New Regions of Interest Image Coding Using Up-Down Bitplanes Shift for Network Applications

Li-bao Zhang, Ke Wang

[1] College of Communication Engineering, Jilin University,
Changchun 130025, China
{ZHANG Li-bao, WANG Ke, libaozhang}@163.com

Abstract. Regions Of Interest (ROI) image coding is one of the most significant features in JPEG2000 for network applications. In this paper, a new approach for ROI coding so-call Up-Down Bitplanes Shift (UDBShift) is presented. This new method separates all bitplanes into three parts: Important Significant Bitplanes (ISB), General Significant Bitplanes (GSB) and Least Significant Bitplanes (LSB). The certain number bitplanes of ROIs are up-shifted to ISB based on different degrees of interest of every ROI. Then, partial BG bitplanes are downshifted to LSB according to encoding requirement. Finally, The residual significant bitplanes of ROIs and BG that are saved in GSB are not shifted. Simulation results show significant improvement in reduction of reduction of transmission time and enhanced flexibility at the expense of a small complexity. Additionally, it can support arbitrarily shaped multiple ROI coding with different degrees of interest without coding the ROI shapes.

1 Introduction

The functionality of ROI is important in applications where certain parts of the image are of higher importance than others. In such a case, these ROIs need to be encoded at higher quality than the background (BG). During the transmission of the image, these regions need to be transmitted first or at a higher priority, as for example in the case of progressive transmission. JPEG 2000 standard in [1] and [2] not only supports ROI coding firstly, but defines two coding algorithms that are called Maxshift (maximum shift) method [3] in part 1 and the general scaling-based method in part 2 along with the syntax of a compressed codestream. In these methods, a region of interest of the image can have a better quality than the rest at any decoding bit-rate.

Although the Maxshift method is efficient, three disadvantages are inevitable [4]. First, this method requires decoding of all ROI coefficients before accessing bitplanes of the BG and uses large shifting values that significantly increase the number of total bit-planes to encode. Second, it is inflexible in interactive net browser. Third, It is difficult that this method handles multiple ROIs of any shapes. The general scaling-based method can support multiple ROI coding. But it needs to code every ROI shape, which not only improves coding complexity, but also restricts every ROI shape.

H. Jin et al. (Eds.): NPC 2004, LNCS 3222, pp. 513-516, 2004.

In this paper, a new method so-call up-down bitplanes Shift (UDBShift) is presented. This new method separates all bitplanes into three parts: Important Significant Bitplanes (ISB), General Significant Bitplanes (GSB) and Least Significant Bitplanes (LSB). The experiment results show that the UDBShift method has three primary advantages: (1) it can support arbitrarily shaped multiple ROI coding with different degrees of interest without coding the ROI shapes; (2) it enables the flexible adjustment of compression quality in every ROI and BG by using appropriate scaling values based on bit rate; (3) it can ensure that all ROIs can be encoded at higher quality than the BG based on requirement. So the UDBShift method is more efficient and flexible than the two standard methods in JPEG2000 for network transmission.

2 Description of UDBShift Method

2.1 UDBShift Method for Single ROI

The UDBShift method is based on the ROI coding theory that at low bit rates, ROI in an image is desired to sustain higher quality than BG, while at the high bit rates, both ROI and BG can be coded with high quality and the difference between them is not very noticeable. First, the wavelet transform is performed, and the transformed coefficients are eventually quantized. Then, all bitplanes are divided into three parts: Important Significant Bitplanes (ISB), General Significant Bitplanes (GSB) and Least Significant Bitplanes (LSB). The certain number bitplanes of ROI called ISBs are upshifted. And some BG bitplanes so-called LSBs are downshifted based on encoding requirement. Finally, The residual significant bitplanes of ROI and BG that are called GSBs are not shifted. Fig.1 shows the ROI coding comparison of the UDBShift method and the PSBShift method [4] for single ROI of an image.

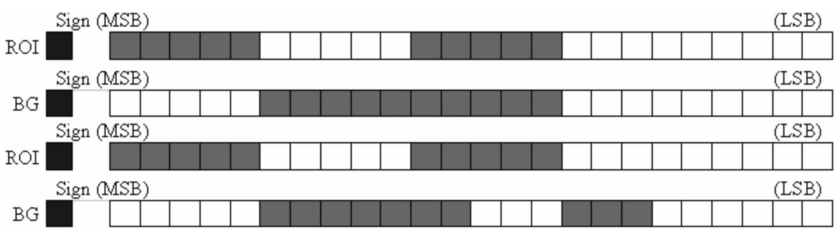

Fig. 1. Comparison of PSBShift method (top) and UDBShift method (bottom) for single ROI

Bitplanes that have not been sent in their entirety, in each subband, are arithmetically encoded again skipping all coefficients that do not belong to the ROI. We can encode every bitplane using arithmetic coding based on context modeling. At the decoder, all bits higher than original MSB will be downshifted until them come back to real value and all bits lower than the original LSB will be up-shifted to real value. If ROI need to have higher quality than BG, the larger scaling value can be used and the results would be closer to the general scaling-based method.

2.2 Multiple ROI Coding Using UDBShift Method

In an image, multiple ROI coding requires multiple ROIs to be coded with different quality according to different degrees of interest. Maxshift method may support multiple ROI coding, but when the number of ROIs increases rapidly, large shifting values that significantly increase the number of total bit-planes to encode is used. Largely increasing the scaling value of wavelet coefficients significantly reduces the compression efficiency. In the worst case, the scaling value of bitplanes may result in bit overflow. In addition, Maxshift only scales all ROI's bitplane using same scaling value. The general scaling-based method can ensure multiple ROI coding in different scaling values, while this method needs to code ROI shape and is only supported by rectangle or ellipse ROI shape in current JPEG 2000 standard. The UDBShift method can support efficient multiple ROI coding by modulate the shifting value of ISBs and LSBs. Fig. 2 shows the method with scaling different bitplanes of three ROIs. First, this method ensures that all ROIs have the same scaling value S_V. And the certain number bitplanes of ROIs are upshifted to ISB based on different degrees of interest of every ROI (Fig. 2 shows that the important significant bitplanes are chosen as S_1=6,S_2=5,S_3=4). Second, certain parts of BG bitplanes are downshifted to LSB based on encoding requirement. Finally, The residual significant bitplanes of ROIs and BG that are saved in GSB are not shifted.

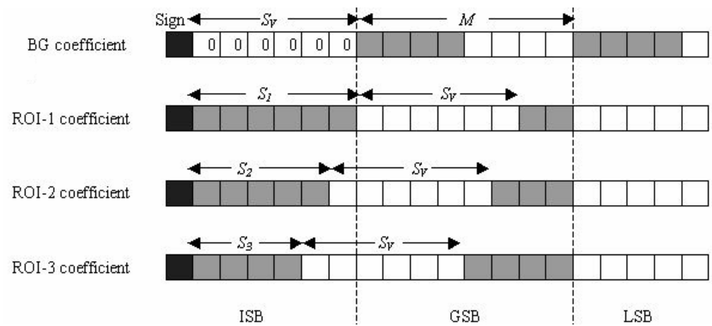

Fig. 2. UDBShift method for three multiple ROI coding (S_1=6,S_2=5,S_3=4)

3 Experimental Results and Conclusions

In Fig. 3, one figure gives multiple ROI coding results for Lena from low bit rates to mediate bit rates. Three ROIs are defined in image. The priority order of these ROIs is ROI-1>ROI-2>ROI-3. The up-shifted numbers of ISBs should be chosen as $s_{ROI-1}>s_{ROI-2}>s_{ROI-3}$, e.g., $s_{ROI-1}=6$, $s_{ROI-2}=5$, $s_{ROI-3}=4$. At low bit rates (e.g., bpp<1.0), all ROIs have the higher quality than BG. ROI-1 has the highest quality among three ROIs. When bit rates increases, BG quality increases quickly. This is because the up-shifted numbers of the ISBs of ROI-2, ROI-3 are not large enough. Three ROIs can reach the lossless quality firstly because some least significant BG bitplanes down-shift. The reconstructed quality (PSNR) of three ROIs is given in Fig. 4.

The proposed method can support arbitrarily shaped multiple ROI coding with different degrees of interest without coding the ROI shapes, which is very important to interactive network transmission and the distance servers based on large images. We expect this idea is valuable for future research in ROI coding and its applications.

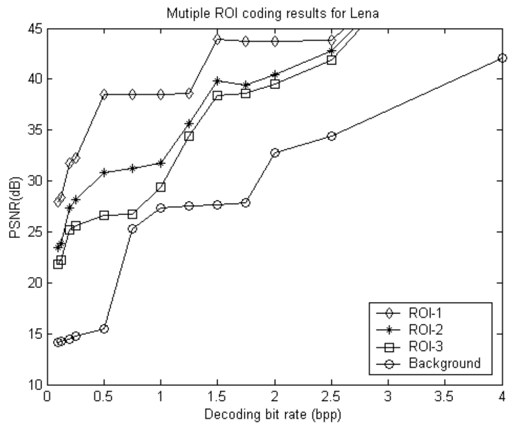

Fig. 3. Multiple ROI coding results for Lena from low bit rates to mediate bit rates

Fig. 4. The reconstructed Lena image with three ROIs. ROI-1 is face region, the ROI-2 is feather region and ROI-3 is hat region using UDBShift method: 0.25 bpp (left), 1.0 bpp (right)

References

1. ISO/IEC, ISO/IEC 15444-1, Information technology JPEG 2000 image coding system-Part 1: Core coding system. http://www.jpeg.org (2003)
2. ISO/IEC JTC 1/SC 29/WC 1 (ITU-Y SC8) JPEG 2000 Part Ⅱ Final Committee Draft Version 1.0 (2000) December
3. C. Christopoulos, J. Askelf and M. Larsson, Efficient methods for encoding regions of interest in the upcoming JPEG 2000 still image coding standard, IEEE Signal Processing Letters, Vol. 7, no.9 (2000) 247-249
4. L. Liu and G. Fan, A new JPEG 2000 Region of interest image coding method: Partial Significant bitpanes shift, IEEE Signal Processing Letters, Vol. 10, no.4 (2003) 35-38