Single-Pass Dependent Bit Allocation in Temporal Scalability Video Coding

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In the scalable video coding [1], we refer to a group-of-pictures (GOP) structure that is composed of hierarchically aligned B-pictures. It employs generalized B-pictures that can be used as a reference to following inter-coded frames. Although it introduces a structural encoding delay of one GOP size, it provides much higher coding efficiency than the conventional GOP structures [2]. Moreover, due to its natural capability of providing the temporal scalability, it is employed as a GOP structure of H.264/SVC [3].

Because of the complex inter-layer dependence of hierarchical B-pictures, the development of an efficient and effective bit allocation algorithm for H.264/SVC is a challenging task. There are several bit allocation algorithms that considered the inter-layer dependence in the literature before. Schwarz *et al*. [2] proposed the QP cascading scheme that applies a fixed quantization parameter (QP) difference between adjacent temporal layers. Liu *et al*. [4] introduced constant weights to temporal layers in their H.264/SVC rate control algorithm. Although these algorithms achieve superior coding efficiency, they are limited in two aspects. First, the inter-layer dependence is heuristically addressed. Second, the input video characteristics are not taken into account. For these reasons, the optimality of these bit allocation algorithms cannot be guaranteed.

We propose a single-pass dependent bit allocation algorithm for scalable video coding with hierarchical B-pictures in this work. It is generally perceived that dependent bit allocation algorithms cannot be practically employed due to their extremely high complexity requirement. To develop a practical single-pass bit allocation algorithm, we use the number of skipped blocks and the ratio of the mean absolute difference (MAD) as features to measure the inter-layer signal dependence of input video signals. The proposed algorithm performs bit allocation at the target bit rate with two mechanisms: 1) the GOP based rate control and 2) adaptive temporal layer QP decision. The superior performance of the proposed algorithm is demonstrated by experimental results, which is benchmarked by two other single-pass bit allocation algorithms in the literature.

The rate and the PSNR coding performance of the proposed scheme and two benchmarks at various target bit rates for GOP-4 and GOP-8, respectively. We see that the proposed rate control algorithm achieves about 0.2-0.3dB improvement in coding efficiency as compared to JSVM [3]. Furthermore, the proposed rate control algorithm outperforms Liu's Algorithm [4] by a significant margin.

References

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* Corresponding author. This work was supported by National Natural Science Foundation of China under contract No.61101078, National Basic Research Program (973 Program) of China under contract No.2009CB320907, and National Key Technology R&D Program of China under Grant 2012BAH18B03.

1068-0314/13 $26.00 © 2013 IEEE
DOI 10.1109/DCC.2013.87