



Color Image Compression Using Wavelet Compression and Zero-Mean Coding

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Abstract

Thousands pictures require a very large amount of storage. So different techniques of digital image compression is used to reduce the storage requirements for these images. In this paper an adaptive compression method applied on color image. Firstly the color image is transformed to the RGB system, and then converts the color data to a luminance/chrominance color space (YIQ). The adaptive compression method is applied on Y. The image may contain a uniform region and edge region; the uniform regions compress depending on zero-mean coding and the edge region compress depending on Daubechies wavelet transform, then returned the final image to RGB system. The proposed algorithms has many advantages which make it very efficient, these are, low bit rate, low computational complexity, fast processing and edge preservation with good reconstructed image quality.

ضغط الصور الملونة باستخدام تقنية التحويل المويجي وتقنية ايجاد المعدل للبلوك

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الخلاصة

هناك العديد من الصور تحتاج إلى مساحة تخزين كبيرة. ومع استمرار تطور تكنولوجيا التخزين للحاسبات فان هناك حاجة مستمرة ومطلوبة لتقليل المساحة الخزن نية للصور. في هذا البحث تم تطبيق طريقة ضغط مطورة على الصور الملونة. قد تحتوي الصور على مناطق موحدة ومناطق تمثل الحافات في الصورة. الخوارزمية المقترحة تعمل على تقسيم الصورة الى بلوك وتقوم بضغط المناطق الموحدة باستخدام Zero-mean coding أما مناطق الحافات فتضغط باستخدام Daubechies wavelet transform تمتلك الخوارزمية المقترحة العديد من المميزات التي تجعلها اكثر كفاءة وهي اختزال في المساحة الخزن لة للصورة مع سرعة المعالجة والمحافظة على الحواف مع نوعية جيدة للصورة المسترجعة

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]. The digital color image devices use RGB color space to represent image data, the multi wavelet methods used here would be to transform the RGB color data to a luminance/chrominance color space (YIQ). 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

Figure1 show the compression system, which is used in this paper. This compression system consists of two distinct structural blocks: an encoder and a decoder.

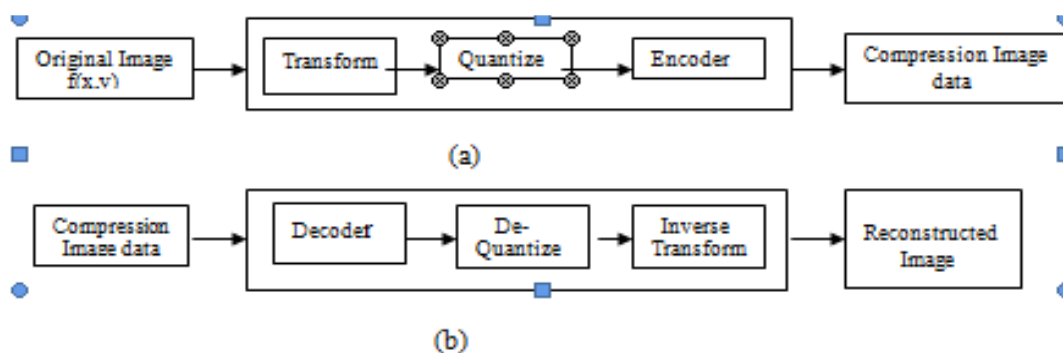


Figure 1- Image Compression System (a) Encoder. (b) Decoder

Wavelet Coding

Wavelet coding also called sub-bands coding [3]. The basis idea is split up the two dimensional frequency band image into sub-sampling channels which are encoded using techniques accurately matched to individual signal statistics and possibly to the properties of the human visual system in the individual sub-bands. One-dimensional filter is used in order to separate the frequency bands both horizontally and vertically, the reason is that separable filter

implementation of non-separable two-dimensional filters. On other hand, the gain in coding efficiency obtain by applications of non-separable filter is usually small or negligible [4]. The main purpose behind using the sub-band coding technique for video and digital image applications is the acquisition of a set of sub sampled frequency bands where each band contains various structural features of the original image. The base-band of the image presents a smaller replica of the original

consisting of all the low frequency components that are of major perceptual importance. The neighboring picture elements of the base are highly correlated and this spatial redundancy needs to be exploited by an appropriate coding scheme [5]. Sub-band filtering provides asset of disjoint upper bands that are structurally different from the base band and do not display strong pixel to pixel intra-band correlation [6]. The original image can be transformed into four sub-images, as shown in figure2

Low/Low	Low/High
High/Low	High/high

Figure 2- The Four Sub-Images Result From The Transformation

- LL sub-image: Both horizontal and vertical directions have low frequencies.
- LH sub-image: The horizontal direction has low frequencies and the vertical one has high frequencies.
- HL sub-image: The horizontal direction has high frequencies and the vertical one has low frequencies.
- LL sub-image: Both horizontal and vertical directions have high frequencies.

Daubechies and Haar basis vectors are more popular example for wavelet transform. These are separable, so they can used to implement a wavelet transform by first convolving them with the rows and then the columns [1,6].

The Daubechies- Basis Transform

Wavelet is the set found by Daubechies, the simplest of which has four coefficients:

$$h_0=(1+ 3^{1/2})/4 \quad h_1=(3+ 3^{1/2})/4 \dots \text{eq.1}$$

$$h_2=(3- 3^{1/2})/4 \quad h_3=(1- 3^{1/2})/4 \dots \text{eq.2}$$

The coefficient can be substituted into $\Psi (t)=\Phi (2t)-\Phi (2t-1)$. An example of Daubechies basis vector:

$$\text{LowPass: } 4 \sqrt{\frac{1}{2}} [1+\sqrt{3}, 3+\sqrt{3}, 3-\sqrt{3}, 1-\sqrt{3}]$$

$$\text{HighPass: } 4 \sqrt{\frac{1}{2}} [1-\sqrt{3}, \sqrt{3}-3, 3+\sqrt{3}, -1-\sqrt{3}]$$

To use the basis vector to implement the wavelet, they must be zero-padded to be the same size as the image. Also the ordinal of the basis vectors in the center, corresponding to the right of the middle of the vector. After the basis

vectors have been zero-padded, doing the following steps performs the wavelet transform.

1. Convolute the low pass filter with rows and save the results.
2. Convolute the low pass filter with columns and sub-sample this result by taking all other value; this gives the low pass, low pass version of the image.
3. Convolute the result from step1, the low pass filtered with the high pass filter on the columns. Sub-sample is taking the other values to produce the low pass-high pass image.
4. Convolute the original image with the high pass filter on the rows and save the result.
5. Convolute the result from step4 with the low pass filter on the columns; Sub sample
6. Convolute the columns of the result from step4 with the high pass filter to obtain the high pass- high pass version.

In Practice the convolution sum of the other pixel is not performed since the resulting values are not used. [2,7]

Colors System

A graphical image is a collection of organized colors intended to communicate some information. A color model also called color space is a three-dimensional body used to represent some color organization according to a particular choice of three coordinates that describe color. Different color models have historically evolved for different applications. Most color models are oriented either toward hardware such as (RGB mainly for use with color CRT monitor, YIQ for use in the broadcast TV color system, CMY used in many color printers), or toward applications where color manipulation is a goal (such as in the creation for animation of color graphics)[5].

YIQ Color Space

In the development of the united states color television system, the N.T.S.C.(National Television System Committee) formulated a color coordinate system composed of three tri-stimulus values Y-I-Q, a luminance component(y) and two chrominance or color components: in phase(I) and quadrature (Q) component. The Y is a measure of the luminance of a color, the two values I and Q jointly describe the hue(that what we normally think of as color, for example green, blue, or orange) and saturation(the measure of how white in the color, for example, pink is red with more white, so it is less saturated than a pure red)[5,6].

Below are transformations from RGB to YIQ and vice versa:

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.144 \\ 0.5596 & -0.275 & -0.321 \\ 0.212 & -0.528 & 0.311 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \dots(5)$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.00 & 0.956 & 0.62 \\ 1.00 & -0.272 & -0.647 \\ 1.00 & -1.108 & 1.705 \end{bmatrix} \begin{bmatrix} Y \\ I \\ Q \end{bmatrix} \dots(6)$$

Proposed Method:

- 1) Convert the color image from RGB space to YIQ space
- 2) An image is divided into blocks, such as (4x4) or (8x8)
- 3) Apply the adaptive compression method on matrix of Y (luminance) depending mean value for uniform region and Daubechies wavelet method on edge regions.
- 4) Finally, Retrieve the image from YIQ space to RGB image
- 5) Calculate the PSNR, and the bit rate for the final image.

Experimental Work

The main advantages with this paper is to improve the compression ratio, first we

compress the luminance image instated of the original .Zero-mean coding is applied on Y space and used to recognized the uniform blocks, background, then encoding it by transmitting only the mean value of law detail block instated of transmit the whole block while the high block ,edge, is encoded by wavelet(Daubechies)transform this leads to decreasing in bit rate, decreasing in the number of computation, fast processing and edge preservation with good reconstructed image quality better than that produced from wavelet transform method.

Conclusions

In this paper, the proposed algorithm has many advantages, these are; low bit rate, low computational complexity, fast processing and edge preservation. These advantages make this algorithm efficient in image compression. Figure 3 show the results of our work used ‘Mustafa’ image by take threshold 0.02. Table 1 show the bit rate (B.r) and PSNR with wavelet transform method and with our proposed method. At last, the blackness is one of reconstruction image with most image compression methods, in this work the blackness is disappear.

Table 1- Compression Performance Of Wavelet Trans. And The Proposed Work, For ‘Mustafa’ Image				
Block size	wavelet trans. method		the proposed work	
	Bit rate	PSNR	Bit rate	PSNR
4x4	0.2	27.469	1.046	29.012
8x8	0.5	24.124	0.332	27.354



Original image



RGB Space



YIQ Space



Wavelet trans. 4x4



The proposed work 4x4



Final image



Wavelet trans. 8x8



The proposed work 8x8



Final image

Figure 3- Represents The Different Stages Of The Work

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