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AN ENRICHED ALGORITHM FOR COMPRESSION OF IMAGES BUILT ON COIFLETS TRANSFORM

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Abstract: Image compression is now essential for applications such as transmission and storage in data bases. A variety of new and powerful algorithms have been developed for image compression over the years. Among them the wavelet-based image compression schemes have gained much popularity due to their overlapping nature which reduces the blocking artifacts that are common phenomena in JPEG compression and multi resolution character which leads to superior energy compaction with high quality reconstructed images. In this image compression we first apply Coiflets transform then on each block of the low frequency sub band and split all values from each transformed block followed by applying arithmetic coding for image compression.

Index Terms— **Compression of Images; Coiflets; Coding using Arithmetic Idea.**

1. Introduction

Image compression is the application of data compression on digital images. In effect, the objective is to reduce redundancy of the image data in order to be able to store or transmit data in an efficient form. Uncompressed multimedia (graphics, audio and video) data requires considerable storage capacity and transmission bandwidth. Despite rapid progress in mass-storage density, processor speeds, and digital communication system performance, demand for data storage capacity and data transmission bandwidth continues to outstrip the capabilities of available technologies. The recent growth of data intensive multimedia-based web applications have not only sustained the need for more efficient ways to encode signals and images but have made compression of such signals central to storage and communication technology.

1.1 Image compression basics

The neighboring pixels of most natural images are highly correlated and thus contain lot of redundant information. A less correlated representation of the image is the result of any compression algorithm. The main task of image compression algorithms is reduction of redundant and irrelevant information. In the present scenario, various methods of compressing still images exist. In any data compression scheme, three basic steps are involved: Transformation, Quantization and Encoding.

1.2 Transformation

In image compression, transform is indented to de-correlate the input pixels. Selection of proper transform is one of the important issues in image compression schemes. The transform should be selected in such a way that it reduces the size of the resultant data set as compared to the source data set. Few transformations reduce the numerical size of the data items that allow them to represent by fewer binary bits. The technical name given to these methods of transformation is mapping. Some mathematical transformations have been invented for the sole purpose of data compression; others have been borrowed from various applications and applied to data compression. These include the Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT), Walsh-Hadamard Transform (WHT), Hadamard-Haar Transform (HHT), Karhune-Loeve Transforms (KLT), Slant-Haar Transform (SHT), Short Fourier Transforms (SFT), and Wavelet Transforms (WT). Transform selection process still remains an active field of research.

1.3 Quantization

The procedure of approximating the continuous set of values in the image data with a finite, preferably small set of values is called quantization. The original data is the input to a quantizer and the output is always one among a limited number of levels. The quantization step may also be followed by the process of thresholding. Each sample is scaled by a quantization factor in the process of quantization, whereas the samples are eliminated if the value of the sample is less than the defined threshold value, in the process of thresholding. These two methods are responsible for the introduction of error and leads to degradation of quality. The degradation is based on selection of quantization factor and the value of threshold. If the threshold value is high, the loss of information is more, and vice versa. The value of threshold or the quantization factor should be selected in a way that it satisfies the constraints of human visual system for better visual quality at high compression ratios. Quantization is a process of approximation. A good quantizer is the one which represents the original signal with minimum distortion. If lossless compression is desired this step should be eliminated.

1.4 Encoding

Encoding process reduces the overall number of bits required to represent the image [1]. An entropy encoder compresses the quantized values further to give better overall compression. This process removes the redundancy in the form of repetitive bit patterns at the output of the quantizer. It uses a model to precisely determine the probabilities for each quantized value and produces a suitable code based on these probabilities so that the resultant output code stream will be smaller than the input. Commonly used entropy coders are the Huffman encoder and the Arithmetic encoder. The Huffman procedure needs each code to have an integral number of bits, while arithmetic coding techniques allow for fractional number of bits per code by grouping two or more similar codes together into a block composed of an integral number of bits. This makes arithmetic codes to perform better than Huffman codes. Therefore, arithmetic codes are more commonly used in wavelet based algorithms. The decoding process involves the reverse operation of the encoding steps with the exception of de-quantization step that cannot be reversed exactly.

II. REVIEW OF LITERATURE

Garima Chopra et al. in [12] described that the Geometric wavelet is a recent development in the field of multivariate nonlinear piecewise polynomials approximation. The present study improves the geometric wavelet (GW) image coding method by using the slope intercept representation of the straight line in the binary space partition scheme. The performance of the proposed algorithm is compared with the wavelet transform-based compression methods such as the embedded zerotree wavelet (EZW), the set partitioning in hierarchical trees (SPIHT) and the embedded block coding with optimized truncation (EBCOT), and other recently developed "sparse geometric representation" based compression algorithms. The proposed image compression algorithm outperforms the EZW, the Bandelets and the GW algorithm. The presented algorithm reports a gain of 0.22 dB over the GW method at the compression ratio of 64 for the Cameraman test image.

Dr. Sudeep D. Thepade et al. in [13] represented that image Steganography is an art and science of unseen communication. Image steganography technique is widely used to secure information utilized for covert communication, featured tagging, copyright protection, military agencies and for many more applications related to secure communications. Image steganography using transforms shows more robustness against attacks. Here, Cosine wavelet transform, Walsh wavelet transform and Slant wavelet transform are proposed to be used for image steganography. Experimentation is done on 10 cover images for hiding 10 assorted message images. Results show that, without attacks Cosine transform performs better but in case of attacks on stego such as Cropping, brightness, darkness, wavelets of Cosine, Walsh and Slant transform performs better than individual orthogonal transforms.

Ivan W. Selesnick in [14] described that the discrete wavelet transform (DWT) is usually carried out by filterbank iteration; however, for a fixed number of zero moments, this does not yield a discrete-time basis that is optimal with respect to time localization. This paper discusses the implementation and properties of an orthogonal DWT, with two zero moments and with improved time localization. The basis is not based on filterbank iteration; instead, different filters are used for each scale. For coarse scales, the support of the discrete-time basis functions approaches two thirds that of the corresponding functions obtained by filterbank iteration. This basis, which is a special case of a class of bases described by Alpert, retains the octave-band characteristic and is piecewise linear (but discontinuous). Closed-form expressions for the filters are given, an efficient implementation of the transform is described, and improvement in a denoising example is shown. This basis, being piecewise linear, is reminiscent of the slant transform, to which it is compared.

Sunil Malviya et al. in [15] represented that with the increasing demand of storage and transmission of digital images, image compression is now become an essential application for storage and transmission. This paper proposes a new scheme for image compression using DWT (Discrete Wavelet Transform) taking into account sub-band features in the frequency domains. Method involves two steps firstly a two levels discrete wavelet transforms on selected input image. The original image is decomposed at different 8x8 blocks, after that apply 2D-Walsh-Wavelet Transform (WWT) on each 8x8 block of the low frequency sub-band. Firstly dividing each sub-band by a factor and then apply Arithmetic Coding on each sub-band independently. Transform each 8x8 block from LL2, and then divide each block 8x8 separated into; DC value and compressed by Arithmetic coding.

Salam Benchikh et al. in [16] elaborated that application to image processing and image compression using the discrete wavelet transform (DWT) is presented. We show the impact of the spectral distribution of the images on the quality of the image compression technique. Four families of wavelets are considered: 1) Bi-orthogonal, 2) Daubechies, 3) Coiflet and 4) Symlet. Since the good basis wavelet recommended for DWT compressor may depend on the choice of test images, we consider three test images with different but moderate spectral activities. We then evaluate the performance of the four wavelets families on each test image. A comparative results for several wavelets used in DWT compression techniques are presented using the peak signal to noise ratio (PSNR) and compression ratio (CR) as a measure of quality. Finally, we present the comparative result according to PSNR versus CR for four families of wavelets, showing that bior4.4 yields a better performance than the other Wavelets in terms of tradeoff between PSNR and CR.

After studying the various image compression methods which have been presented, aiming to fill up the missing techniques which come in our mind that Slant-Coiflet with arithmetic coding.

III. PROPOSED METHOD

The major steps of our proposed method for image compression summarizing the following steps:

1. Select an input image.
2. Choose the Coiflets which is used for compression.
3. Set the quantization factor parameters, which is denoted by F1 and F2 from the standard parameter set.
4. Set compression ratio factor (CRF) from range 1-10.
5. Apply the Slant-Coiflets transform for transform, and then using the arithmetic coding for compress the image.

Step 5 consists of the following:

5.1 Two levels Discrete Coiflets Transform.

5.2 Apply 2D Slant Transform on each 8x8 block of low frequency sub-band.

5.3 Split all values form each transformed block 8x8.

5.4 Compress each sub-band by using the Arithmetic coding, the first part of Slant-Coiflets compression steps for high frequency, domains, and then second part of the Slant-Coiflets compression steps for low frequency.

Fig. 2: Test Images

IV. RESULTS AND ANALYSIS

As a test images it is taken here three classic images: Barbara image, Lena image and Mandrill image. The size of each one is 512x512. The test images are shown in the figure 2.

6. The output image obtained by the compression.

The flow chart of our proposed method is given below:

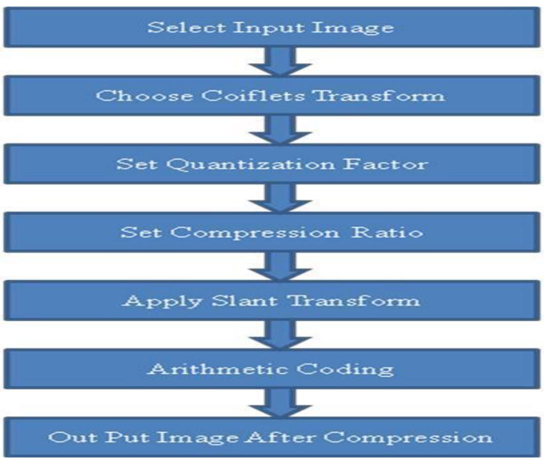

Fig. 1: Flow chart of proposed method

The proposed method is applied on these test images. The image compression is done using coif5 wavelet. Here the value of quantization factor F1, F2 and compression ratio factor (CRF) is chosen as 0.02, 0.02 and 2 respectively. After getting the results it is compared with the results of the existing methods EBCOT, EZW, GW, JPEG 2000 and SPHIT. For analysis the results it is taken the PSNR value is chosen here.

TABLE I

Comparison of PSNR of proposed method with different method

Methods	PSNR (in db)		
	BARBARA	**LENA**	**MANDRILL**
EBCOT	29.36	28.58	31.96
EZW	28.54	30.38	32.23
GW	32.84	31.39	30.20
JPEG 2000	30.96	29.58	31.90
SPHIT	30.32	29.30	30.90
Proposed Method	**34.05**	**33.45**	**32.50**

Table I shows the result of comparison of PSNR value of Barbara image, Lena image and Mandrill image of different methods such as EBCOT, EZW, GW, JPEG 2000 and SPHIT with the proposed method.

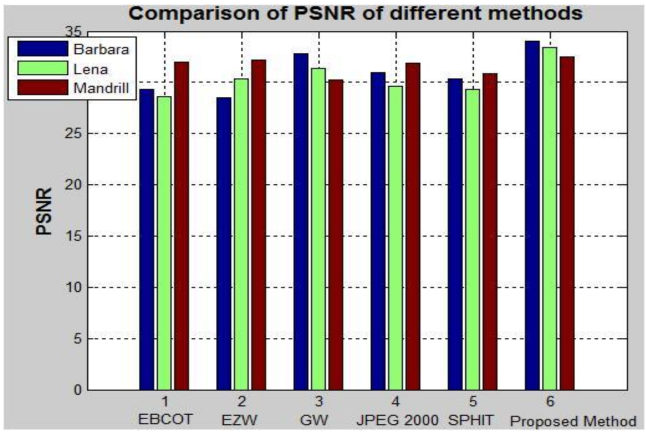

Fig. 3: Comparison of PSNR of different method

It is seen from the above fig.3 and table that the proposed method has able to reduce the blocking artifacts and false counting effects significantly which occurs during the image reconstruction. Moreover, the proposed algorithm gives better PSNR value as compare to some existing standard algorithms.

V. CONCLUSION AND FUTURE WORK

The wavelet transform is a powerful tool to analyze the signals. There are many applications of the wavelet transform, such as image compression. The Coiflets transform for image compression is simple and effective algorithm as compared to other algorithms. The compressed image quality is also maintained. In this paper it is presented an image compression framework that adopts Coiflets with Slant transform to remove the redundancy from images. Here it is proposed an improved image compression algorithm with this correspondence. My presented Coiflets with Slant transform method is capable to restore the removed regions for good visual quality.

As a future work it can be extend the quality of the picture with the increasing compressed ratio factor. Also it can extend this method for image compression by using different type of compression techniques and different transforms as well as using different discrete wavelet for better results.

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