is desire and meaningful. The bit stream contains progressive transmission property and organized at the sub band order. It is enlightened as more competitive from the output. Maintaining color images fidelity at high rate is achieved from test of perceptual view (Tsai, 2000).

IMAGE COMPRESSION SYSTEM USING DATA RE-ORDERING TECHNIQUE

Data re-ordering technique is a better alternative for the context modeling. The computation and memory complexity in the proposed technique are greatly reduced with a small per cent (<3% in worst case) of compression ratio decrease (Xu *et al*., 2003).

COLOR IMAGE COMPRESSION

Color-quantized images scheme for compression that relies and developed on progressive code of color information. B-trees structure of is implemented except using color indexes to linear list sorting. An image can be retain as original image color from two color with this the new algorithm in progressive way and lossless recovery is achieved (Koh *et al*., 2003; Ratakonda and Ahuja, 2002). Transformed image was partition into several sub images with respect to frequencies for the purpose to achieve good compression quality (Wu, 2002).

HADAMARD BASED IMAGE DECOMPOSITION AND COMPRESSION

The CDC method presented consists of relatively simple but effective techniques for decomposition and

Table 7: Coding schemes

Ref.	Type	Features	Merits	Demerits	Application	Result
Kuo *et al*. (2002)	ESPBIC	Method based on spatial prediction	Memory requirement is less, computation efficiency and high visualization quality	Filters selected not guarantee to be optimal	Real-time and wireless transmission	Competitive performance with the baseline JPEG compression ratio is 1:86
Lin and Hao (2005)	SPEC	Compound compression algorithm for real time applications	Low complexity visually lossless quality	-	Real-time applications	Much better perform than JPEG ratio of compression from 10:1 to 20:1 also achieve
Lee (2000)	CNNUM	Spatial sub band coding algorithm for the lossy or lossless compression	Fast compression efficiency	If sub band is large performance effected badly depend on size of sub band	Radiographic image storage and multimedia applications	The gain of the proposed compression compared to the JPEG was 3-7%
Su *et al*. (2005)	BACIC	Method suitable for lossless bi-level image compression	Simple, efficient easy-to implement coder	Power consumption is hard to quantify	Halftone images	On the typed documents BACIC achieve high CR
Tsai (2000)	Stack-run-end coding scheme	Low complexity wavelet based image coding scheme usually develop for color image	Reduce bandwidth consumption used for transmission	-	Wireless multimedia transmission	Refining zero tree type method
Chung and Wu (2000)	S-tree and shading approach image compression	Novel method for gray images compression	Speed and satisfactory image quality also preserves	-	Real-time communication and retrieval of image	Execution time is less than ½ over BTTC method
Kaarna *et al*. (2000)	Three-dimensional SPIHT (3D SPIHT)	KLT or VQ implemented in the spectral dimension compression algorithm of multi spectral images	Good encoding performance	Too much memory required due to 3 lists	Remote sensing images	Achieve compression ratios of 10:1

compression of grayscale images. The AIW represents an approach for obtaining the inverse solution using a layered network with BP algorithm. It is able to utilize a pair of different data types, corresponding to different physical quantities (Mateu-Villarroya and Prades-Nebot, 2001; Valova and Kosugi, 2000).

Fast fractal image compression using the hadamard transforms: The algorithm using the HT has been proposed to increase the speed of encoder and still good quality of images is provided for the FIC. The improvement is achieved by removing all computations which are repeated of the eight dihedral symmetries of domain blocks. In performing the HT only +, - operations are included these operations are more suitable for software and hardware implementations. This new algorithm can be easily applied most of the fast algorithms such as quad tree and classification mechanisms (Reichel *et al*., 2001).

CONCLUSION

Coding schemes discussed in this study are implemented in different fields for various applications owing to their unique characteristics. For wide commercial usage there various available schemes but for improved performance there is need of newer and better techniques to be developed. Still this field demands more progress and research possibilities. We discuss different image compression techniques and their merits demerits their applications. See Table 7 for more coding schemes.

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