

Image Reduction using Edge Based Region of Interest

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Abstract: Region of Interest in an image reduction is significant problem in DCT based image compression, which introduces the apparent distortion of visual quality. In this paper, an effective region of interest based reduction on an image is proposed. Compared with the existing method, first the edges are identified for compression. Secondly a range of ROI type is introduced according to DCT co-efficient distribution. An adaptive compound method is carried out to reduce the region on the image.

Keywords: Adaptive, Compression, Edge, Image, Region.

1. INTRODUCTION

In this paper, a novel and systematic scheme is proposed for reducing the ROI reconstruction in transform domain. Adaptive creation of ROI, deduction of ROI reconstruction is carried out by an adaptive compound method. The adaptive choice of concrete method is based on the value of the criterion, derived according to the DCT co-efficient distributions, which are in half ROI size shifted image block and also in the original target image blocks. Compared with some existing methods], the proposed method keeps better visual effects, no matter under low bit rate encoding scenarios, which was measured with subjective method and also objective method.

The remaining paper is organized as follows. Section II introduces the method of locating the edge in compression scheme. Section III describes performing deduction of ROI reconstruction in DCT domain. Experiment results and conclusion of the paper is given in section IV.

2. LOCATING EDGES

In this section, a fast and efficient edge detection which is carried out directly with the DCT co-efficient is briefly introduced.

Firstly the 8x8 2-D DCT as below

$$X(U, V) = \frac{e(u)e(v)}{16} \sum_{k=0}^7 \sum_{l=0}^7 x(k, l) R_{16}^{(2k+1)u} \cdot R_{16}^{(2l+1)v} \quad (1)$$

$$u, v = 0, 1, \dots, 7 \text{ and } N = 8$$



Where

$$R_{2N} = \cos\left(\frac{\pi T}{2N}\right)$$

and $e(\delta) = \frac{1}{\sqrt{2}}$ if $\delta = 0$, elsewhere $e(\delta) = 0$

The inverse transform will be expressed as

$$x(u, v) = \sum_{m=0}^7 \sum_{n=0}^7 e(m) e(n) \cdot X(m, n) R_{16}^{(2u+1)m} \cdot R_{16}^{(2v+1)n} \tag{2}$$

$u, v = 0, 1, 2, \dots, 7$

Secondly with 8x8 2-D DCT ROI, divide the ROI in to four sub region equally. Then the average intensity value of each sub region is expressed as

$$S_{m,n} = \frac{1}{16} \sum_{i=0}^3 \sum_{j=0}^3 x(4m+i, 4n+j) \tag{3}$$

Where $m, n = 0, 1$ and $N=4$

Where $X(u, v)$ $u, v = 0, 1, 2, \dots, 7$ denote the intensity value of each pixel in the ROI. U and V are the vertical and horizontal indexes. Based on the equation 1 and 3 the resultant equation is represented below

$$S_{m,n} = \sum_{u=0}^7 \sum_{v=0}^7 W_{mn}(u, v) \cdot (u, v) \quad m, n = 0, 1 \tag{4}$$

Where

$$W_{m,n}(u, v) = e(u) e(v) \cdot R_4^u R_8^u R_{16}^u \cdot R_4^v R_8^v R_{16}^v \cdot X(2R_2^u - 1)^m (2R_2^v - 1)^n$$

Based on the fourth equation calculations are made and the estimation of the rough edge orientation of the certain ROI. The relationship between S_{mn} and the measurement

$$T_\theta(\theta \in \left\{ NE, 0, \frac{\pi}{2}, \frac{\pi}{4}, 3\frac{\pi}{4} \right\}) \text{ is given in Table I.}$$

The final edge orientation of the certain block will choose the largest T_θ .

Table I Measures for directional Edge patterns

Edge Direction	Measures
0	$T_\theta = 2 \left(\frac{s_{00} + s_{01}}{2} - \frac{s_{10} + s_{11}}{2} \right)$
$\frac{\pi}{2}$	$T_{\frac{\pi}{2}} = 2 \left(\frac{s_{00} + s_{01}}{2} - \frac{s_{10} + s_{11}}{2} \right)$
$\frac{\pi}{4}$	$T_{\frac{\pi}{4}} = \max \left\{ \left(s_{00} - \frac{s_{01} + s_{10} + s_{11}}{3} \right), \left(s_{11} - \frac{s_{00} + s_{01} + s_{10}}{3} \right) \right\}$
No Edge	Set by user

The above computation cost will only be 18 multiplications (M) and 27 additions (A). An exact edge map of the compressed image will be extracted with an expressive speed which will contribute a lot to the later deduction ROI operation.

3. DEDUCTION OF ROI

Based on the above map information, the whole image is classified into two areas (Edge, No edge). The de region of interest will only be done in the area of No edge. In a common platform the ROI effect is introduced by truncating those undesired high frequency DCT components. If the distributions of the pixel values near the ROI boundary accords with linear functions.

Let firstly consider the horizontal situation by choosing two adjacent blocks as the de region of interest units (a_n, b_n). The right four columns of a_n and the left four columns of b_n from a new image region of interest c_n which can be expressed as

$$\begin{aligned} c &= aD_1 + bD_1^T \\ a &= aD_2 + cD_1^T \\ b &= bD_3 + cD_1^T \end{aligned} \quad (5)$$

$$\text{with } D_1 = \begin{pmatrix} 0_{4 \times 4} & 0_{4 \times 4} \\ I_{4 \times 4} & 0_{4 \times 4} \end{pmatrix}$$

$$D_2 = \begin{pmatrix} I_{4 \times 4} & 0_{4 \times 4} \\ 0_{4 \times 4} & 0_{4 \times 4} \end{pmatrix}$$

$$D_3 = \begin{pmatrix} 0_{4 \times 4} & 0_{4 \times 4} \\ 0_{4 \times 4} & I_{4 \times 4} \end{pmatrix}$$

Where D_1^D is the transpose of D_1 , $0_{4 \times 4}$ is zero matrices and $I_{4 \times 4}$ is the identity matrix correspondingly the DCT domain counterpart is

$$C = Aw_1 + Bw_1^D \quad (6)$$

C is the half-block size shifted image block, which can need to deal with if any abrupt change happens must deduct region of Internet solutions are following either zero-masking scheme or curve replacing scheme (1) and (2) to reconstruct the low frequency part of the C to be a linear one. However those methods will lose some details or introduce some distortions under higher

bit rate encoding case or detail. Many experienced criteria have been set up to decide whether the above handling should be done or not on current region of Internet criterion can be defined as

$$CR = (\text{SUM}(A_0 \oplus B_0) / \text{SUM}(C_0))$$

Where A_0 , B_0 and C_0 are 16 bit vectors to indicate the DCT co-efficient of the first line of A, B and C.

Where \oplus is exclusive or operation and / is division operation.

The different types of range are

1. CR is in the range: [0 to range1]
Only low frequency DCT co-efficient of C and the magnitude of C (0, 1) is regularized, where range1 is 0.62.
2. CR under the range: [range2 to range3]
This will directly utilized to reducing the ROI reduction, where range2 is 0.2 and range3 is 0.4.
3. When CR is under the range: [rangeC3 \neq 0]
Assume rangeC3=1.0 ROI Co-efficients of C are not really suffered and the correlation is not required for further processing.

4. RESULTS

The proposed algorithms are performed with number of monochrome images. The performance of the proposed method is illustrated under different bits per pixel based on the resulting subjective image quality and also objective measurement in PSNR.

The results are shown in the table. It can be seen that the proposed method is better than the method under many classic condition with different BPP values. As a result, the proposed algorithm outperforms some classic methods in ROI reduction. The efficiency is verified under both the subjective and objective measurements. It is suitable for fast image region of interest compression.

Table II Results

Bits Per Pixel	PSNR		
	Shape Adaptive	Medium	Proposed
0.17	22.02	22.03	22.46
0.27	24.00	24.05	24.94
0.39	24.25	24.40	24.96
0.52	25.00	25.05	25.12
0.61	26.06	25.08	25.20
0.72	26.30	26.40	26.80
0.85	26.46	26.51	26.82

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