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HIGH RATE COMPRESSION BASED ON LUMINANCE & CHROMINANCE OF THE IMAGE USING BINARY PLANE TECHNIQUE

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ABSTRACT

When working with color images, many processing algorithms and procedures can perform separation of pixel values into their luminance and chrominance components .This paper presents a new approach to compress the luminance and chrominance components using lossy and lossless Binary Plane Techniques respectively. The results are compared with the compression applied directly on RGB image using lossy and lossless Binary Plane Technique.

Keywords: *Lossy and Loss less Binary Plane Techniques, luminance, chrominance, Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR),*

1. INTRODUCTION

The primary advantages of luma/chroma systems such as Y'UV are that they remain well matched with black and white analog television. Y' channel saves nearly all the data recorded by black and white cameras, so it produces a suitable signal for reception on old monochrome displays. In this case, the U and V are simply discarded. While displaying color, all three channels are used, and the original RGB information can be decoded.

Another advantage of Y'UV is some of the information can be discarded so that bandwidth is reduced. The human eye has fairly little spatial sensitivity to color. The accuracy of the brightness information of the luminance channel has more impact on the image detail discerned than that of the other two. Understanding this shortcoming of human vision, the bandwidth of the chrominance channels can be reduced considerably.

Therefore, the resulting U and V signals can be substantially "compressed".

2. PROBLEM STATEMENT

In this paper, we propose an approach in which chrominance data is processed separately from luminance which allows to exploit the limited resolution of color perception in human visual system as related to perception of the light intensity. Also a lower information content of the chrominance channels is exploited. The color artifacts observed in other traditional technique are overcome.

The chrominance components of color image data are processed independently using Lossy Binary Plane Technique and Luminance components are compressed with Loss less Binary Plane Technique.

This achieves more compression rate compared to the Binary Plane Technique applied on RGB plane of the image. The Mean Square Error can also be reduced compared to the Lossy Binary Plane Technique.

3. APPROACH

The RGB image is converted to Y, Cb, Cr Components. The luminance (Y) is directly compressed using Lossless Binary Plane

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Technique. The Chrominance components (Cb,Cr) are quantized first and then compressed using Lossy Binary Plane Technique. Finally all the three compressed components are merged to generate the compressed image as given in the fig1.

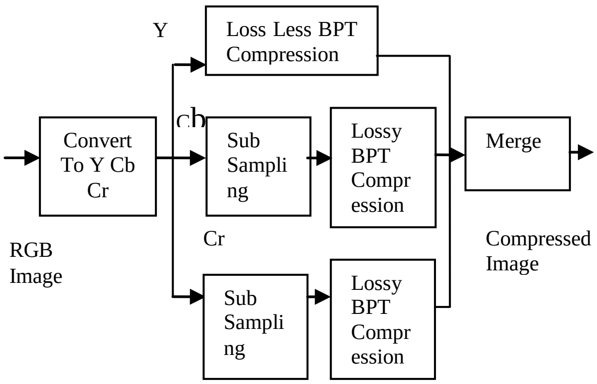

Figure.1Generation of compressed Image

3.1Conversion from RGB to Y'CbCr

Y'CbCr is the most common way to express color in a way suitable for compression/transmission. Y'CbCr signals are typically created from RGB source.

The possible range of values for chrominance and luminance reserves some footroom and headroom, which is necessary to provide some space for overshooting, e.g. in combination with analog video equipment. For computer based applications using RGB and YCbCr color formats, in many cases the complete possible range of 8 bit is used without providing a footroom or headroom. Typically this full-range color format is used for JPEG images.

The conversion of RGB colors into full-range YCbCr colors is described by the following equation.

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0 \\ 128 \\ 128 \end{bmatrix} + \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.169 & -0.331 & 0.500 \\ 0.500 & -0.419 & -0.081 \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Ranges;
R/G/B [0,,, 255]
Y/Cb/Cr[0,,, 255]

RGB to full-range YCbCr color conversion

The other way round, to convert a full-range YCbCr color into RGB is described by the following equation.

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.000 & 0.000 & 1.400 \\ 1.000 & -0.343 & -0.711 \\ 1.000 & 1.765 & 0.000 \end{bmatrix} \cdot \begin{bmatrix} Y \\ (Cb-128) \\ (Cr-128) \end{bmatrix}$$

Ranges;
Y/Cb/Cr [0,,,255]
R/G/B [0,,,255]

Full-range YCbCr to RGB color conversion

3.2Chroma subsampling

It is the practice of encoding images by implementing less resolution for chroma information than for luma information. It is used in many video encoding schemes both analog, digital and also in JPEG encoding.

Because of storage and transmission limitations, there is always a desire to reduce (or compress) the signal. Since the human visual system is much more sensitive to variations in brightness than color, a system can be optimized by devoting more bandwidth to the luma component (usually denoted Y'), than to the color difference components Cb and Cr. In uncompressed images, for example the 4:2:2 Y'CbCr scheme requires two-thirds the bandwidth of (4:4:4) R'G'B'. This reduction results in almost no visual difference as perceived by the viewer.

3.3Type of subsampling

Even though the different sub-sampling types like 4:4:4, 4:2:2, 4:2:1, 4:1:1 are present, the commonly preferred one is 4:2:1. In this the two chroma components are sampled at half the sample rate of luma the horizontal chroma resolution is halved. This reduces the bandwidth of an uncompressed video signal by one-third with little to no visual difference. Many high-end digital video formats and interfaces use this scheme.

But in the approach discussed 4:2:2 subsampling is followed.

4. BINARY PLANE TECHNIQUE

The main objective of this technique is to take advantage of repeated values in consecutive pixels positions. For a set of repeated consecutive values only one value is retained. In this proposal Lossless Binary Plane Technique is applied on luminance (Y) component and Lossy Binary Plane Technique is applied on Chrominance components of the image as shown in the figure1

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In the Lossless Binary plane technique the first part ‘bit plane’ holds the bit 0 for each pixel similar to previous pixel and the bit 1 for each pixel different from previous pixel. The second part ‘data table’ holds only the necessary pixel values, i.e. for a set of consecutive repeated values one value is stored in the data table.

In the Lossy Binary Plane Technique if current pixel value is just same as the previous pixel value or the difference within the threshold value selected, code bit 0 is stored in bit plane table. Otherwise code bit 1is stored in bit plane table and value of current pixel is stored in data table.

5. MERGING

Finally the three files of the compressed components are merged into a final form of compressed file and the size of each file is maintained in the beginning of the compound compressed file.

5.1Decompression Process

The inverse compression process is shown in Fig2.

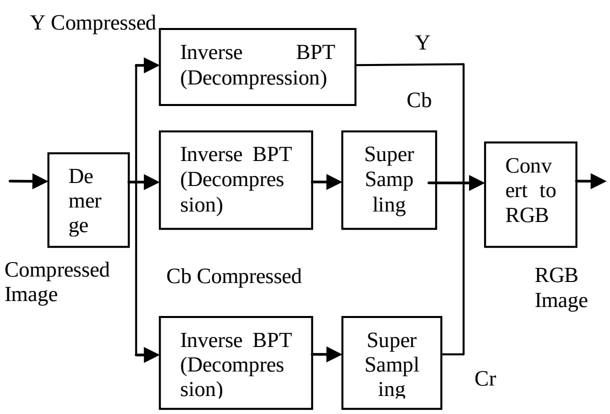

Figure 2.Inverse compression process

Initially the three compressed components (Luminance and two chrominance) are separated from the compound compression file. Each file is decompressed separately. The two chrominance component decompressed files are super sampled. Finally the image data in YCbCr format is converted into RGB format.

6. RESULTS

The images used for testing are shown in Fig 3, Fig 4 and Fig 5

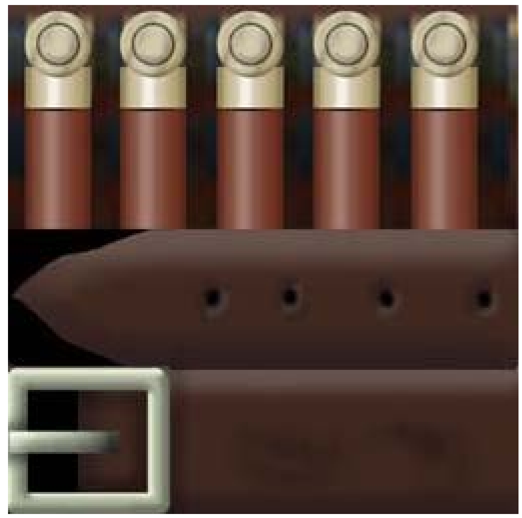

Figure 3 Test image T32

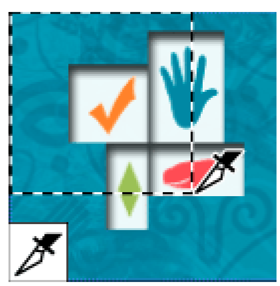
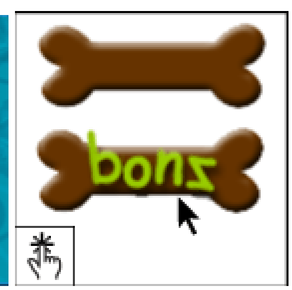

Figure 4 Test image hwa_07 Figure 5 Test image hwa_39

The results of the current technique with respect to Binary Plane Techniques and JPEG are as shown in the following Table 1.

The Table 1 gives comparison of compression rates achieved by different compression techniques when applied on different images. The corresponding graph shown is in Fig 6. The Table-2 gives the MSE and PSNR for the same set of images

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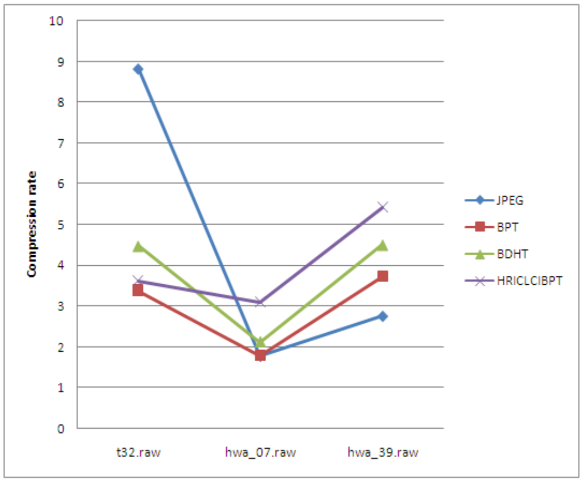

Figure 6 Compression Rates of different compression techniques

Table-1

Image	t32.raw	hwa_07.raw	hwa_39.raw
SIZE	196608	57132	57132
Jpeg	22276	31991	20687
C R	8.82	1.78	2.76
BPT	58007	31898	15330
C R	3.38	1.79	3.72
BDHT	43875	26877	12653
C R	4.48	2.12	4.51
HRICLCIBPT	54475	18428	10537
CR	3.61	3.1	5.42

Note: CR stands for Compression Rate

Table-2

Image	PSNR	MSE
t32.raw	36.54749	14.39896
hwa_07.raw	39.19143	7.833176
hwa_39.raw	37.81615	10.75142

From the results it is evident that in some cases the compression rate of the proposed technique is better than JPEG and other BPT techniques.

7. CONCLUSION

The high compression ratio can be achieved with this technique without much compromising the quality of the image. The subject evaluation of image is necessary as the PSNR ratings do not reflect perceived quality.

8. FUTURE WORK

The other sub sampling technique can be tried in place of 4:2:2 sub sampling to study the further impact on compression rate. Binary Plane coding is promising it can be mixed with DWT/DCT or Fractal compression methods to study and improve the effect on compression rate, MSE etc for an image

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