경계 강도 기반의 적응적 보간 필터

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Boundary Strength based Adaptive Interpolation Filter

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Abstract

This paper presents an adaptive interpolation filtering scheme for the High Efficiency Video Coding (HEVC) standard. In regards to interpolation for motion estimation and compensation, the conventional HEVC employs 8-tap and 4-tap filters for luma and chroma samples, respectively. Coefficients in such filters are determined by discrete cosine transform (DCT). In the proposed scheme, boundary strength values are stored after the execution of the deblocking filter. For each block, the sum of boundary strength values is calculated to indicate whether its region is complex or simple. Consequently, based on the region classification, 12-tap and 8-tap interpolation filters are used for complex and simple regions, respectively. This process is applied to luma sample interpolation only. Simulation results show 1.8% average BD-rate reduction compared to the conventional method.

1. Introduction

The latest video coding standard, High Efficiency Video Coding (HEVC), was developed by Joint Collaborative Team on Video Coding (JCT-VC) [1]. Experts from Moving Picture Experts Group (MPEG) of ISO/IEC and Video Coding Experts Group (VCEG) of ITU-T contributed to the development. HEVC aims coding of high resolution videos with improved compression ratio.

Interpolation filter is used for motion estimation and motion compensation with quarter-sample accuracy [2]. HEVC employs 8-tap filter for luma and 4-tap filter for chroma samples. While DCT-based interpolation filter (DCT-IF) efficiently reduces residual energy, this does not take input video characteristics into account. Based on regions, an adaptive interpolation filter can be effective.

In this paper, we present an adaptive interpolation filtering scheme based on boundary strength (Bs) values from deblocking filtering. Based on Bs sums of the coding unit (CU), its region is classified as complex or simple. Interpolation filter is selected according to the classified region. This is applied to luminance only while chrominance interpolation is unchanged.

2. Proposed Method

The proposed method exploits Bs values calculated in the deblocking filtering stage. The sum of Bs values is stored for every CU. After deblocking and prior to motion estimation stage of the successive frame, the Bs sum of CU is compared with the average Bs sum to determine the complexness of the region.

A 12-tap DCT-IF is introduced for interpolation of the complex region. For the simple region, the conventional 8-tap DCT-IF is applied. Figure 1 represents the flowchart of the proposed scheme.

2.1 Boundary Strength

Boundary strength (Bs) values indicate the possibility of intra coding, non-zero residual coefficients, difference of reference pictures or motion vectors. These factors can be an indication of how complex the region.

For region classification, the average of all Bs sums is used as a threshold prior to motion estimation. If the Bs sum of CU is greater than the threshold, its region is classified as a complex region. Otherwise, it will be represented as a simple region.

2.2 Interpolation Filter

The proposed scheme uses region-based interpolation filter selection. Each region is classified as either complex or simple based on the Bs sum value. We introduce a 12-tap DCT-IF for complex regions. The conventional 8-tap DCT-IF is applied to simple regions. In other words, we apply the complex filter only to sophisticated areas to improve the quality while minimizing the complexity issue.

In general, 12-tap DCT-IF with 8-bit arithmetic precision provides the highest quality. However, in the current HEVC model 8-tap DCT-IF uses 6-bit precision. To keep the arithmetic precision consistent in the codec structure, we used 6-bit precision 12-tap DCT-IF in the proposed scheme. The chroma interpolation part is unchanged in the proposed scheme.

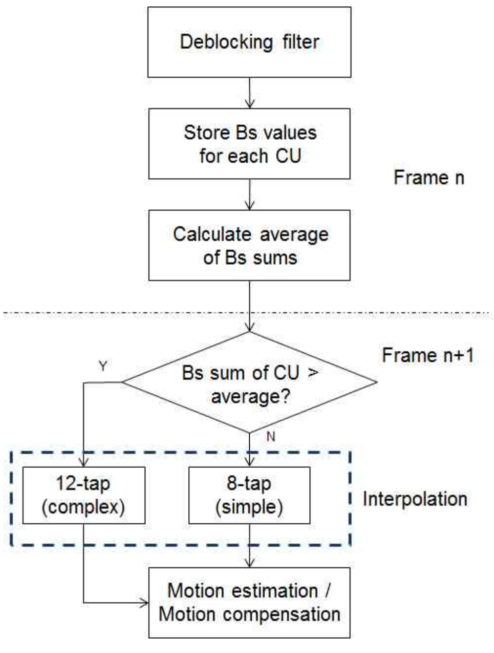

Figure 1. Flowchart of the proposed method

3. Simulation Results

The proposed method was implemented on HEVC test model (HM) 11.0. Fifty frames of four sequences were tested: BQSquare (416×240), PartyScene (832×480), FourPeople (1280×720) and BasketballDrive (1920×1080). The main profile with random access mode was used. Quantization parameters of 22, 27, 32 and 37 were selected [3]. Table 1 displays the Bjontegaard delta rate (BD-rate) for each sequence and the average [4]. PSNR values of luminance were used for evaluation.

High gains were achieved in two sequences, 5.0% for BQSquare and 2.7% for PartyScene. These sequences commonly possess numerous textured regions in the background. On the other hand, small losses were observed in FourPeople and BasketballDrive simulations. Compared to BQSquare and PartyScene, these sequences have less textured areas. Thus, the proposed scheme is effective when the test data possesses detailed characteristics.

Table 1. Coding performance of the proposed method

Sequence	BD-rate (%)
BQSquare	-4.9
PartyScene	-2.6
FourPeopole	0.2
BasketballDrive	0.2
Average: -1.8%	

4. Conclusion

In this paper, we presented an adaptive interpolation filtering scheme. HEVC uses 8-tap DCT-IF is used for luma sample interpolation. In the proposed scheme, boundary strength (Bs) values of each block are summed and stored for each CU. This information is exploited during inter prediction of the successive frame. If the Bs sum of a CU is greater than the average Bs sum, this region is classified as complex region, 12-tap DCT-IF is used for accuracy. On the other hand, 8-tap DCT-IF is used for the simple region, i.e., the Bs sum is less than average. Simulation results exhibited 1.8% BD-rate reduction on average.

Acknowledgment

This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIP) (No. 2013-067321)).

References

[1] B. Bross, W.J. Han, J.R.Ohm, G.J. Sullivan, Y.K. Wang, and T. Wiegand, "High Efficiency Video Coding (HEVC) Text Specifica tion Draft 10," JCTVC-L1003, Jan. 2013.

[2] J.R. Ohm, J. Sullivan, H. Schwarz, T.K. Tan, and T. Wiegand, "Comparison of the Coding Efficiency of Video Coding Standards−Including High Efficiency Video Coding (HEVC)," IEEE Trans. Circuits and Systems for Video Technology, vol. 22, no. 12, pp. 1669-1684, Dec. 2012.

[3] F. Bossen, "Common Test Conditions and Software Reference Configurations," JCTVC-L1100, Jan. 2013.

[4] G. Bjontegaard, "Calculation of Average PSNR Differences Bet ween RD-curves," VCEG-M33, April 2001.