Blocking Artifacts Reduction using Two Modes Shift Block Filter

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Abstract： Blocking effect is the major drawbacks in DCT-based codec at low bit-rate. An efficient anti-blocking effect algorithm is induced in the DCT domain. The proposed algorithm eases the false edges with low computational complexity. Two operations are suggested to different region according the region feature. One operation applies to the smooth region and the boundary edges become to linear distribution and more gradual. The other operation tries to remove some high frequency DCT component and to make the false edge smoothness but not harm for the image quality. The proposed scheme can take best quality in both objective and subjective metrics. Moreover, the objective metric, Peak Signal-to-Noise Ratio (PSNR), can improve to 0.5 dB.

1. Introduction

For high compression rate, a lot of DCT-based codec are proposed to reduce the storages of transmitting multimedia. However, low bit-rate compression cause serious blocking artifact to annoy the end users. There are many attempts [1-5] to reduce blocking artifacts in images. Two kinds of DCT domain schemes [2-5] are performed. One [2-3] predicts the DC and AC values to reduce discontinue effect according neighbor blocks DC values. The other [4-5] yields the new shift block to update several coefficients to produce good perception quality. In Zeng and Luo's method, pruning high frequency information off approaching the required bit-rate results plaid signal to affect the quality of image quality. Blocking effect is a certain noise exhibits as vertical and horizontal filaments between the boundaries of DCT blocks and conspicuous in smooth regions. In this paper, a deblocking algorithm is proposed for enhancing the image quality both subjective and objective metrics with low computation complexity. The reminder of this paper is organized as follow. Section 2 describe in details The simulation results in section 3 show that our algorithm efficiently reduces the blocking effect in both smooth and edge-texture regions. Section 4 provides the conclusions and discussions.

2. Proposed algorithm

According to the blocking features, four kinds of DCT blocks are defined as smooth, vertical, horizontal, and texture. Fig.1 depicts the examples of smooth, vertical and horizontal region. The distribution of the gray value presents in Fig. 2 (a)-(c). A smooth blocking region (Fig. 1 (a)) processed by DCT-based encoder contains four DCT blocks that have different gray values resulting in the discontinuous false edges, annoy the users. Fig. 1(b)-(c) reveal the examples of vertical blocking and horizontal blocking regions suffering from the blocking artifact.
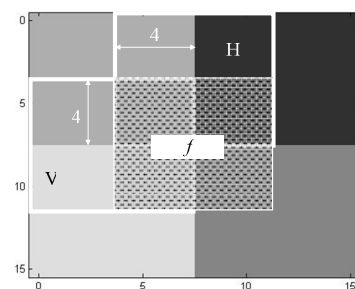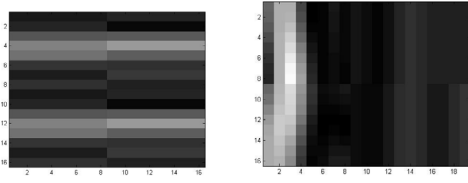

(a)

Fig. 1 Three regions with blocking artifact (a) smooth region (b) horizontal region (c) vertical region

Two DCT-domain anti-artifact algorithms are proposed by Zeng [4] and Luo [5]. Zeng's Zero-Masking technique heightens the image quality using a global operation that set several DCT coefficients to zero. Luo's algorithm differentiates the regions between smooth and edge region using different operators to enhance the perception of image. However, their methods suffer from high computation complexity that two processing directions, horizontal and vertical (shown in Fig. 1(a) H, V) need to be processed and lower the objective metric, peak signal to noise ratio(PSNR).
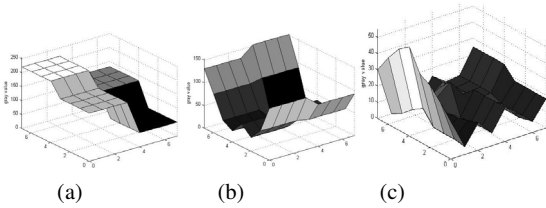

Fig. 2 The gray value distribution of each region (a) smooth region (b) horizontal region (c) vertical region
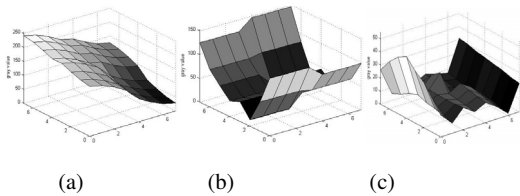

Fig. 3 The gray value distribution of each region by applying the operation α(a) smooth region (b) horizontal region (c) vertical region

In Zero-Masking technique, one direction processing block (V or H) would be chosen to execute the operation and then turn to the other direction. For example, each horizontal-block is transformed by DCT and several DCT coefficients that is K(0, 3), K(0, 5), and K(0, 7) set to zero (K represents the DCT coefficients for Zeng's block). Invert DCT is applied to the modified shift block and the DCT coefficients, K(3, 0), K(5, 0), and K(7, 0), is denoted as zero in another direction. After applying the Zero-Masking

scheme one iteration, the perception of image does not improve noticeably. The image quality can be enhanced by applying several iterations conspicuously. However, the blurring effect appears nearby the edges after several iterations and two direction processing results in high DCT complexity. The proposed scheme decreases the computation complexity and does not bring out new artifact such as blurring artifact.

In order to reduce the number of DCT transform, the processing block involves the false horizontal and vertical edge in proposed algorithm. The processing block shifts the DCT block by four horizontal and four vertical pixels, as presented in Fig. 1(a). The 8×8 block $f(x,y)$ is transformed by DCT in Eq. (1) and DCT coefficient is specified as F(u,v).

$$F(u,v)=\frac{1}{4}C(u)C(v)\left[\sum_{x=0}^{7}\sum_{y=0}^{7}f(x,y)*\cos\frac{(2x+1)u\pi}{16}\cos\frac{(2y+1)v\pi}{16}\right] \quad (1)$$

Owing to Ref. [1] has proved that smoothing the boundary pixels can alleviate the blocking effect, the target of anti-blocking algorithm is to make the distribution of gray value become slacker in the boundaries of DCT block. The operation proposed by Zero-Masking is applied to proposed processing block (F). The operation (α) is shown in Eq. (2) to set the DCT coefficients in F(3, 0), F (5, 0), F (7, 0) F (0, 3), F (0, 5), and F (0, 7) to zero and then transform by IDCT.

$$F(u,v)=\begin{cases} 0, & u=0, v=3,5,7 \\ 0, & u=3,5,7, v=0 \\ F(u,v), & otherwise \end{cases} \quad (2)$$

The operation α is applied to the smooth blocking, horizontal blocking, and vertical blocking regions in Fig. 1 (a)-(c) and present the distribution of the gray value in Fig. 3 (a)-(c). In the smooth blocking region, the boundary edges become to linear distribution and more gradual. Nevertheless, consecrating the operation α to the edge regions that is shown in Fig. 3 (b)-(c) still containing extremely sharp peaks that can not make the edge gaps more slacker.

Applying α to the blocking regions does not reduce the artifact nearby the edge. Two operations, β and μ, show in Eq. (3)- (4) intend to reform the results of edges a better

result in the proposed algorithm.

$$F(u,v) = \begin{cases} 0, & u = 0, v = 5,7 \\ 0, & u = 5,7, v = 0 \\ F(u,v), & otherwise \end{cases} \quad (3)$$

Applying operation β to the same edge regions (Fig. 1(b) and Fig. 1 (c)) to acquire the distribution of gray value is shown in Fig. 4(a) and 4(b). Each processing block (f) is transformed by DCT and uses operation β to set F(5, 0), F(7, 0), F(0, 5), and F(0, 7) to zero. Finally, F is transformed by IDCT and shown in Fig. 4. Comparing Fig. 4 with Fig 3, the valley in Fig. 4(a) is slight heave but Fig. 4(b) is rough and uneven in surface. However, applying operation β to each processing block can not make the edge smoothness to alleviate the blocking artifact.

Fig. 4 indicates the edge regions still contain some peak and valley in the block after applying operation β. Some high frequency component cause the surface is rough and uneven. Operation μ removes high frequency DCT component to make smooth the false edge but not harm for the image quality. Twenty-eight DCT coefficients are set to zero in operation μ (Eq. (4)). Fig. 5 represents the gray-level distribution and sharp peaks are disappearing.

$$F(u,v) = \begin{cases} 0, & u = 5,7, v = 0,1,23,...,7 \\ 0, & u = 0,1,23,...,7, v = 5,7 \\ F(u,v), & otherwise \end{cases} \quad (4)$$
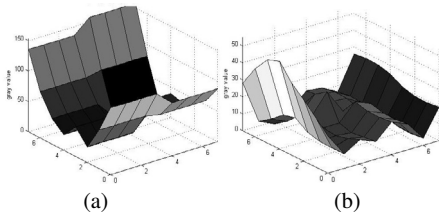

(a)   (b)

Fig. 4 The gray value distribution of edge region by applying the operation β (a) horizontal region (b) vertical region

The proposed anti-blocking scheme adopts these two operations, α and μ, to enhance image quality. In the smooth region, operation α can make the false edge become almost linear and operation μ smooth out the edge regions. The algorithm is summaries in fig. 6.

3. Simulation results

In our experiments, two metrics are applied to verify the performance of our scheme. PSNR (Peak Signal-to-Noise Ratio) is the most widely used objective image quality

distortion metric. But PSNR is widely criticized as well for not correlating well with perceived quality measurement. Ref. [6] is developed objective NR (No-Reference) quality assessment algorithm for DCT-based compressed image. The NR assessment scheme assigns each image a quality score between 0 and 10 (10 represents the best quality and 0 the worst). In our simulation result, our scheme can take best quality in both objective and subjective metrics.
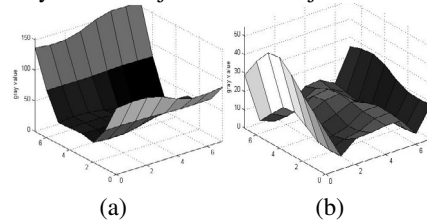

(a)   (b)

Fig. 5 The gray value distribution of edge region by applying the operation μ (a) horizontal region (b) vertical region
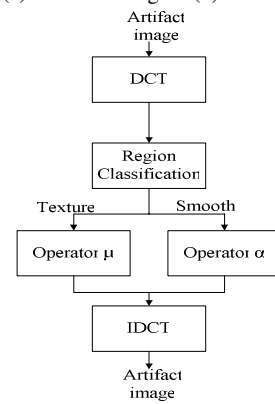

Fig. 6   The flowchart of the proposed method.

The proposed algorithm has been applied to a number of JPEG-coded images at low bit rates. The test images is Waltham with 3800 × 2600 pixels. Fig. 7 shows the deblocking results of Luo, Zero-Masking with five iteration, and our scheme. Fig. 7(a) is the JPEG Waltham dial image at 0.29 bpp, containing many artifacts around smooth and complex regions. The results of Luo and Zero-Masking technique slight remove the artifact especially the body of pocket watch in Fig. 7 (b)-(c). The false edges near dial are almost removed in Fig. 7 (d) and the texture is more closed to original image.

Table 1 presents the results of the others test images at 0.2 bpp using previous three methods and JPEG standard. As the Lena image, our result is superior to other algorithms and improves the PSNR value to 0.5 dB. A JPEG quality score [6] computed on the test images further confirms the effectiveness of the proposed filter method in Table 2. The JPEG-coded boat image is only 1.93 score at 0.2 bpp, but its

post-processed image uses the proposed scheme to reach 8.5 score. The proposed method establishes an excellent performance in comparisons with several deblocking method. Unlike other methods, our scheme does not smooth out the image after removing blocking artifacts. All these favorable features make the algorithm versatile enough to be used as a post-processing filter across a wide bit-rate range.
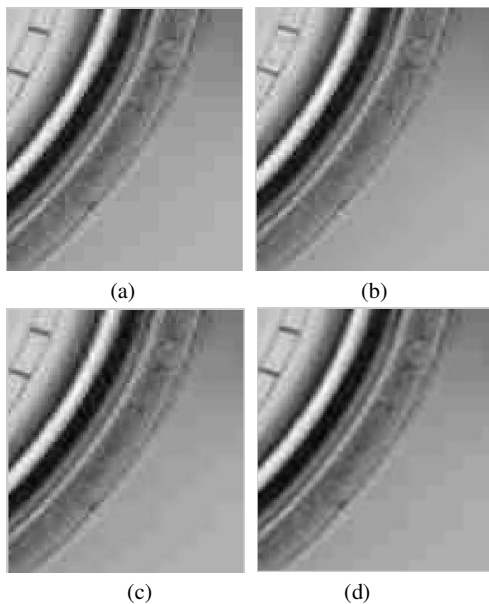

(a)　　　　　　　(b)

(c)　　　　　　　(d)

Fig.7 The deblocking Results of the Waltham dial test image at 0.29 bpp (a) original JPEG image (b) result of applying Luo scheme (c) result of applying Zero-Masking, five iterations (d) result of applying proposed scheme

4. Conclusions

In this paper, we have proposed a post-processing that has two operations for the reduction of blocking artifacts in DCT-coded image. One operation applies to the smooth region and the boundary edges become to linear distribution and more gradual. The other operation tries to remove some high frequency DCT component and to make the false edge smoothness but not harm for the image quality. Zeroing out a few AC coefficients of processing block can provide better visual quality to coded-images. The scheme not only eases the artifacts off but also gets the good image quality of coded image. Comparing by other schemes our method reduces computational complexity and adapts to real-time applications.

Table 1.The comparison subjective metric (PSNR) of test images at 0.2 bpp using proposed , Luo and Zero-Masking schemes.

	JPEG	proposed	Luo	Zero-Masking
Lena	29.15	29.66	29.12	29.03
baboo	19.56	19.78	19.74	19.66
boots	22.26	22.73	22.51	22.62
boat	26.82	27.23	26.77	26.66
F16	26.19	26.71	26.19	26.23
Goldhill	26.87	27.20	27.02	27.00
7 sister	29.66	30.00	29.10	29.40

Table 2. The comparison objective metric (JPEG-score) of test images at 0.2 bpp using proposed , Luo and Zero-Masking schemes.

	JPEG	proposed	Luo	Zero-Masking
Lena	2.68	8.99	4.53	7.40
baboo	1.25	7.16	2.65	5.39
boots	0.00	6.85	0.93	5.34
boat	1.93	8.46	4.08	7.21
F16	1.94	8.39	3.94	7.15
Goldhill	0.80	8.26	3.87	7.26
7 sister	3.32	9.45	5.72	7.86

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