A Novel Approach to Image Compression of Colour Images by Plane Reduction Technique

K.Sowmyan, A.Siddarth, D.Menaka

***Abstract*—**Several methods have been proposed for color image compression but the reconstructed image had very low signal to noise ratio which made it inefficient. This paper describes a lossy compression technique for color images which overcomes the drawbacks. The technique works on spatial domain where the pixel values of RGB planes of the input color image is mapped onto two dimensional planes. The proposed technique produced better results than JPEG2000, 2DPCA and a comparative study is reported based on the image quality measures such as PSNR and MSE.Experiments on real time images are shown that compare this methodology with previous ones and demonstrate its advantages.

***Keywords*—**Color Image compression, spatial domain, plane reduction, root mean square, image restoration

I. Introduction

THE need for storing and transmitting huge volumes of data in today's computer and communication systems necessitates data compression in many fields ranging from medicine to aerospace. With the increase in evolution of multimedia and technology, there has been a growing need for the transfer of colour images with good image quality. Image processing is often very difficult because of large amounts of data used to represent an image. Technology permits ever-increasing image resolution (spatially and in gray levels) and increasing numbers of spectral bands, and there is a consequent need to reduce the resulting data volume.

Over the years many image compression algorithms have been developed and typically a compressed image when decoded to reconstruct its original from will be accompanied by distortion [1],[2],[4]. A major problem in evaluating lossy techniques is the extreme difficulty in describing the type and amount of degradation in reconstructed images. Coding in the spatial domain involves the direct manipulation of the sample image data to remove existing redundancies. It is easy to implement and modify the data statistics .The previous techniques which have been used for color image compression produced relatively high mean square error (MSE) and low peak signal-noise ratio(PSNR). This results in huge noise content during the reconstruction of the compressed images. The proposed technique is based on plane reduction of color images.Plane reduction has emerged to be a very effective approach for reducing size of images for transmission purposes. The colour images as such require huge storage space which has been a major drawback in satellite communication systems for capturing images from outer space. Here the RGB planes are reduced to a single plane based on processing the pixel elements. The processed pixels are mapped onto the resultant plane by preserving the dimensions of the image and the color components, thus achieving compression. The inverse problem of reconstruction of the image is achieved by mapping the pixels back to the RGB planes. During the mapping process the pixels are processed in a way so as to preserve the information of the image and not modify it. An input image of size M x N x 3 is converted to M x N and hence reduces the size of the color image. The mapping is done such that most of the information is retained during compression process. The error between the original input image and the reconstructed image is less and provides high peak signal-noise ratio. Further sections describe the technique in detail and experimental results on real time images in support.

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II. Image Quality Measures

A number of quality measures [4] are evaluated for gray scale and color image compression. They are all bivariate , exploiting the differences between corresponding pixels in the original and the degraded images. Image quality assessment is an important but difficult issue in image processing applications such as compression coding and digital watermarking. For a long time, mean square error (MSE) and peak signal-to-noise ratio (PSNR) are widely used to measure the degree of image distortion because they can represent the overall gray-value error contained in the entire image, and are mathematically tractable as well. We begin with a discussion of the MSE as a signal fidelity measure. The goal of a signal fidelity measure[3] is to compare two signals by providing a quantitative score that describes the degree of similarity/fidelity or, conversely, the level of error/distortion between them. Usually, it is assumed that one of the signals is a pristine original, while the other is distorted or contaminated by errors.

The MSE for two m x n images is given by:

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j)-K(i,j)]^2 \qquad (1)$$

In the MSE, we will often refer to the error $e_i = x_i - y_i$, which is the difference between the original and distorted signals. If one of the signals is an original signal of acceptable (or perhaps pristine) quality, and the other is a distorted version of it whose quality is being evaluated, then the MSE may also be regarded as a measure of signal quality.

The peak signal to noise ratio (PSNR) is given by:

$$PSNR = 10\log_{10}\left(\frac{MAX^2}{MSE}\right) \quad (2)$$

The higher the signal to noise ratio the better is the reconstruction process. The proposed method produces better results as compared to the previous 2DPCA[1] and Eigenimage[2] techniques.

III. Compression And Restoration

Consider a colour image whose size is M x N x 3 (Fig 1a), where M=number of rows and N=number of columns. The image is resized (Fig 1b) such that the number of columns is a multiple of three. A 1x3 block is considered in the Red plane of the image (Fig 1c) where each pixel lies in the range 0-255. The root mean square (rms) value of the block is calculated . The same process is carried out for the Green and Blue planes. The rms pixel values of each of the 1 x 3 blocks of the planes are mapped onto a single 1 x 3 block in a separate plane (Fig 1d).

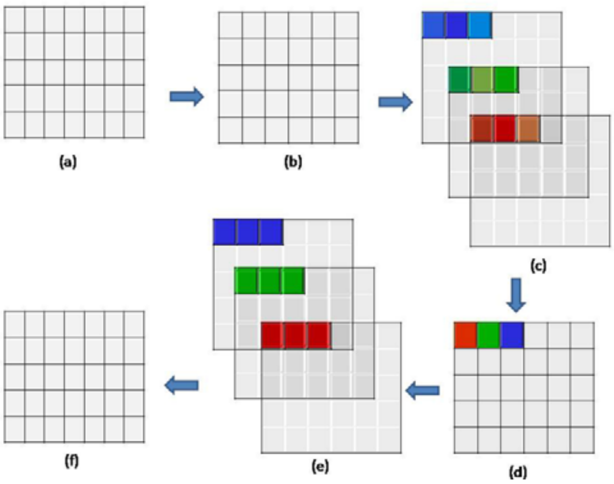


Fig 1 (a) Original colour image, (b) resized image with columns in multiplies of 3, (c) RGB planes of image, (d) compressed image (e) RGB planes of compressed image, (f) reconstructed colour image

The three planes, RGB in spatial domain is mapped onto a single plane of size M x N. The colour image of size M x N x 3 has been compressed to a size of M x N which occupies a space that is three times lesser than the original image.The compressed image has to be restored at the receiver end which is considered as the inverse problem. A 1 x 3 block is considered in the compressed plane. The first value is mapped back to a 1 x 3 block of the Red plane , the second value is mapped back to a 1 x 3 block in Green plane and the third value is mapped back to a 1 x 3 block in the Blue plane (Fig 1e).

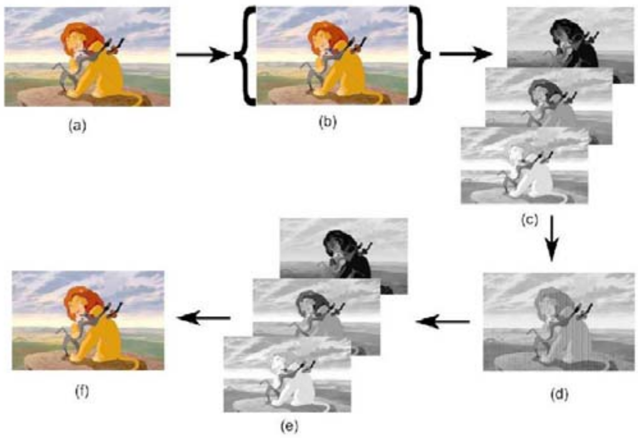


Fig. 2 (a) Original colour image, (b) resized image, (c) RGB planes of image, (d) compressed image, (e) RGB planes of compressed image, (f) reconstructed colour image.

The compressed image (M x N) is restored back to M x N x 3 colour image (Fig 1f). The technique provides a compression ratio of 3. The loss of information is justified by the low MSE and high PSNR values, thus providing better results than the previous techniques.

IV. Experimental Results

The proposed technique was implemented in a 512 x 512 peppers image. The technique produced amazing results which were far better than the previous spatial domain compression techniques. The 2DCPA[2] technique produced a PSNR of 33.088 db, Eigenimage technique[1] produced a PSNR of 33.6 db and JPEG produced a PSNR of 35.56 db. The proposed plane reduction technique produced a PSNR of 78.83 which is clearly more than twice the other techniques.

(a)

(b)

(c)

(d)

Fig 3 (a)Original colour image (b)-grayscale image (c) compressed image (d)-reconstructed colour image

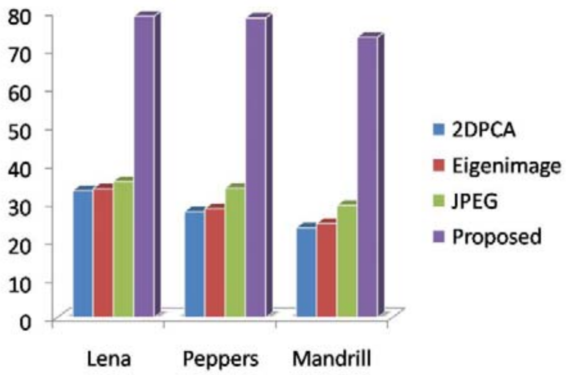


Fig. 4 PSNR values comparing the proposed technique with other techniques on Lena , Mandrill and Peppers colour image

It is clear from Fig 4 that the plane reduction technique is far better than other methods. The method was then used on real time colour images of various sizes and the technique proved to be applicable for all types of image formats (Eg. png , tiff , jpg , bmp etc).Some of the sample images on which the technique was implemented is shown in Fig 5 and the results are shown in Table I.

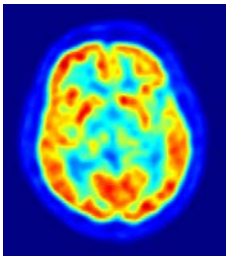
(a)

(b)

(c)

(d)

(e)



(f)

Fig 5. Sample images on which the proposed compression method was used

TABLE I
MSE AND PSNR VALUES OF PROPOSED TECHNIQUE ON SAMPLE IMAGES

SAMPLE	IMAGE	SIZE	MSE	PSNR
5 (a)	Peppers	512 x 512	9.48×10^{-4}	78.39
5 (b)	House	1944 x 2592	3.05×10^{-4}	83.32
5 (c)	Shelf	1944 x 2592	1.61×10^{-4}	86.10
5 (d)	Monalisa	864 x 560	8.98×10^{-4}	78.63
5 (e)	President Barack Obama	1634 x 1200	4×10^{-4}	82.14
5 (f)	Brain MRI	1132 x 1002	3.90×10^{-5}	92.25

V. CONCLUSION

The proposed Plane Reduction technique is proved to be highly efficient in compression and reconstruction of color images . Comparative study of the results with the previous available methods clearly shows the superiority of the proposed color image compression technique. This methodology can be implemented using wavelet transforms. Edge preservation algorithms and resolution enhancement will make the proposed technique useful for medical applications.

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