A Zonal JPEG

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Abstract

In this paper, a simple approach is proposed to improve the performance of JPEG. In the proposed approach, the coding scheme is identical to the JPEG except only a fixed number of coefficients are coded for each image block. Consequently, it is totally compatible with the JPEG and is termed as zonal JPEG. Simulation results indicate that the proposed zonal JPEG is able to trade little PSNR with significant bit rate reduction when compared with thee JPEG.
Keywords: JPEG, zonal coding, image compression, bit rate reduction

1. Introduction

Up to present, the standard JPEG [1] has been extensively applied in many fields where image compression is required. Though a new coding standard JPEG2000 [2-3] has been proposed, the JPEG is still employed in many applications such as digital camera and multimedia systems. Moreover, the core technology in the JPEG is also a fundamental in popular video coding standards like MPEG1, MPEG2, H.261, and H.263 [4]. Consequently, a more effective JPEG coder could benefit storage or bandwidth utilization for a period of time before the new standard JPEG2000 and other video coders prevails over the coding community.

In this paper, we propose a simple approach to make the JPEG more effective in bit rate utilization. In the proposed approach, only a fixed number of transform coefficients are coded. By this simple modification, the bit rate utilization is improved at the cost of little loss in PSNR. This paper is organized as follows. The proposed zonal JPEG is described in Section 2. An example is provided in Section 3 to justify the proposed zonal JPEG where simulation results are discussed as well. Finally, conclusions are made in Section 4.

2. The Proposed Zonal JPEG

The zonal JPEG, which is modified from the JPEG, is introduced here. In the zonal JPEG, for each image block only M transform coefficients are selected, quantized, and coded while the JPEG codes all quantized transform coefficients. Since the concept is same as zonal coding [5-6], the proposed approach is called zonal JPEG. The coding process of the JPEG is shown in Figure 1. The proposed zonal JPEG is identical to the JPEG except the following modification: By the zigzag scan order, the first M coefficients are selected, quantized, and coded. When $M = 64$, the zonal JPEG is same as the JPEG.

3. Simulation Results

In this section, simulation results are provided to verify the proposed zonal JPEG. the 512×512 image Lena is used in the simulation. In the simulation, the default settings for the JPEG are used. For details, one may consult [1, 4]. To demonstrate the proposed zonal JPEG having better bit rate utilization than the JPEG, the tradeoff between PSNR and BR in the zonal JPEG is investigated. The simulation is performed as follows. First, the JPEG is performed on image Lena. The reconstructed Lena shown in Figure 2 is of PSNR (peak signal-to-noise ratio) 36.4003 dB and BR (bit rate, bit/pixel) 1.0641. Then, image Lena is coded by the proposed zonal JPEG with various values of M at 8, 16, 24, and 32 which are recorded in Table 1, where ZJPEG stands for the zonal JPEG and ΔPSNR and ΔBR mean the differences between the JPEG and the zonal JPEG in PSNR and BR, respectively. In the case of $M = 32$, the simulation result implies that the 33^{rd} to 64^{th} coefficients in the zigzag scan order almost have

no improvement on PSNR since ΔPSNR = 0.0447 dB. In this case, ΔBR = 0.3436 which means the zonal JPEG saves 0.3436 BR when compared with the JPEG. The reconstructed Lena in this case is given Figure 3. By ΔPSNR and ΔBR, it comes to the conclusion that the JPEG pays 0.3436 of BR to improve 0.0447 dB on PSNR in this case. Or it can be said that the proposed zonal JPEG is able to trade 0.0447 dB of PSNR with 0.3436 bit rate reduction. The simulation results indicate that the proposed zonal JPEG has better bit rate utilization than the JPEG and that the JPEG wastes too much bit rate in the coding of high-frequency coefficients which generally contribute very little to PSNR. As a rule of thumb, the reconstructed image with $M = 40$ is almost as good as that obtained from the JPEG for most of images.

4. Conclusions

In this paper, we propose a simple approach to make bit rate utilization more effective in the JPEG. The proposed approach is modified from the JPEG where only $M < 64$ transform coefficients are coded for each 8×8 image block. The modified JPEG is called the zonal JPEG which is totally compatible with the JPEG. The simulation results indicate that the zonal JPEG is able to trade little PSNR with significant bit rate reduction when compared with the JPEG.

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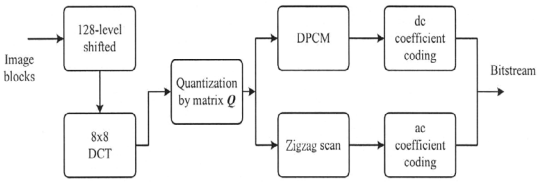

Figure 1. The coding process of the JPEG

Figure 2. Reconstructed Lena (JPEG)

Figure 3. Reconstructed Lena (ZJPEG, *M*=32)

Table 1. Comparisons of PSNR and BR between the JPEG and the zonal JPEG

M	PSNR (dB)		BR (bit/pixel)	
	ZJPEG	ΔPSNR	ZJPEG	ΔBR
4	28.0255	8.3748	0.2611	0.8030
8	31.5424	4.8579	0.4032	0.6609
12	32.6627	3.7376	0.4719	0.5922
16	34.4988	1.9015	0.5316	0.5325
20	35.6150	0.7853	0.6085	0.4556
24	35.6973	0.7030	0.6614	0.4027
28	36.2173	0.1830	0.6953	0.3688
32	36.3556	0.0447	0.7205	0.3436