ADAPTIVE PROGRESSIVE CODING FOR COMPRESSION OF BI-LEVEL VIDEO IMAGES

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Abstract

In video compression, progressive coding plays an important role in terms of coding efficiency and error resilience and has been an attractive research topic since the standardization of H.264/AVC. In this paper, we propose a high-performance progressive coding scheme with the help of bi-level images. Different from progressive H.264/AVC and other video standards, we construct image epitomes as coding priors and use them to generate predictions of intra blocks at the encoder. In addition, we reduce the loss during coding and transmit the compressed images to the decoder. We perform compression-oriented video bi-level image analysis and search for the best bi-level images by using the expectation maximization algorithm. The resulting image bi-level for a video sequence can be viewed as the base layer in spatially scalable video coding. Experiments show that our proposed progressive scheme improves the state of the art by an average of 0.53 dB in PSNR. Simulations under a packet loss environment also demonstrate that intra refresh with bi-level images outperforms random intra refresh by up to 2 dB, leading to better subjective quality.

***Keywords*: Compression; Resilience; Progressive; Spatially.**

The Main Text

1. Image Compression

Most modern image compression methods are progressive or optionally so. Progressive image compression is an alternative choice when compressed images are transmitted over a communication linen and are viewed in real time .When such an image is received and are decompressed, the decoder can very quickly, display the entire image [9] in a low quality format, and improve the display quality as more and more of the image is being received and decompressed. A user watching the image developing on the screen can normally recognize most of the image features after only 5-10 % of it has been decompressed. The progressive mode is a JPEG option. In this mode, the higher–frequency DCT coefficient is written on the compressed stream in blocks called 'SCANS'. Each scan that is read and processed by the decoder results a sharper image. The best way to think progressive image compression is to imagine that the encoder compresses the most important image information first ,and then compresses the less important information and appends it to the compressed stream ,and so on. Here the user can control the amount of loss by means of a parameter that tells the encoder how soon to stop the process.

Jojic *et al.*[14] and Cheung and Frey [15] were the first to report progressive analysis on image or video. The resulting epitome is considered as an image's most essential representation, which preserves its global texture and shape characteristics, and its size is only a fraction of the original image after fusing similar textures. Consequently, the compressed image is well suited for use as coding priors. In addition, progressive analysis has recently gained popularity in accomplishing image processing tasks such as de nosing, in painting, and super-resolution [5]. Inspired by [4] and [15], we propose an intra-coding scheme with progressive coding .Here the best coding efficiency can be achieved by minimizing the joint rate distortion cost, with the rate including the overhead for progressive coding. Growth Geometry Coding combines image compression and progressive image transmission in an original and unusual way [12].

2. Proposed method

Adaptive progressive encoding process can be achieved in the following three ways.

a) Encode spatial frequency data progressively and an observer who is watching such an image being decoded sees the image changing from blurred to This type of Progressive image compression is sometimes called SNR progressive .

b) Start with a gray image and add colors or shades of gray to it and an observer who is watching such an image being decoded will see all the image details from the start, and will see them improve as more color is continuously added to them.

c) Encode the image in layers ,where early layer consist of a few large low –resolution pixels, followed by later layers with smaller higher –resolution pixels. An observer who is watching such an image being decoded sees the image will see more detail added to the image over time.

Fig. 1. Three type of adaptive progressive coding

This way of progressively encoding an image is called pyramid [13] coding or hierarchical coding. Most progressive methods use this principle**.** Assuming that the image size is $\mathbf{2}^{n}$ X $\mathbf{2}^{n}$ $=4^{n}$ pixels ,the simplest method that for implementing progressive compression ,is to calculate each pixel of layer i – 1 as the average of a group of 2X2 pixels of layer i. Thus layer 'n' is the entire image, layer n-1 contains $2^{\mathbf{n-1}}$ X $\mathbf{2}^{n-1}=4^{n-1}$ large pixel, representing the entire image. The pixels are then written on the compressed stream in reverse order, starting with layer 1.The single pixel of layer 1 is the parent of the four pixels of layer 2, and each of which is the parent of four pixels in layer 3 and so on. The total number of pixels in the pyramid is 33% more than the original number. A new video coding standard can offer opportunities [11] for more efficient video compression systems. However, migrating a hardware based environment to a new video codec brings about a huge investment providers or end users are not willing to pay for. A gradual upgrade where investments could be spread in time could offer the solution. For such a gradual upgrade to work, a forward compatible [6] design is proposed here. Nowadays, the majority of hardware solutions provide compatibility withH.264/AVC compression. To generate prediction, we borrow ideas from classical approaches such as intra-displacement compensation (IDC) [8] and template matching prediction (TMP) [9] in intra-coding. IDC codes the motion vectors explicitly and applies to 8 X 8 blocks. In contrast, TMP (for 4×4 blocks) does not code the motion vectors and 8×8 blocks are too big for TMP since the prediction accuracy cannot be guaranteed for samples in 8×8 blocks that are distant from the template. Instead of using the reconstructed part [9]of the current frame in conventional IDC and TMP, we have the progressive image index as the reference frame and can add two new modes to the signaling syntax. These two new modes can be combined with existing prediction modes to form a new candidate mode set, and the best prediction mode selected from the set via RDO, within the context of H.264/AVC. For 4 X 4 blocks, the strategy of reusing the DC mode is adopted because there are 16, 4×4 blocks in every macro block[5], and if a new mode were introduced on top and beyond the existing nine modes, the extra overhead would be unaffordable. The prediction generation method is governed by the variance of the adjacent boundary.

For 8×8 blocks, direct coding of the mapping relationships represented by motion vectors is preferred. The smallest block size of 4 X4 would get the most accurate prediction with the highest rate for motion vectors. On the other hand, the biggest blocks with size 16X16 would incur the smallest rate for motion vectors at the price of prediction and accuracy [10].To balance the prediction accuracy and the rate for motion vectors [4], we choose 8X8 as the basic unit for motion estimation in our analysis. The motion vectors are transmitted using fixed-length codes that are determined by the length and width of image codes. In our experiments, the size of image codes for QCIF sequences is 80×64 and the length for the horizontal components of motion vectors is seven bits and that for the vertical components is six bits. The rate for motion vectors is included in the process.

For each video shot, its image code should be encoded and transmitted to the decoder side. In our proposed intra-coding scheme, the codes are coded lossless, using the method of minimum-rate predictors [13], resulting in a compression ratio of than 6:1. In addition, a small number of overhead bits are sent to the decoder to indicate the integration of image with the video bit stream. Instead of partitioning the image into quadrants, it can be recursively split into half, and this is the basic principle of the bin tree method [5]. This method is very useful in cases where many sub images [4] are needed. Here we propose an application of bin trees for the progressive transmission of gray scale images. Here we are considering an image with resolution 384X512 and this image will be divided into blocks of size 3X2 each. There are $128=2^{7}$ rows and $256 =2^{8}$ columns of these 6tuples, so their total number is 2^{15}= 32,768The encoder to construct a binary tree by dividing the entire image into two horizontal halves, splitting each into two vertical quadrants, and continuing in this way, down to the level of 6-tuples.

3. Result and conclusion

To facilitate the performance evaluation, the image epitome size is fixed at 80 × 64 sequences, and the image patch is set to be 8×8. To obtain the image patch set for the coherence term , the image patch sampling period is fixed at 0.5, which means that the patches are sampled [8]at an interval of (4, 0), (0, 4), or (4, 4). The 8 × 8 blocks partitioned by video compression are regarded as the patch sets. We calculate the average PSNR gain at the same bit rate and the equivalent average bit rate savings at the same PSNR relative to H.264/AVC intra coding using the method of [9], with the rate for epitomic priors added to the total rate for each sequence. The *Orbi*, Interview, Ballet, and Break dance video test sequences [2] are encoded using the H.264/AVC video coding standard (JM reference software Version 16.0). The selected test sequences cover a range of texture and motion characteristics and the depth maps of these sequences are obtained using a depth-range camera (Orbi and Interview) and a stereo matching algorithm (Ballet and Break danc*e*). Ten-second long sequences (i.e., 250 frames from Orbi and *Interview* sequences and 150 frames from Ballet and Break dance) are encoded, using QP values 1, 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50. An I frame is encoded by every one second. Slices (one row of one slice) are also introduced in order to make the decoding process more robust to errors. The transmission of the encoded bit-stream over an IP core network is simulated by using IP error patterns generated for Internet experiments [7]. The individual correlation coefficients (i.e., SSE, *R-square*) for the Orbi, Interview, Ballet, Break dance color image sequences and for all color image sequences in general are listed in Table **1.**

Table 1. Individual correlation coefficients

Sequence	SSE	R-square
Orbi	0.368	0.9161
Interview	0.261	0.9654
Ballet	0.084	0.9528
Break dance	0.131	0.9607
All sequence	1.266	0.9273

References:

[1] Gomezjurado, J. Reininger D; Medrn-a Mutual Aid Information Network for Emergency Response Military Communication Conference. 2006. pp:1-7

[2] Johnston.A, Session Initiation Protocol Call Control – Conferencing for User Agents, IETF Drufr, July. 2004

[3] Handley.M, J Crowcroft, et at., The internet Multimedia conferencing architecture. IETF Draft, 2000

[4] Kim.D, *Enhanced Intra Coding*, document VCEG-AH11, Video Coding Expert Group (VCEG), Antalya, Turkey, Jan. 2008.

[5] Min.J, S. Lee, I. Kim, W. Han, J. Lainema, and K. Ugur, *Unification of the Directional Intra Prediction Methods in TMuC*, document JCTVCB100,Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T, Jul.2010.

[6] Maani.E, A. Tabatabai, and T. Yamamoto, *Summary and Improvements,of Differential Coding of Intra Modes (DCIM)*, document JCTVC-D279,Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Daegu, Korea, Jan. 2011.

[7] Onural.L, "Television in 3-D: What are the prospects ? vol 95,jun2007

[8] Shiodera.T, A. Tanizawa, T. Chujoh, and T. Yamakage, *BidirectionalIntra Prediction*, document JCTVC-C079, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T, Guangzhou, China, Oct. 2010.

[9] Starck, J. Kilner, and A. Hilton, "Objective quality assessment in free-viewpoint video production," in *Proc. 3DTV '08 Conf.*, Istanbul,Turkey, 2008.

[10] T. Tan, C. Boon, and Y. Suzuki, "Intra rediction by template matching,"in *Proc. ICIP*, Oct. 2006, pp. 1693–1696.

[11] Viterbi , J.V.Omura,Principles of digital communications and coding, New York ,NY:McGraw-Hill,1997.

[12] Wiegand.T, W. Han, J. Ohm, and G. Sullivan, *WD1: Working Draft1 of High-Efficiency Video Coding*, document JCTVC-C403, Joint CollaborativeTeam on Video Coding (JCT-), Oct. 2010.

[13] Yu.S and C. Chrysafis, *New Intra Prediction Using Intra Macroblock Motion Compensation*, document JVT-C151, Joint Video Team (JVT),Fairfax, France, May 2002.

[14] Yeung M and B.-L.Yeo, “Video visualization for compact presentation and fast browsing of pictorial content,” IEEE Trans. Circuits Syst. Video Technol., vol. 7, no. 5, pp. 771–785, Oct. 1997.

[15] Zhao.J. Parallel Intra Coding, document JCTVC-D279, Joint Collaborative Team on Video Coding (JCT-VC) of Daegu, Korea, Jan. 2011.

[16] Cao, X. Peng, C. Lai, Y. Wang, Y. Lin, J. Xu, L. Liu, J. Zheng, Y. He,H. Yu, and F. Wu, *Report on Short Distance Intra Prediction Method*,document JCTVC-D299, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC, Daegu,Korea, Jan. 2011.

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