COLOR IMAGE COMPRESSION USING HIERARCHICAL PREDICTION OF PIXELS

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***Abstract*— A vital problem in evaluating the picture quality of an image compression system is the difficulty in describing the amount of degradation in reconstructed image, Wavelet transforms are set of mathematical functions that have established their viability in image compression applications owing to the computational simplicity that comes in the form of filter bank implementation. This paper presents a new lossless color image compression algorithm, based on the hierarchical prediction and Wavelet Coding. We develop a hierarchical scheme that enables the use of upper, left, and lower pixels for the pixel prediction, whereas the conventional raster scan prediction methods use upper and left pixels. An appropriate context model for the prediction error is also defined and Haar wavelet transform is applied to the error signal corresponding to each context. Proposed work is carried out by the application of hand designed wavelet family like Haar on a variety of bench mark images. It is shown that the proposed method further increases the compression ratios with more peak signal to noise ratios.**

***Index Terms*— Hierarchical prediction, Lossless color image compression, Reversible color transform, Wavelet Coding.**

I. INTRODUCTION

Memory and channel bandwidth are the prime constraints in image transmission and storage applications. In view of the growing energy requirements of wireless data services, the volume of multimedia data being transmitted over wireless channels may be reduced using various compression techniques, image compression entails transforming and organizing the data in an easy way of representation in which images of various types and sizes are compressed using different methodologies.

Image compression is one of the most visible applications of wavelet transforms additional to diversified fields as biomedical applications, wireless communications, computer graphics etc. [1] Wavelet based image coders like JPEG2000 standard easily outperform the traditional discrete cosine transform based JPEG image compression.

Wavelets provide good compression ratios for high resolution images and perform better than competing technologies like JPEG, in terms of signal to noise ratio and visual quality[4]. Unlike JPEG, wavelets show no blocking affects but allows for a degradation of the image quality while preserving the significant details of the image. In JPEG2000 standard wavelet based image compression system the entire image is transformed and compressed as a single data object rather than block by block as in a DCT based compression system there by allowing uniform distribution of the compression error across the entire image to provide better image quality and high compression ratio[3].

This paper is organized as follows. Section 2 discusses the proposed transform based image compression system. Section 3 details the objective fidelity measures to assess the quality of reconstructed images and their measures..

II. TRANSFORM BASED COMPRESSION SYSTEM

Image compression techniques are broadly classified as lossy compression techniques and lossless compression techniques, depending on whether or not an exact replica of the original image could be constructed using the compressed image.

Lossless image compression techniques are limited in terms of compression ratios, they encode data exactly such that decoded image is identical to the original image. Lossless compression uses predictive encoding which uses the gray level of each pixel to predict the gray value of its right neighbor, the overall result is the reduction of redundancy in the data. Lossless image compression techniques are mainly preferred for applications with stringent requirements such as medical imaging and diagnosis etc.

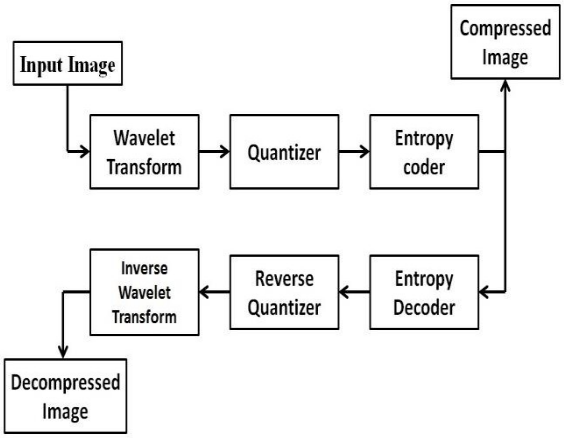

Fig 1: Transform based image compression system

III. PROPOSED WORK

For the compression of color images, the color components are first de-correlated by a color transform, and each of the transformed components is independently compressed. For example, the RGB to *Y CbCr* transform may be the most frequently used one for the lossy compression of color image and video. However, in the case of lossless compression, most color transforms cannot be used due to their un-invertibility with integer Hence an invertible version of color transform, the reversible color transform (RCT) was defined and used in JPEG2000 .

After the transformation of RGB to *Y Cu Cv* by an RCT the Y channel is encoded by a conventional gray scale image compression algorithm. In the case of chrominance channels (*Cu* and *Cv*), the signal variation is generally much smaller than that of RGB, but still large near the edges. For more accurate prediction of these signals, and also for accurate modeling of prediction errors, we use the hierarchical scheme: the chrominance image is decomposed into two sub images; i.e. a set of even numbered rows and a set of odd numbered rows respectively. Once the even row sub image *Xe* is encoded, we can use all the pixels in *Xe* for the prediction of a pixel in the odd row sub image *Xo*. In addition, since the statistical properties of two sub images are not much different, the pdf of prediction errors of a subimage can be accurately modeled from the other one, which contributes to better context modeling for Wavelet coding[5].

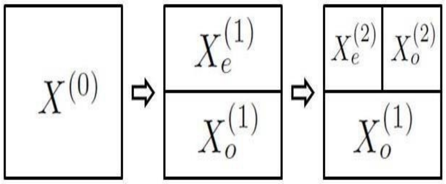

Fig 2: Illustration of hierarchical decomposition.

The efficiency of lossless compression based on the estimation of the pdf of the prediction error. For the compression of Xo pixels using Xe, directional prediction is employed to avoid large prediction errors near the edges. for each pixel xo(I,j) in Xo, the horizontal prediction x^h(I,j) and vertical predictor x^v(i,j) are defined as

$$x\hat{}_h\,(i,j) = x_o(i, j-1)$$

$$\hat{}(i,j) = round\left(\frac{(\quad)\qquad(\quad)}{}\right)$$

One of them is selected as a predictor for Xo (i,j).With these possible predictors, the most common approach to encoding is “ mode selection” where the predictor of each pixel is selected and the mode is also transmitted as side information. We define a variable for the direction of edge at each pixel dir(i,j) ,which is given either H or V .Mode selection is tried when more than one of dir(i-1,j) or dir(i,j-1) are H and the vertical prediction is performed for the rest.

For the efficient compression, the statistics of symbols (prediction errors) should well be described by an appropriate model and/or parameters. We model the prediction error as a random variable with pdf $P(e|Cn)$, where Cn is the coding context that reflects the magnitude of edges and textures. Specifically, Cn is the level of quantization steps of pixel activity $\sigma(i, j)$ defined as

$$\sigma\,(i\;\;j) = |x_e\,(i,j)\text{-}x_e(i+1)|$$

Note that the local activity and its quantization steps are calculated with the pixels in X_e, because all the pixels of X_e are available and its statistical property would be almost the same as that of Xo. The local activity is quantized into K steps such that C_n represents the step

$$q_{n\text{-}1} <= (i, j) < q_n$$

for $n = 1, \ldots, K$ with $q_0 = 0$ and $q_K = \infty$. The length of quantization steps is determined such that each step includes the same number of elements (local activities). For each context, a generic adaptive arithmetic coder [12] is used to encode the prediction error. For illustration, Fig 3 shows an input image, the local activity of a sub image (context), and $P(e|Cn)$ for several Cn. It describes the statistical property of prediction error very well, in that the error magnitude is large when the local activity is strong. Hence the proposed model is strong with wavelet coding. The Context is taken as the input of haar wavelet transform, which are again divided in to LL, LH, HL, HH sub images [2]. LL sub image is having more information than the remaining sub images hence, LL sub image is taken into consideration and Haar wavelet transform is applied. The output obtained is having design metrics such as mean square error(MSE),peak signal to noise ratio(PSNR) and compression ratio(CR)[6].

IV. ANALYSIS OF RESULTS

In the proposed work, different color images and gray scale images with varying content of details are considered with decomposition using hand design wavelet family like haar wavelet transform. Metrics PSNR, CR and MSE so obtained are tabulated in Table I for analysis after simulation in Matlab environment.

Table I: Quality Metrics

Image (128x128)	PSNR	CR	MSE
Lena	11.9084	18.2156	4.1902
Mandrill	10.1693	10.6176	6.2617
Barbara	11.9053	16.1377	4.1933
Endoscope	16.0378	26.4924	1.6192

V. CONCLUSIONS

The Proposed work of lossless color image compression method based on a hierarchical prediction of pixels .For the compression of an RGB image, it is first transformed into $Y\ C_u\ \ C_v$ color space using an RCT. After the color transformation, the luminance channel Y is compressed by a conventional lossless image coder. Pixels in chrominance channels are predicted by the hierarchical decomposition and directional prediction. Finally Haar wavelet transform is applied to the context image. This proposed method is tested on different images. The results obtained clearly indicate that Haar offer good compression performance; it can be concluded that compression performance depends on the size and content of the image therefore it is appropriate to tailor the choice of wavelet based on image size and content for desired quality of reconstructed image

VI. REFERENCES

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