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| *Title:* | **TE4: Cross-check results of test 4.4.3 on inter-layer refining filter** | | | |
| *Status:* | Input Document to JCT-VC | | | |
| *Purpose:* | Informational | | | |
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| *Source:* | MediaTek USA Inc. | | | |

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# Abstract

This document reports the cross check results of JCTVC-0287 [1] (test 4.4.3) on inter-layer adaptive refine filtering from Intel. The proposed techniques have been studied. The provided software has been checked, compiled and the results reported by the proponents can be confirmed.

1. Introduction of the proposed methods

In scalable coding, the inter-layer texture prediction is used to produce the predicted pixel samples based on the reconstructed pixels from BL. In JCTVC-0287 [1], an inter-layer refining filter is proposed to further process the predicted pixel samples. This refining filter can improve the accuracy of inter-layer prediction to achieve better compression performance for video in EL. This contribution applies a 13-tap 2D filter on each predicted pixel sample value. The refining filter has the diamond shape as shown in the following figure,

.



Figure 1 Filter window of inter-layer refining filter

P0 to P12 indicate the predicted pixel samples before filtering. Assume P0’ is the refined value of the center pixel P0, the filtering process can be expressed as the following equation,

P0’ = C0\* P0 + C1\* P1 + … + C12\* P12 (1)

where C0 to C12 are the filter coefficients. The filter coefficients are produced by encoder, and are adaptively refreshed to decoder according to the characteristics of the input video. This contribution uses picture-level refreshing of the filter by coding the coefficients in the first slice header of each picture in EL video.

In order to reduce the overhead of transmitting the coefficients, the refining filter is implemented in symmetry. Specifically, the filter taps whose positions are with respect to center with symmetry share the same coefficients, as described in following equations,

C0

C1 = C2;

C3 = C4;

Filter coefficients include: C5 = C6; (2)

C7 = C8;

C9 = C10;

C11 = C12.

With symmetry, the number of filter coefficients is reduced from 13 to 7. In this contribution, two sets of refining filter are used by Luma component and Chroma components, respectively. The total number of coefficients for each picture of EL video is equal to 14.

# Experimental Results

Simulations were conducted following common test conditions defined in TE4 [3]. Anchor data was generated using SMuC0.1.1 software [2]. Results produced by current software implementation are reported in the following tables. In the JCTVC-L0287 [1] software, one macro has been introduced to integrate the proposed methods:

* INTER\_LAYER\_ALF

Table 1 reports the results. All the BD rate results matched what proponent provided. Since the simulation jobs were done in computer clusters with variable CPU and memory, the encoding and decoding time is not accurate.

Table 1. Results with the proposed methods

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **AI HEVC 2x** | | | **AI HEVC 1.5x** | | |  |  |  |
|  | Y | U | V | Y | U | V |  |  |  |
| Class A | 0.0% | -0.6% | -0.7% |  |  |  |  |  |  |
| Class B | -0.3% | -0.4% | -0.4% | -0.4% | -0.9% | -1.0% |  |  |  |
| **Overall (EL+BL)** | -0.2% | -0.5% | -0.5% | -0.4% | -0.9% | -1.0% |  |  |  |
| **Overall (EL)** | -0.3% | -1.0% | -1.1% | -1.1% | -3.1% | -3.2% |  |  |  |
| Enc Time[%] | 114.5% | | | 141.2% | | |  |  |  |
| Dec Time[%] | 113.6% | | | 140.5% | | |  |  |  |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | |  |  |  |
| BL Match | Matched | | | Matched | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | **RA HEVC 2x** | | | **RA HEVC 1.5x** | | | **RA HEVC SNR** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | 0.1% | -0.2% | -0.3% |  |  |  | -3.9% | -1.2% | -1.0% |
| Class B | 0.0% | -0.1% | 0.0% | -0.1% | -0.4% | -0.3% | -0.8% | -1.0% | -1.0% |
| **Overall (EL+BL)** | 0.0% | -0.1% | -0.1% | -0.1% | -0.4% | -0.3% | -1.7% | -1.0% | -1.0% |
| **Overall (EL)** | 0.1% | -0.3% | -0.2% | -0.2% | -1.2% | -0.4% | -3.5% | -2.0% | -1.9% |
| Enc Time[%] | 117.0% | | | 116.6% | | | 117.2% | | |
| Dec Time[%] | 142.4% | | | 138.6% | | | 140.4% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/0! | | |
| BL Match | Matched | | | Matched | | | Matched | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **LD-P HEVC 2x** | | | **LD-P HEVC 1.5x** | | | **LD-P HEVC SNR** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | 0.1% | -0.3% | -0.4% |  |  |  | -5.5% | -2.3% | -2.2% |
| Class B | -0.3% | -0.6% | -0.2% | -0.4% | -0.8% | -0.3% | -1.8% | -1.4% | -0.6% |
| **Overall (EL+BL)** | -0.2% | -0.5% | -0.3% | -0.4% | -0.8% | -0.3% | -2.9% | -1.7% | -1.0% |
| **Overall (EL)** | -0.4% | -1.1% | -0.6% | -1.1% | -2.6% | -1.1% | -5.3% | -3.5% | -2.5% |
| Enc Time[%] | 121.9% | | | 119.1% | | | 122.5% | | |
| Dec Time[%] | 155.7% | | | 143.5% | | | 156.5% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/0! | | |
| BL Match | Matched | | | Matched | | | Matched | | |

# References

1. W. Zhang, L. Xu, Y. Han, Z. Deng, X. Cai, Y. Chiu,“TE B4: Inter-layer adaptive refine filtering,” Document of Joint Collaborative Team on Video Coding, JCTVC-L0287, Jan, 2013.
2. SMuC0.1.1 Software, <https://hevc.hhi.fraunhofer.de/svn/svn_SMuCSoftware/branches/0.1.1-bugfix>
3. J. Chen, A. Segall, E. Alshina, S. Liu, J. Dong, J. Park, “Description of Tool Experiment B4: Inter-layer filtering,” Document of Joint Collaborative Team on Video Coding, JCTVC-K1104, OCT, 2012