Image Data Compression By Using Multiwavelete for Color Image

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Date of acceptance 31/10/2006

Abstract:

Thousand pictures requires a very large amount of storage. So the science of digital image compression is used to reduce the storage requirements for these images

Wavelet transforms require filters that combine a number of desirable properties, such as orthogonally and symmetry. The design possibilities for wavelets are limited because they can not simultaneously passes all these desirable properties. The relatively new field of multi-wavelets show promise in removing some of the limitations of wavelets. multiwavelets offer more design options and hence can combine all desirable transform features. The few previously published results of multiwavelet based image compression have mostly fallen short of the performance enjoyed by the current wavelet algorithms.

This paper attempts to given an understanding of the multiwavelet transform by using particular application of wavelet techniques to compress color image data. Two types of quality measure tests are used, quality measure, by demonstrating the final results with different bit quantization levels, and quantitatively measure, by comparing the decoding results, using the Peak-signal-to-Noise-Ratio "PSNR" test.

Introduction:

The rapid expansion of the internet and fast advancement in color imaging technologies have made digital color images more and more reading available to professional and a amateur users. The large amounts of image collection available from a variety of sources such as digital camera, digital video, scanner, the Internet...etc. Have posed increasing technical challenges to computer systems to store/transmit and index/manage the image data effectively and efficiently to make such collections easily accessible [1].

For more than 30 years, image coding/compression have been studied so that the storage and transmission challenge is tackled by it. Also the significant advancements have been made. Many efficient, successful and effective image-coding techniques have been developed and the body of literature on image coding is huge. A number of methods have been presented over the years to perform image compression. They all have one common goal: to alter the representation of information contained in an image so that it can be represented sufficiently well with less information [2]. Most of these methods are essentially based on the extraction and retention of the most important (visual) information of the image.

Generally image compression involves reducing the size of image data file, while retaining necessary information, The reduced filed is called the compressed file and is used to reconstruct the image, resulting in the decompressed image [3].

Multiwavelets are only now beginning to approach the maturity of development of their scalar counter

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parts. Few paper that have tested the image compression properties if multiwavelet suggest that multiwavelets can sometimes perform as well as, or better than scalar wavlets[4,5,6]. Using multiwavelet, for image compression is a little more complicated than other transform; the coefficients are computed in a normalized two-dimensional adaptive Haar basis. The algorithms presented and employed in this paper are designed to work on color images. Multiwavelet-based compression of color images performs well composed to methods based on wavelet and DCT transforms. The digital color image devices use RGB color space to represent image data, the multiwavelet methods used here would be to transform the RGB color data to a luminance/chrominance color space (YUV). The human eye is more sensitive to high-frequency information in the luminance values corresponding to the "grayscale" data of image. The luminance planes could be quantized more severely, resulting in good compression rates with good visual quality.

Image Compression System:

Figure 1 show the compression system, which is used in this paper. This compression system consists of two distinct structural blocks: an encoder and a decoder

The Vindication for Using Multiwavelet

There must be some vindications to use multiwavelets in place of scalar wavelets. Some reasons for potentially choosing multiwavelets have been mentioned in this paper.

1) The extra degrees of freedom inherent in multiwavelets can be used to reduce restrictions in the filter properties.
2) One desirable feature of any transform used in image compression is the amount of energy compaction achieved.
3) Image compression results presented in a paper by Strela and Walden [10] show that the popular Bi9/7 scalar wavelet gives better results than some older multiwavelets on images like lena. More recent results show that newer multifilters can be competitive with some of the better filters like Bi9/7[6, 7]. Also, a paper by Strela [9] presents results in which at least one multiwavelet dramatically outperformed scalar wavelets on a synthetic test image.
4) Multiwavelets still compare favorably because they can give performance comparable to scalar wavelets with shorter filters.

Iteration of Decomposition

Since multiwavelet decomposition produce two lowpass subbands and two highpass subbands in each dimension, the organization and statistics of multiwavelet subbands differ from the scalar wavelet case. The 2-D image data is replaced with four blocks corresponding to the subbands representing either lowpass or highpass in both dimensions. These subbands are illustrated **Figure2 a**. The multiwavelets used here have two channels, so there will be two sets of scaling coefficients and two sets of wavelet coefficients. Since multiple iterations over the lowpass data are desired, the scaling coefficients for the two channels are stored together. The wavelet coefficients for the two channels are also stored together. The multiwavelet decomposition subbands are shown in **Figure 2 b**. For multiwavelets, the L and H labels have subscripts denoting the channel to which the data corresponds.

In practice, more than one decomposition is performed on the image data. Successive iterations are performed on the lowpass coefficients from the previous stage to further reduce the number of lowpass coefficients process yields better energy compaction is performed on the image data. Since the lowpass coefficients contain most of the original signal energy, this iteration process yields better energy compaction. After a certain number of iterations, the benefit gained in energy compaction becomes rather negligible compared to the extra computational effort. Usually five levels of decomposition are used in current wavelet-based compression schemes [8, 11]. Experiments performed for this paper indicate that two levels are sufficient for multiwavelets, with gains in PSNR diminishingly rapidly with decomposition depth increasing above 2. A single level of decomposition with a symmetric-antisymmetric multiwavelet is roughly equivalent to two levels of wavelet decomposition. Thus a 2-level multiwavelet decomposition effectively corresponds to 4- level scalar wavelet decomposition. Since tests indicate that the improvement from depth 4 to depth 6 for scalar wavelets is negligible, 2-level multiwavelet decomposition can be considered comparable to 3-level scalar wavelet decomposition. Scalar wavelet transforms give a single quarter-sized lowpass subband from the original larger subband, as seen in figure 2a.The multiwavelet decomposition iterate on the lowpass coefficients from the previous decomposition, as shown in **Figure 3**. In the case of scalar wavelets, the lowpass quarter image is a single subband. But when the multiwavelet transform is used, the quarter image of lowpass coefficients is actually a 2*2 block of subbands(the L_iL_j subband in **Figure 2b**) Due to the nature of the preprocessing and symmetric extension method, data in these different subbands becomes intermixed during iteration of the multiwavelet transform. The intermixing of the multiwavelet lowpass subbands leads to suboptimal results.

Implementation Details

The multiwavelet results in this paper were obtained using a separable decomposition of the 2-D image data. The approximation-preserving prefiltering and signal extension approach presented by Xia et al. [6] was used. Figure 3 show a block diagram of each level of decomposition, including preprocessing. The 2-D data is processed first in rows, and then columns. The processing of each row or column involves splitting the 1-D signal into even and odd subsets and multiplying the resulting 2*1 vector by the prefilter matrix. The data is then extended symmetrically (filtered) and down sampled. Subsequent iterations for multiwavelets were performed only on the L_1L_1 subband of the previous transform result. Similarly, multiwavelet packets were implemented by iterating on whole subbands, this yield that each subband becoming a 4*4 block smaller subbands. Tests were performed both with and without the use of the coefficient shuffling method. For the wavelet packet and multiwavelet packet cases, a cost function approach was used. This choice was made with an eye toward computational complexity, since the rate distortion searching methods are much more computationally expensive than a simple cost function method [11]. After the transform. No entropy coder was used in these experiments. Since the entropy coding process typically just adds a roughly constant gain in dB to the PSNR [8], entropy coding is not necessary for comparison of different transform methods The reconstruction method followed the opposite order of steps: read in bit stream, perform dequantize process to obtain quantized transform coefficients, and perform inverse transform to obtain the reconstructed image.

Results and Conclusion

The results obtained by this paper can be demonstrated through the values of the bit-rate (BR), the Peak-Signal-to-Noise-Ratio (PSNR) and Compression Ratio (CR). Image that is used to demonstrate the coding results is shown in figure4. The adaptive image is Lena image. The compressing image with the multiwavelet, which based upon the Haar transform, was implemented on the above sample image for different values of the parameters.

The performance of multiwavelet can be evaluated in the following:

Multiwavelet yields higher speed of computation, also, higher compression ratio, comparing with the traditional methods. The compression ratio of multiwavelet is almost twice with a better image quality when we choose the subbands of LL. The effect of subbands of LH, HL, HH is a little in image reconstruct process, comparing with the effect of subbands of LL, where we can reconstructed the same image with the same CR, BR and PSNR if we choose the subbands of LL only. Also the ignored of subbands of HH (H1H2, H2 H1, H2 H2) has no effect on the reconstructed image.

In comparing with scalar wavelet, the multiwavelets used in this paper give performance equal to the best scalar wavelets in many cases. While the scalar wavelet gives consistently good performance for natural images, in most cases a multiwavelet can be selected which gives similar performance with lower computational complexity. This makes multiwavelets a viable alternative to the conventional scalar wavelets in many situations.

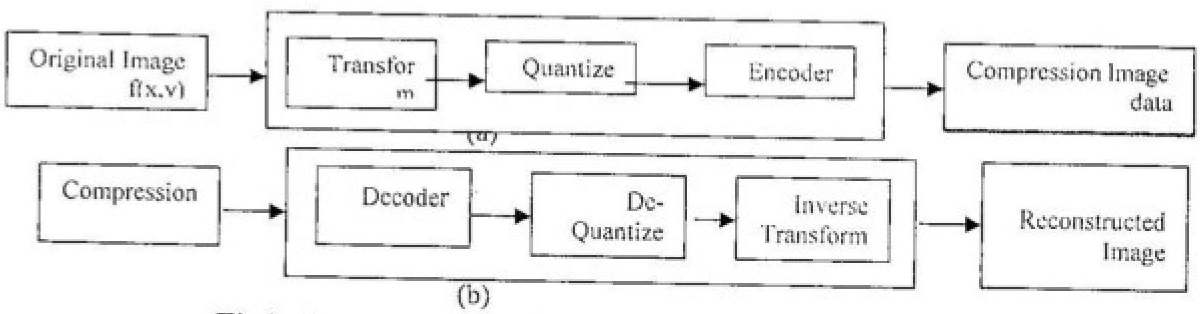

Fig1: Image compression system (a) encoder. (b) decoder

LL	LH
HL	HH

(a)

L_1L_1	L_1L_2	L_1H_1	L_1H_2
L_2L_1	L_2L_2	L_2H_1	L_2H_2
H_1L_1	H_1L_2	H_1H_1	H_1H_2
H_2L_1	H_2L_2	H_2H_1	H_2H_2

(b)

Figure 2: Image subbands after a single-level decomposition
(a) for scalar wavelets
(b) for multiwavelet.

Fig. 3: Conventional iteration of multiwavelet decomposition

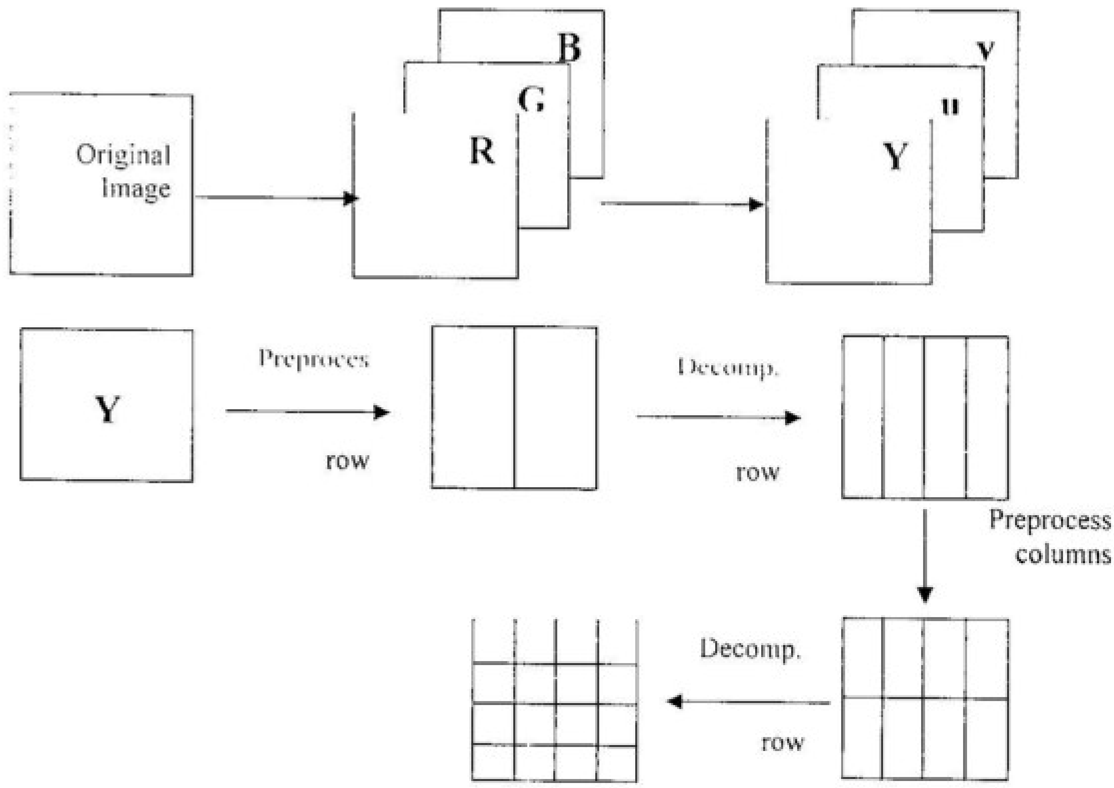

Fig. 3: Illustration of 2-D multiwavelet filtering with approximation-based preprocessing

The original image

BR=1.25 bpp, CR=6.2 b/p, PSNR=22.64

BR=2 bpp, CR=4 b/p, PSNR=24.53

BR=3 bpp, CR=2.6 b/p, PSNR=24.78

BR=1.5 bpp, CR=5.3 b/p, PSNR=22.49

BR=0.87 bpp, CR=9.14 b/p, PSNR=21.74

Fig 4: decoded images reconstructed by using multiwavelet compression over Lena image

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ضغط بيانات الصور الملونة باستخدام طريقة التعدد المويجي

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الخلاصة:

هناك العديد من الصور تحتاج إلى مساحة خزنيه كبيرة. ومع استمرار تطور تكنولوجيا التخزين للحاسبات فان هناك حاجة مستمرة ومطلوبة لتقليل المساحة الخز نية للصور. ولضغط الصور بطريقة جيدة، فان طريقة التحويل المويجي تحتاج إلى منقيات (filters) والتي تدمج عدة خواص مطلوبة مثل التعامدية orthogonally والتناظرية (symmetry). وعلى كل حال فان احتمالات التصميم لل(wavelet) تكون محددة وذلك لأنها لا تستطيع تمرير كل هذه الخواص المرغوبة وبصورة متزامنة. ولذلك فان طريقة التعدد المويجي (multiwavelet) يعطي ثقة في التخلص من بعض المحددات لطريقة(wavelet) مع إعطاء خيارات تصميم والتي تدمج معظم إشكال التحويل المويجي.

هذا البحث يحاول أن يعطي صورة واضحة لطريقة تحويل التعدد المويجي (multiwavelet transform من خلال تطبيق معين لتقنية (wavelet) والتي تم استخدامها لضغط بيانات الصور الملونة. ولقد تم استخدام اختبارات القياس النوعية ومنها الموضوعية من خلال استخلاص النتائج النهائية لمستويات تكميم مختلفة بالإضافة إلى استخدام الاختبارات الكمية منها اختبار ال (PSNR) لغرض مقارنة نتائج فك التشفير (decoding)