An Early TU Decision Algorithm Based on Adaptive Depth of RQT for Fast HEVC encoder

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With the rapid development of electronic technology, the panels of 4K×2K (or 8K×4K) high-resolution will become the main specification of large size digital TV in future. However, the current H.264 video coding standard can’t support the video applications of high definition (HD) and ultrahigh definition (UHD) resolution. Therefore, the ITU-T Video Coding Experts Group (VCEG) and ISO/IEC Moving Pictures Expert Group (MPEG) through their Joint Collaborative Team on Video Coding (JCT-VC) has been developed a newest high efficiency video coding (HEVC) for video compression standard to satisfy the UHD requirement in January 2010, and the first version of HEVC was finalized by JCT-VC in January 2013. HEVC can achieve an average bit rate decrease of 50% in comparison with H.264 (High Profile) while still maintaining video quality. This is because the HEVC adopts some new coding structures including coding unit (CU), prediction unit (PU) and transform unit (TU). The CU can be split by coding quad-tree structure of 4 level depths (ranges from 64×64 to 8×8 pixels) and the TU can be split by residual quad-tree (RQT) of 3 level depths (vary from 32×32 to 8×8 pixels), separately. The optimal partitions of PU are according to the different prediction modes. The HEVC can achieve the highest coding efficiency but requires a very high computational complexity such that its real-time application is limited.

In order to speed up the encoding process of HEVC, there have been many fast encoding methods proposed to reduce the number of CUs and PUs [1-3]. Besides, the early TU decision algorithm (ETDA) is another method selected to reduce the encoding complexity. Recently, Chio et al. proposed a new ETDA by determining the number of nonzero DCT coefficients (NNZ) of RQT (called NNZ-ETDA) to accelerate the encoding process of TU module [4]. However, the NNZ-ETDA can’t effectively reduce the computational load for sequences with active motion or rich texture. Therefore, in order to further improve the performance of NNZ-ETDA, we propose an adaptive RQT depth for NNZ-ETDA (called ARD-NNZ-ETDA) by exploiting the characteristics of high temporal-spatial correlation exists in nature video sequences. Firstly, we analyze and calculate the temporal and spatial correlation values from the temporal (co-located) and spatial (left, upper and left upper) neighboring blocks of the current TU. And then, the dynamic depth level range of RQT of the current TU is predicted by using the correlation weight and maximum depth levels of its neighboring blocks. Finally, we combine the proposed adaptive depth of RQT and the NNZ-ETDA to further reduce the computational load of TU.

The simulation results show that the proposed algorithm can achieve an average time improving ratio (TIR) about 61.26%~81.48% when compared to HEVC (HM 8.1). Compared with the NNZ-ETDA [4], the proposed algorithm can further achieve an average TIR about 8.29%~17.92%. It is clear that the proposed method can efficiently reduce the computational complexity in TU module with insignificant loss of image quality. In addition, the proposed algorithm also can be equally implemented with or be considered in design of a fast HEVC encoder.

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References


