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An Optimized Color Image Coding using Quadtree Method

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Abstract— Generally the RGB images are characterised by high degree of inter-correlation. Based on this information the compression algorithms reduce the amount of bits required for coding, by transferring the RGB color space to another colorspace. Images consist of luminance and chrominance components but human eye is sensitive to luminance components. So, more bits are allocated to luminance components. This paper proposes Quadtree decomposition-based image coding. Most of the researchers have proposed several colorization-based image coding techniques, in which, the luma component is encoded by a standard encoder, while the two chroma components encoded by colorization. The proposed method colorizes the luminance image fast and effectively. The simulation results show that the proposed technique gives better results than the existing coding methods derived from classical methods.

Keywords—Luminance Image, Image coding, Quadtree decomposition

I. INTRODUCTION

The processing steps of the reversible compression are invertible themselves. These processing steps map integer input values to integer output values. This also concerns the color transformation, which aims at decorrelating the color components Red, Green and Blue (RGB).

In recent years, the demand for multimedia and its storage capacity of an electronic device increases tremendously. Compression technique has come into existence to reduce the size as much as possible. An inverse technique known as decompression is applied to the compressed images to reconstruct the original images.

Image compression is a reduction technique which reduces the size of a graphics file without decreasing the quality of images. The reduction can be done in both spatial and spectral redundancy in the image data for efficient transmission. Image compression is of two types. They are lossy and lossless compression techniques. Lossless compression technique is mainly used in medical imaging, technical drawings especially used at low bit rates. Lossy method is used for natural images where imperceptible loss of fidelity is acceptable. Most of the methods are classified under lossy methods i.e. the reconstructed image is an approximation of real image.

Fractal image compression is a new compression technique used to compress an image. In this paper, the hybrid method of fractal image compression (FIC) is applied which comes into the category of lossy image compression. But the main challenge is FIC takes long time for compression and it may also affect the image quality. Therefore, our method focus on achieving high Peak Signal to Noise Ratio (PSNR), higher compression ratio and also to reduce the compression time without decreasing the image quality.

The proposed methodology includes Hybrid FIC using Quadtree decomposition along with Huffman coding. This method is best suited for natural images. The basic step is to divide the image into segments by using the image processing techniques. The segmented image is further processed by using the Hybrid FIC to obtain better results.

RGB color model

Generally RGB colorspace is used in visual displays such as monitor, CRT monitor. The RGB colorspace uses 24 bit size for storage. RGB colorspace is denoted with three dimensions for three colors each. The combination of two colors produces another color such as red and blue gives magenta, while blue and green gives cyan, etc. The RGB colorspace produces a cube with all the shades with black and white at the corners.

The black and white colors consist of equal amount of red, green and blue colors. The length of the cube consists of the shades of the colors based on the proportion of red, green and blue colors. It is the basic and foremost colorspace.

II. EXISTING METHOD

The existing method is Color Image Coding Based on Linear Combination of Adaptive Colorspace. The block diagram of this approach is shown in Fig. (1).

A. Image coding

Image coding is used to transform one colorspace to another and each layer is encoded by different coding schemes. The transformed colorspace can be represented in 3 × 3 transform matrix. In our method RGB colorspace is transformed to Ycbcr colorspace. Y indicates the luminance value and cb, cr indicates the chrominance value. Based on the linear combination of luminance and chrominance values the coding scheme approximates the pixel values.

B. Chrominance Coding

The luminance layer and chrominance layer are less correlated, when the image consists of many edges. The above coding process cannot preserve the edges. So, in order to preserve the edges chrominance layer is encoded for each image segments. The image segmentation can be done based on the SLIC algorithm. SLIC (Simple Linear Iterative Clustering) algorithm clusters the image pixels in five dimensional colorspace in order to obtain uniform super pixels. This process reduces the approximation error of chrominance layer. After this linear combination, we use Huffman coding to express them in smaller bits. By this Huffman coding, we built a Huffman code table. In this entire process four coding schemes are prepared. So that, the encoder can selects the efficient one.

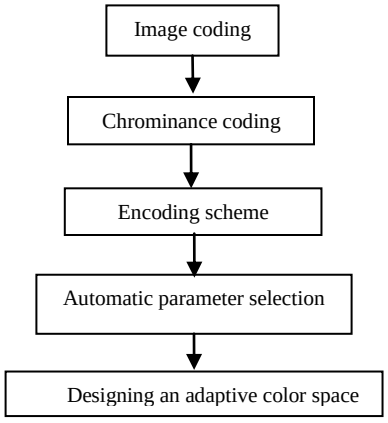

Fig. 1: Block diagram of existing method

C. Automatic Parameter Selection of SLIC

In the process of segmentation, SLIC technique is used to find K segments automatically as stated above. The parameter K can be obtained based on quality factor Q. The relation between K and Q can be approximated on the exponential solution as given in eq. (1).

$$K = \gamma \exp(\alpha Q + \beta) \qquad (1)$$

The automatic parameter selection scheme reduces the execution time for segmentation process.

D. Designing an adaptive colorspace

The Ycbcr colorspace is originally is used to suppress the variance of chrominance value. But this colorspace is not enough to reduce approximation error. So, an adaptive colorspace is introduced to form a transform matrix to RGB colorspace. In this process cb, cr are replaced by c1 and c2. In order to produce the transform matrix the weights should be calculated based on the minimizing the approximation error. The value of the weight vector should be in the range (-2, 2) to encode with high precision. The optimisation of color space requires many inverse problems to calculate Y_i, to increase the execution time for encoding. Final transform matrix is formed for some test images**.**

III. PROPOSED METHOD

A. Quadtrees Decomposition

The Quadtree decomposition is applied to the image after the fractal image compression. Fractal geometry is a branch of modern mathematics and nonlinear science. It also covers the branches like science and engineering. This wide usage of fractal technique leads to application of fractal geometry in image compression. But this fractal compression takes long time to compress the image. So researches focus on the hybrid fractal compression which uses fractal technique along with other techniques to reduce the compression time. Many methods are implemented to reduce the compression time but of no results. So, Quadtree algorithm along with fractal image compression is used. This algorithm divides an image into four equal sized square blocks, and each block is tested to meet the criterion of homogeneity. This process is iterative until it meets the criterion. The block diagram of the proposed method is shown in Fig. (2).

B. Encoding

The encoding process starts by constructing the alphabets in descending order according to their propobilities. Then, a binary tree is constructed with a symbol at every leaf from bottom up. This construction is done based on some steps. At each step two symbols with lowest propobilities are added to the top of the tree, delete from the list and replaced with auxiliary symbol, then the tree is completed. Finally this binary tree is transverse to determine the code words.

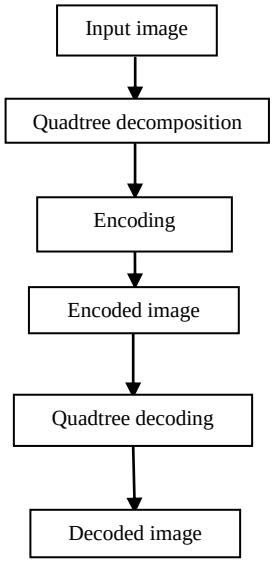

Figure 2: Block Diagram of Proposed Method

C. *Decoding*

After determining the code words of symbols from encoding procedure the compression of data file starts. The decompression procedure is as follows: the propobilities and corresponding frequencies is noted as side information on the output to decompress the propobilities as scaled integers. In this process it normally adds few hundred bytes to the output image. It is also possible to write the quadtree on the output, but it requires more space.

THE PROPOSED ALGORITHM

The algorithm for the proposed method is developed and the steps of the algorithm are:

(i). Firstly, divides the original image using quadtree decomposition.
(ii). From this decomposition record x and y coordinates, mean and block size.
(iii). Record the fractal coding information to complete the process of encoding.
(iv). For the encoded image apply quadtree decoding process to reconstruct the original image and calculate PSNR value.

IV. RESULT

The proposed color image coding using Quadtree decomposition method is implemented in MATLAB. The performance of the proposed technique is verified using two parameters namely: PSNR and Structure Similarity Index (SSI) for two color image. The simulations results of the proposed methods are also compared with the existing method. The performance of the proposed Quadtree method is verified on two color images. Fig 3(a) is applied as input image to proposed algorithm. The encoding color image is performed by the quadtree operations, this is done finally the reconstructed quadtree decoded image shown in Fig 3(d). Similarly Fig 4(a) is original image is applied, the reconstructed quadtree decoded image shown Fig 4(d).

Fig. 3(a): original image

Fig. 3(b): original padded image

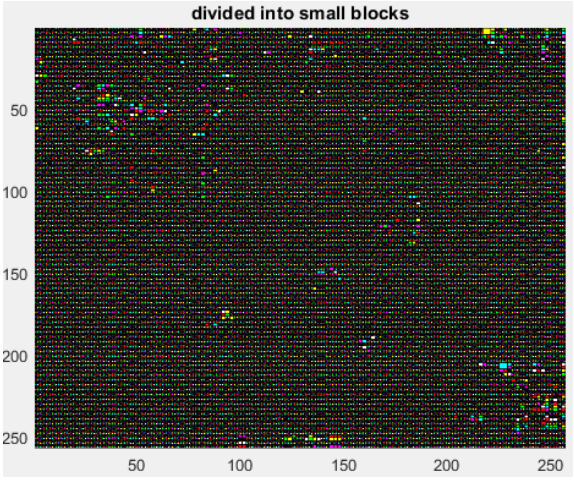

Fig. 3(c): divided into small blocks

Fig. 3(d): Quadtree decoded image

Fig. 4(a): original image

Fig. 4(b): original padded image

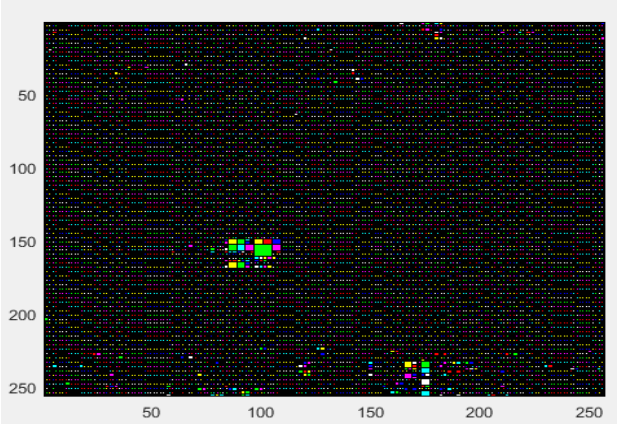

Fig. 4(c): divided into small blocks

Fig. 4(d): quadtee decoded image

The performance of the proposed algorithm is also verified using quantitative analysis with PSNR and SSI. The parameter values of PSNR and SSI of the proposed and existing methods for the above two input images are provided in Table 1.

Table 1: comparison of existing and proposed metrics

Methods	**Fruit Image**		**Car Image**	
	PSNR	*SSIM*	*PSNR*	*SSIM*
Existing Method	55.2702	0.6938	54.1241	0.6905
Proposed Method	68.7037	0.9768	61.7353	0.9489

V. CONCLUSION AND SCOPE

This paper explained about existing methodologies of color image coding and also presented the color image coding using quadtree decomposition method. The existing methods have dealt with exploiting this inter-correlation by expressing some color components as a functional of a base component, thus reducing the amount of data required for representation.

The proposed method produces reconstructed result with higher PSNR and SSIM. It also produces superior results compared with the existing method for images of well-defined separate color regions.

The future scope of this methodology reduces the compression time by using some advance techniques like neural network, fuzzy logic and by using different thresholding methods.

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