Proceedings of the 6th WSEAS International Conference on Multimedia Systems & Signal Processing, Hangzhou, China, April 16-18, 2006 (pp102-104)

An Image Coding Method by Construction of Variable Block Size and Region Compensation

JIN-TAE KIM*, DONG-WOOK KIM**, JEONG-SU OH***, HANKYU LIM****, HO-KEUN SONG*

* Department of Computer & Information Science, Hanseo University, Korea
** Department of Information & Communication Engineering, Jeonju University, Korea
*** Division of Image and Information Engineering, Pukyung National University, Korea
**** Department of Multimedia Engineering, Andong National University, Korea

ABSTRACT: In this paper, an efficient image data compression technique is proposed, using the discrete cosine transform (DCT) and region compensation with variable block size. In order to achieve higher coding efficiency, variable block sizes are constructed based on information about image segmentation. And then the region compensation technique is applied to the blocks that include contours.

Key-Words: region compensation, variable block size, segmentation, contour, texture

1 Introduction

The discrete cosine transform (DCT) is widely used for image and video compression. Based on the transform, a grayscale image can be compressed to about 0.8 bits per pixel (bpp) with almost no perceptible defects. Generally, the coding scheme based on the DCT is developed by utilizing a fixed block size. In this case, it makes no allowance for the image's features and correlation among each block or pixel. If a variance of brightness levels in the block is heavy, the high bit rate is allocated to transform coefficients. However, at a low bit rate (e.g., less than 0.4 bpp [1]), a reconstruction image often contains artifacts which present themselves as discontinuities at block boundaries. Discontinuities between blocks occur in the contour region of the image. Various methods have been suggested to reduce blocking artifacts [2].

In this paper, we aim to solve the problems which are generated with constant block size, as is the case with most transform coding schemes. This paper is based on the coding scheme where an image is split into blocks of variable sizes with image segmentation. Also, a region compensation technique is applied to the contour regions.

2 Variable Block Construction

One of the variable block size coding schemes attempts to describe an image in terms of contour and texture [3]. Each object in a natural scene is characterized by its borders and surfaces. Image segmentation refers to the decomposition of a scene into its components in wavelet transform. It is a key step in image analysis and image coding. In our study, image segmentation is done by a hybrid linkage region-growing method [4]. It contains preprocessing, initial segmentation and postprocessing. To reduce the creation of small regions, median filtering is performed on local neighborhoods of input pixels during the preprocessing.

Generally, a transform scheme involves subdividing an $M \times M$ image into smaller $N \times N$ blocks. In most cases, a block size is set to 8×8. But, when a variance of brightness levels in the block is great, it brings about the diminution of energy packing, resulting in a decrease in coding efficiency. By construction of a variable block size with a base for similarity of features in the image, we could solve these problems. In this paper, block sizes are composed of 8×8, 16×16 and 32×32. The decisions on block sizes are made as follows:

Step 1: An $M \times M$ input image is divided into the smallest block.
Step 2: Determine the largest block size.
Step 3: With scanning left to right and then top to bottom, a block is selected if all pixels in the selected block are included in the same region.
Step 4: If a pixel is an endpoint of the image but not the smallest size, reduce the block size and go to step 3.
Step 5: If the block size is the smallest size, finish all work.

Since this method is applied to an image, pixel by pixel, it can achieve higher coding efficiency than the scheme based on a quadtree. As a necessary consequence, contours are composed of 8×8 block size only. We assign the name “texture block” to a block formed with one region only, and “contour block” to a block formed with two or more regions.

3 Region Compensation

Region compensation is used in this paper to improve the efficiency of the transform coding. This is applied to the contour blocks, blocks composed of two or more regions. It performs a function that reduces the brightness differences of each region. First, let the following conventions be made: *master region*, the largest region inside a contour block, and *slave region*, elsewhere. Then, the region compensation is performed by using (1) and (2). As an example, let us consider a contour block as shown in Fig. 1.

$$B' = B + (mean(A) - mean(B)) \times \beta \qquad (1)$$

$$C' = C + (mean(A) - mean(C)) \times \beta \qquad (2)$$

Using the master region A, regions B and C, slave regions, are compensated with (1) and (2). Where, β is a factor of region compensation quantity, selection for β can be given by considering the relationship between bit rate to be allocated and a reconstruction image quality to be obtained. A, B, C are marks for before region compensation, A', B', C' for after region compensation, respectively. After region compensation, each region has similar mean values, as follows:

$$mean(B') \approx mean(A) \qquad (3)$$

$$mean(C') \approx mean(A) \qquad (4)$$

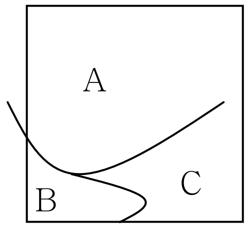


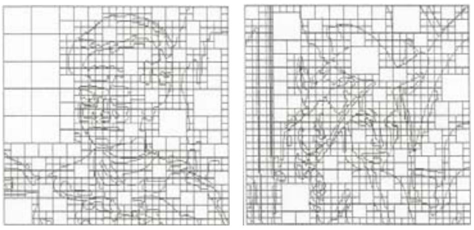
Fig. 1. Region segmentation

Region compensation is not always applied to all contour blocks. It is selectively performed. Namely, a good criterion is used about whether region compensation is applied or not, based on the bit rate allocated to the AC coefficients in each case. The image coding method using the region compensation is processed as follows: on the quantization and encoding, transform coefficients are treated separately with coefficients DC and AC. In DC coefficient, the texture block and contour block are respectively quantized and encoded by a different scheme. First, for a texture block, if it is the first block of a region, the difference between the DC coefficient value and the mean for a region of the block included is quantized. Otherwise, the DC coefficient difference between the block and the previous block is quantized. Second, for a contour block, quantization of the DC coefficient is achieved with difference between the DC coefficient and the brightness mean value of the master region. As a matter of course, it makes it possible by transmission to the receiver, as part of the header information, contour information and brightness mean values of each region. The region compensation technique produces a reduction of the difference between DC brightness mean values. And owing to the reduction of the difference between each region of a contour block, the magnitude of AC coefficients is reduced.

4 Computer Simulation

In order to demonstrate the performance of the proposed algorithm, computer simulations were performed using ‘Girl’ and ‘Lenna’ images with 256×256 size and 8 bits/pixel. Fig. 2 shows a construction of variable block sizes for the segmented image.

Proceedings of the 6th WSEAS International Conference on Multimedia Systems & Signal Processing, Hangzhou, China, April 16-18, 2006 (pp102-104)



(a) 'Girl' (b) 'Lenna'

Fig. 2. Construction of variable block

The degree of region compensation β is selected by consideration of the relationship between bit rates and PSNR. In our simulations, $\beta = 0.4$ is used.

Table 1 summarizes the results obtained with the proposed algorithm and the conventional method. The results show that the proposed algorithm is superior to the conventional algorithm in bit rate by 11.3% on average. In the proposed algorithm, results show that our proposed scheme saves the bit rate for transform coefficients. But the bit rate to be allocated to overhead information is relatively high.

5 Conclusion

A new bit rate reduction technique is proposed in this paper. This technique can be summarized as follows. Using the image segmentation, an image is split into blocks of variable size with application pixel by pixel. Then region compensation is applied to the contour blocks. This algorithm has advantages over the conventional algorithm in bit rates with almost the same PSNR. From the experimental results, one can see that the new technique produces a bit rate of 11.3% lower than the conventional algorithm. There is a room for further study on reducing the bit rate to be allocated to overhead information.

References:

[1] T. P. O'Rourke and R. L. Stevenson, Improved Image Decompression for Reduced Transform Coding Artifacts, *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 5, No. 6, 1995, pp. 490-499.

[2] J. J. Zou and H. Yan, A Deblocking Method for BDCT Compressed Images Based on Adaptive Projection, *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 15, No. 3, 2005, pp. 430-435.

[3] H. Choi and T. Kim, Blocking-artifact Reduction in Block-coded Images using Wavelet-based Subband Decomposition, *IEEE Transaction Circuits and Systems for Video Technology*, Vol. 10, No. 5, 2000, pp. 801-805.

[4] R. M. Haralick and L. G. Shapiro, Survey: Image Segmentation Techniques, *Computer Vision, Graphics and Image Processing*, Vol. 29, No. 1, 1985, pp. 100-132.

Table 1. Experimental results

Image	Method	Region	Block	Transform coefficient			Overhead				Bit rate	PSNR
				DC	AC	Total	Class	Texture	Contour	Total		
Girl	conventional	0	1024	5754	44686	50440	0	0	0	0	0.770	34.76
	proposed	56	676	3387	35318	38705	428	392	5248	6456	0.689	34.56
Lenna	conventional	0	1024	7607	68929	76536	0	0	0	0	1.168	31.51
	proposed	75	766	4810	55730	60540	474	525	5730	6729	1.026	31.50

Class: indicates whether a contour block is the compensated block or not