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| *Title:* | **AHG7: Cross-verification of SONY and Sharp proposal JCTVC-I0107 on “Modification of merge candidate derivation to reduce MC memory bandwidth”** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Information | | |
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# Abstract

This contribution reports cross-check results for SONY/Sharp joint proposal JCTVC-I0107 on “Modification of merge candidate derivation to reduce MC memory bandwidth”. In the proposal, it is advocated to restrict PUs of small block sizes (e.g. 4x4, 4x8, 8x4 and 8x8) to uni-prediction to address the worst case motion compensation memory bandwidth issue. To reduce the coding loss, it is proposed to normatively change the merging candidate list derivation process by converting the bi-predictive merging candidates to uni-predictive ones for small block size PUs. Which combination of small block size PUs is restricted to have uni-predictive prediction is signalled in the SPS. For test cases are run and the BD-rate results match the ones reported by the proponents. The source code was checked and confirmed to be consistent with the proposal description.

# Test Settings and Conditions

The simulations of this document have used HM6.0 software, the simulation platform is LSF equipped with Intel(R) Xeon(R) CPU X5570 64 bits Linux machines of different frequencies, the common test conditions and reference configurations specified in [1] are followed.

The following for test cases are verified:

1. Case C: disable bi-predictive mode for 4x4, 8x4 and 4x8 inter PUs, encoder only method.
2. Case G: disable bi-predictive mode for 4x4, 8x4 and 4x8 inter PUs, and convert bi-predictive merging candidates to uni-predictive merging candidates in the merging candidate list derivation for inter PUs of 4x4, 4x8 and 8x4.
3. Case D: disable bi-predictive mode for 4x4, 8x4, 4x8 and 8x8 inter PUs, encoder only method.
4. Case H: disable bi-predictive mode for 4x4, 8x4, 4x8 and 8x8 inter PUs, and convert bi-predictive merging candidates to uni-predictive merging candidates in the merging candidate list derivation for inter PUs of 4x4, 4x8, 8x4 and 8x8.

Uni-predictive mode is also disabled for 4x4 PUs in the four test cases above.

# Experimental results

The experimental results for the four test cases are summarized in Table 2 to Table 5. Compared to the HM6.0 anchor, the average loss of four tests are list in Table 1. The normative changes in the merging list derivation do reduce the loss (see Case G vs. Case C, and Case H vs. Case D in Table 1). The results here perfectly match the ones reported by the proponents. The runtime here may not be accurate.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test** | **RA-Main (%)** | **RA-HE10 (%)** | **LB-Main (%)** | **LB-HE10 (%)** |
| Case C (encoder only) | 0.5 | 0.4 | 0.8 | 0.6 |
| Case G (proposed) | 0.4 | 0.3 | 0.4 | 0.3 |
| Case D (encoder only) | 1.5 | 1.2 | 2.1 | 1.7 |
| Case H (proposed) | 1.0 | 0.8 | 1.1 | 0.9 |

Table 1. Summary of results

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main** | | | **Random Access HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A | 0.3% | 0.3% | 0.3% | 0.2% | 0.3% | 0.2% |
| Class B | 0.3% | 0.2% | 0.3% | 0.2% | 0.1% | 0.1% |
| Class C | 0.6% | 0.6% | 0.5% | 0.4% | 0.5% | 0.5% |
| Class D | 0.8% | 0.8% | 0.8% | 0.8% | 0.7% | 0.5% |
| Class E |  |  |  |  |  |  |
| **Overall** | 0.5% | 0.5% | 0.5% | 0.4% | 0.4% | 0.3% |
|  | 0.5% | 0.5% | 0.5% | 0.4% | 0.4% | 0.3% |
| Class F | 0.2% | 0.3% | 0.3% | 0.2% | 0.3% | 0.3% |
| Enc Time[%] | 94% | | | 91% | | |
| Dec Time[%] | 100% | | | 95% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B Main** | | | **Low delay B HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 0.4% | 0.1% | 0.4% | 0.3% | 0.3% | 0.0% |
| Class C | 0.9% | 0.8% | 1.0% | 0.7% | 0.7% | 0.8% |
| Class D | 1.2% | 1.0% | 1.3% | 1.0% | 0.6% | 0.3% |
| Class E | 0.7% | 0.4% | 0.6% | 0.3% | 0.4% | 0.4% |
| **Overall** | 0.8% | 0.6% | 0.8% | 0.6% | 0.5% | 0.4% |
|  | 0.8% | 0.6% | 0.8% | 0.6% | 0.5% | 0.3% |
| Class F | 0.5% | 0.1% | 0.6% | 0.5% | 0.5% | 0.8% |
| Enc Time[%] | 90% | | | 89% | | |
| Dec Time[%] | 98% | | | 95% | | |

Table 2. Experimental results of case C: disable bi-predictive mode for 4x4, 8x4 and 4x8, encoder only.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main** | | | **Random Access HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A | 0.1% | 0.1% | 0.3% | 0.0% | 0.1% | 0.0% |
| Class B | 0.2% | 0.2% | 0.2% | 0.2% | 0.1% | 0.2% |
| Class C | 0.4% | 0.4% | 0.4% | 0.3% | 0.4% | 0.3% |
| Class D | 0.7% | 0.6% | 0.6% | 0.6% | 0.5% | 0.5% |
| Class E |  |  |  |  |  |  |
| **Overall** | 0.4% | 0.3% | 0.4% | 0.3% | 0.3% | 0.2% |
|  | 0.4% | 0.3% | 0.4% | 0.3% | 0.3% | 0.3% |
| Class F | 0.1% | 0.3% | 0.3% | 0.0% | 0.1% | 0.2% |
| Enc Time[%] | 92% | | | 92% | | |
| Dec Time[%] | 97% | | | 96% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B Main** | | | **Low delay B HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 0.2% | -0.3% | -0.1% | 0.2% | 0.1% | 0.1% |
| Class C | 0.5% | 0.6% | 0.4% | 0.4% | 0.4% | 0.3% |
| Class D | 0.7% | 0.6% | 0.8% | 0.7% | 0.0% | 0.2% |
| Class E | 0.2% | 0.1% | 0.8% | 0.1% | -0.1% | -0.3% |
| **Overall** | 0.4% | 0.2% | 0.4% | 0.3% | 0.1% | 0.1% |
|  | 0.4% | 0.2% | 0.5% | 0.3% | 0.2% | 0.1% |
| Class F | 0.3% | 0.2% | 1.1% | 0.2% | 0.6% | 0.7% |
| Enc Time[%] | 91% | | | 90% | | |
| Dec Time[%] | 100% | | | 94% | | |

Table 3. Experimental results of case G: disable bi-predictive mode for 4x4, 8x4 and 4x8, with normative changes in the merging list derivation

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main** | | | **Random Access HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A | 0.9% | 0.8% | 0.9% | 0.6% | 0.6% | 0.6% |
| Class B | 1.3% | 0.7% | 0.8% | 1.0% | 0.6% | 0.6% |
| Class C | 1.7% | 1.9% | 2.1% | 1.4% | 1.6% | 1.7% |
| Class D | 2.2% | 2.0% | 2.3% | 1.8% | 1.8% | 1.9% |
| Class E |  |  |  |  |  |  |
| **Overall** | 1.5% | 1.3% | 1.5% | 1.2% | 1.1% | 1.2% |
|  | 1.5% | 1.3% | 1.5% | 1.2% | 1.1% | 1.2% |
| Class F | 0.8% | 1.0% | 1.1% | 0.6% | 0.8% | 1.0% |
| Enc Time[%] | 92% | | | 93% | | |
| Dec Time[%] | 103% | | | 102% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B Main** | | | **Low delay B HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 1.6% | 0.2% | 0.5% | 1.3% | 0.3% | 0.5% |
| Class C | 2.4% | 2.3% | 2.5% | 2.0% | 2.1% | 2.1% |
| Class D | 2.7% | 1.7% | 2.6% | 2.4% | 1.5% | 2.1% |
| Class E | 1.6% | 1.1% | 1.8% | 0.9% | 0.5% | 0.6% |
| **Overall** | 2.1% | 1.3% | 1.8% | 1.7% | 1.1% | 1.3% |
|  | 2.1% | 1.3% | 1.8% | 1.6% | 1.1% | 1.3% |
| Class F | 1.4% | 1.9% | 1.7% | 1.2% | 1.1% | 1.8% |
| Enc Time[%] | 86% | | | 86% | | |
| Dec Time[%] | 95% | | | 93% | | |

Table 4. Experimental results of case D: disable bi-predictive mode for 4x4, 8x4, 4x8 and 8x8, encoder only.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main** | | | **Random Access HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A | 0.5% | 0.5% | 0.6% | 0.2% | 0.6% | 0.4% |
| Class B | 0.9% | 0.5% | 0.6% | 0.7% | 0.3% | 0.4% |
| Class C | 1.2% | 1.3% | 1.4% | 1.0% | 1.0% | 1.2% |
| Class D | 1.7% | 1.5% | 1.6% | 1.5% | 1.4% | 1.5% |
| Class E |  |  |  |  |  |  |
| **Overall** | 1.0% | 0.9% | 1.0% | 0.8% | 0.8% | 0.8% |
|  | 1.0% | 0.9% | 1.1% | 0.8% | 0.8% | 0.8% |
| Class F | 0.5% | 0.7% | 0.7% | 0.5% | 0.6% | 0.8% |
| Enc Time[%] | 95% | | | 93% | | |
| Dec Time[%] | 104% | | | 100% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B Main** | | | **Low delay B HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 0.8% | -0.3% | 0.0% | 0.6% | -0.1% | 0.0% |
| Class C | 1.3% | 1.1% | 0.9% | 1.1% | 1.1% | 1.2% |
| Class D | 1.6% | 0.9% | 0.8% | 1.5% | 0.4% | 1.2% |
| Class E | 0.5% | 0.2% | 0.9% | 0.2% | -0.1% | 0.1% |
| **Overall** | 1.1% | 0.4% | 0.6% | 0.9% | 0.3% | 0.6% |
|  | 1.1% | 0.4% | 0.6% | 0.9% | 0.4% | 0.6% |
| Class F | 0.5% | 0.6% | 0.9% | 0.6% | 0.8% | 0.7% |
| Enc Time[%] | 94% | | | 92% | | |
| Dec Time[%] | 108% | | | 100% | | |

Table 5. Experimental results of case H: disable bi-predictive mode for 4x4, 8x4 4x8 and 8x8, with normative changes in the merging list derivation

# Comments

Restriction of bi-predictive mode for small block size PUs is an effective way to limit the worst case motion compensation memory bandwidth. It is recommended to consider the proposed restriction together with other restrictions in the same category, and apply the restrictions across levels.

In addition to normative changes in the merging list derivation, avoiding transmitting the PU-level merge flag and inter prediction direction flag for small block size PUs can further reduce the coding loss of the proposed restriction.

The 4x4 inter PUs are hard to use in practical encoder implementation, and may also significantly increase the cost of merging candidate list derivation logic even on the decoder side. It is therefore strongly recommended to disable 4x4 inter PUs in the HEVC standard.

# References

[1] F. Bossen, “Common test conditions and software reference configurations,” JCT-VC Document, JCTVC-G1100, San Jose, CA, USA, February 2012.

[2] [B. Bross](mailto:benjamin.bross@hhi.fraunhofer.de), [W.-J. Han](mailto:wjhan.han@samsung.com), [J.-R. Ohm](mailto:ohm@ient.rwth-aachen.de), [G. J. Sullivan](mailto:garysull@microsoft.com), [T. Wiegand](mailto:thomas.wiegand@hhi.fraunhofer.de) “High Efficiency Video Coding (HEVC) Test Model 6 (HM 6) Encoder Description” JCT-VC Document, JCTVC-G1003, San Jose, CA, USA, February 2012.

[3] K. Kondo, T. Suzuki, T. Yamamoto, “AHG7: Modification of merge candidate derivation to reduce MC memory bandwidth,” JCT-VC Document, JCTVC-I0107, 9th Meeting: Geneva, Switzerland, 27 April – 07 May, 2012