An Improved Image Compression Algorithm Based on Slant-Coiflets Transform with Arithmetic Coding

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***Abstract*— The growth of digital imaging application have increased the need for effective image compression techniques. To remove the redundant information from an image, the image compression is necessary. Image compression helps to store only the essential information so that transmission time, transmission bandwidth and storage size get reduce. Inspired by the recent research in advancement of image compression techniques, we propose Slant-Coiflets transform with arithmetic coding towards the improvement over the visual quality. The image compression using Slant-Coiflets transform with arithmetic coding is good techniques of compression and quite simple to produce better compression results. 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*— Image Compression; Coiflets; Arithmetic coding.**

I. INTRODUCTION

Recently increase in image related application have created an issue of image transmission and storing. Transmission and storage of image require considerable amount of bandwidth and space. The image compression addresses this problem. It reduces the number of bites required to represent an image. So, in the age of digital communication, the image compression is an important field of research. Today various image compression methods are available. Broadly they are classified as lossless and lossy compression [1].

In lossless compression, the reconstructed image is exactly same as compressed image. So for medical image and text data compression it is used. The lossy compression is especially useful in the image data compression where some loss in decompressed data is acceptable. It eliminates the redundant information which is not perceptible of human eyes. Hence the lossy image compression provides the high compression ratio. So many times lossy compression is preferred over lossless image compression. The approaches for lossy compression include transform coding and predictive coding. For image compression the transform domain techniques [2] are powerful approaches.

In transform coding, initially DCT was the popular image compression techniques. DCT shows the satisfactory performance and simplicity in image compression. The correlation across the block boundaries cannot be eliminated as it is applied on the blocked image. It introduces the blocking artifacts specifically at the low bit rate. The drawback was overcome by the wavelet transform. The wavelet transform gives time and frequency analysis of data. It can be applied directly to the whole image without blocking. Under the transmission and decoding errors [3] the wavelet based coding is more robust. The multi-resolution property of wavelet transforms help to view image at different scales. The algorithms for compression, such as JPEG [4] and MPEG [5] for images are based on the DCT [6]. The vision system of human has been incorporated with the schemes [6, 7] of compression and effort has been given to improve the visual quality and coding efficiency by removing some visual redundancy.

In the framework of the image compression, the main stages are the transform and quantization, modeling and finally the ordering, and the third stage is the entropy encoding and post processing. According to the previous works for a successful algorithm of image compression the modeling and ordering is very much important to design. Here we are going to propose a new algorithm based on a novel scheme of modeling and ordering in wavelet domain pixel classification and sorting [8]. Recently, many image compression algorithm such as the, EZW [9], SPIHT [4], EBCOT [5], GW [10] and JPEG 2000 [11] image coding method have been introduced.

The paper can be divided in following ways that: in section II describes the review of literature. And in section III explain our proposed method of Slant-Coiflets transform base image compression with arithmetic coding. The section IV represents the results and analysis. And at last in the section V we share the conclusion and future work.

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,

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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.

6. The output image obtained by the compression.

The flow chart of our proposed method is given below:

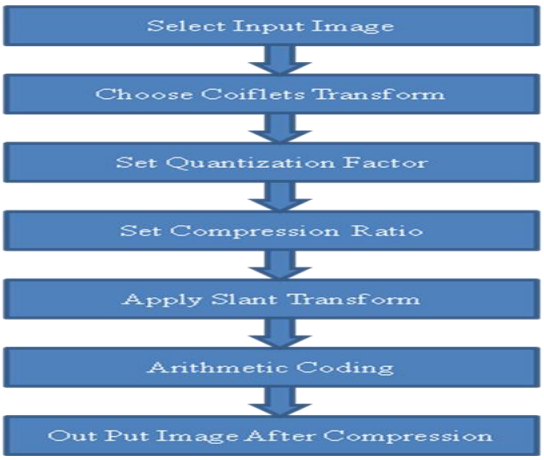

Fig. 1: Flow chart of proposed method

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.

Fig. 2: Test Images

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.

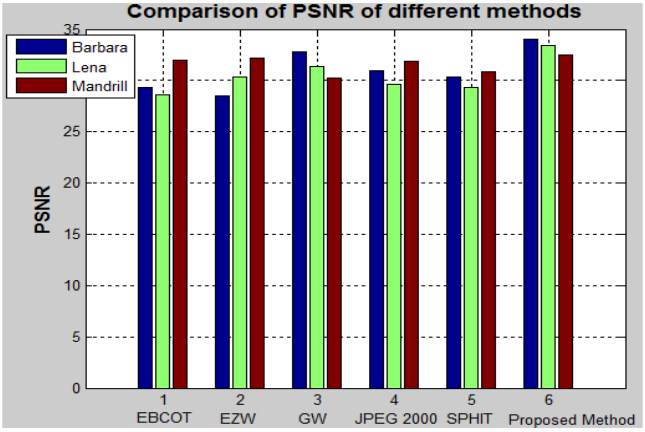

Fig. 3: Comparison of PSNR of different method

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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