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| *Title:* | **AHG7: On luma-chroma mode support in HEVC fidelity range extension** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | Kei Kawamura Tomonobu Yoshino Sei Naito  2-1-15, Ohara, Fujimino-shi, Saitama, JAPAN | Tel: Email: | +81 49 278 7411 ki-kawamura@kddi.com |
| *Source:* | KDDI Corp. (KDDI R&D Laboratories, Inc.) | | |

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# Abstract

This contribution reports the result of luma-chroma mode in HEVC fidelity range extension. Extension of luma-chroma mode to non-4:2:0 chroma format contributes improvement of total coding performance. The reason is that this mode improves the chroma coding performance and the amount of chroma pixels increases in such format. The support of luma-chroma mode for YUV422 sequences achieves 2.8%, 1.3%, and 0.3% BD-rate reduction under AI/RA/LDB-HE10 condition, respectively. The BD-rate gains for YUV444 sequences are 3.1%, 1.5%, and 0.4%.

# Introduction

This contribution proposes to support luma-chroma mode in HEVC fidelity range extension (FrExt). Luma-chroma mode is one of the chroma intra prediction methods and is discussed deeply in the phase of HEVC version 1 [1-3]. Due to the hardware complexity issue, this luma-chroma mode is dropped at the profile discussion.

Non-4:2:0 chroma format, which is dealt with in fidelity range extension, consists of larger amount of chroma pixels than that of 4:2:0 chroma format. Therefore, contribution by the luma-chroma intra prediction to BD-rate becomes large.

Non-YUV chroma format such as RGB, XYZ and so on, is also dealt with in FrExt. Such chroma formats contains high correlation between color planes. In this situation, luma-chroma mode realizes more effective performance compared to the coding in YUV chroma format.

Based on the above reason, we propose to support luma-chroma mode in HEVC FrExt.

# Extension method of luma-chroma mode

## Derivation process

Derivation process of luma-chroma mode is same as “8.4.2 Derivation process for chroma intra prediction mode” of working draft 7 [3].

## Decoding process

When luma-chroma mode is used, the chroma values are predicted from reconstructed luma values of same block as follows,

,

where indicates the predicted chroma samples in a block and indicates the reference luma samples in the block. Parameter and are derived from reconstructed sampled of coded blocks around the current block.

Parameter and are derived from the top and left pixels. Detailed description can be found in “8.4.3.1.6 Specification of Intra\_FromLuma (35) prediction mode” of working draft 7.

When chroma format is 4:2:2, reference values are derived as follows,

,

and reconstructed pixels for parameter derivation are located at left side by 2 columns.

When chroma format is 4:4:4, reference values are same as luma values and reconstructed pixels for parameter derivation are located at left side by 1 column.

## Parsing process

Derivation process of luma-chroma mode is same as “9.3.2.9 Binarization process for intra\_chroma\_pred\_mode” of working draft 7.

# Experimental results

The proposed scheme is realized by changing the following macro in TypeDef.h.

#define REMOVE\_LMCHROMA 0

Common test condition for AHG7 follows the BoG report of JCTVC-J0581.

Following tables show the summary of BD-rate for YUV422/YUV444 sequences.

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|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE10 (YUV422)** | | | **All Intra HE10 (YUV444)** | | |
|  | Y | U | V | Y | U | V |
| Kimono | -2.8% | -4.1% | -3.5% | -2.6% | -2.5% | -3.5% |
| Parkscene | -3.6% | -6.9% | -3.5% | -3.9% | -3.4% | -3.9% |
| BirdsInCage | -3.0% | -3.8% | -9.4% | -2.4% | -3.7% | -9.0% |
| DucksAndLegs | -1.0% | -1.1% | -1.4% | -1.2% | -1.2% | -1.8% |
| Traffic | -1.3% | -2.2% | -3.7% | -1.1% | -1.9% | -3.7% |
| CrowdRun | -2.0% | -6.5% | -4.3% | -2.6% | -5.7% | -5.0% |
| OldTownCross | -1.9% | -4.9% | -3.1% | -2.2% | -24.9% | -0.2% |
| Seeking | -6.5% | -16.6% | -10.8% | -8.6% | -12.6% | -9.3% |
| **Overall** | -2.8% | -5.8% | -5.0% | -3.1% | -7.0% | -4.6% |
| Enc Time[%] | 105% | | | 108% | | |
| Dec Time[%] | 102% | | | 101% | | |

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|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access HE10 (YUV422)** | | | **Random Access HE10 (YUV444)** | | |
|  | Y | U | V | Y | U | V |
| Kimono | -1.2% | -7.0% | -2.4% | -1.2% | -4.2% | -2.5% |
| Parkscene | -1.8% | -9.2% | -2.1% | -2.1% | -6.2% | -2.3% |
| BirdsInCage | -2.0% | -5.9% | -9.6% | -1.6% | -2.1% | -10.0% |
| DucksAndLegs | -0.6% | -1.3% | -1.1% | -0.8% | -0.8% | -1.6% |
| Traffic | -0.5% | -2.9% | -3.4% | -0.5% | -1.6% | -3.6% |
| CrowdRun | -0.7% | -6.5% | -3.3% | -1.0% | -5.7% | -3.7% |
| OldTownCross | -0.9% | -9.0% | -4.8% | -1.0% | -3.5% | -3.6% |
| Seeking | -3.0% | -19.9% | -10.2% | -4.2% | -14.8% | -8.9% |
| **Overall** | -1.3% | -7.7% | -4.6% | -1.5% | -4.9% | -4.5% |
| Enc Time[%] | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | |

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|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B HE10 (YUV422)** | | | **Low delay B HE10 (YUV444)** | | |
|  | Y | U | V | Y | U | V |
| Kimono | -0.3% | -3.3% | -1.3% | -0.4% | -1.6% | -0.8% |
| Parkscene | -0.3% | -2.3% | -0.5% | -0.4% | -1.5% | -0.5% |
| BirdsInCage | -0.6% | -1.5% | -5.4% | -0.1% | -0.4% | -5.6% |
| DucksAndLegs | -0.1% | -0.3% | -0.2% | -0.2% | -0.2% | -0.4% |
| Traffic | -0.1% | -2.0% | -1.7% | -0.2% | -1.0% | -1.8% |
| CrowdRun | -0.2% | -2.6% | -1.2% | -0.3% | -2.1% | -1.1% |
| OldTownCross | -0.1% | -2.0% | -1.3% | -0.2% | -0.4% | -0.5% |
| Seeking | -1.1% | -10.0% | -5.9% | -1.7% | -6.8% | -4.4% |
| **Overall** | -0.3% | -3.0% | -2.2% | -0.4% | -1.8% | -1.9% |
| Enc Time[%] | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 102% | | |

Following table shows the summary of BD-rate for additional RGB444 sequences, which are obtained from VQEG web site.

Table 4 Results of RGB444 sequences

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE10** | | | **Random Access HE10** | | | **Low delay B HE10** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| CrowdRun | -18.3% | -16.4% | -16.6% | -9.0% | -7.3% | -7.9% | -4.0% | -2.7% | -3.1% |
| ParkJoy | -10.7% | -10.9% | -11.8% | -12.0% | -9.1% | -11.7% | -8.1% | -4.8% | -6.9% |
| DucksTakeOff | -10.2% | -11.3% | -9.6% | -2.8% | -4.2% | -2.5% | -0.7% | -0.8% | -0.5% |
| InToTree | -7.6% | -8.4% | -7.7% | -2.7% | -1.5% | -1.6% | -0.9% | -0.6% | -0.3% |
| OldTownCross | -14.6% | -13.3% | -13.5% | -6.9% | -5.7% | -6.3% | -3.2% | -2.3% | -2.2% |
| **Overall** | -12.3% | -12.1% | -11.8% | -6.7% | -5.6% | -6.0% | -3.4% | -2.3% | -2.6% |
| Enc Time[%] | 109% | | | 101% | | | 100% | | |
| Dec Time[%] | 98% | | | 98% | | | 99% | | |

# Conclusion

This contribution proposed to support luma-chroma mode in HEVC fidelity range extension. A series of proposal realted to this mode can be found in JCTVC-E266 and working draft 7 (JCTVC-I1003).

Experimental results showed that the proposed method achieved 2.8%, 1.3%, and 0.3% BD-rate reduction respectively for all intra, random access, and low-delay B configuration with HE10 for YUV422 sequences. The BD-rate gain was 3.1%, 1.5%, and 0.4% for all intra, random access, and low-delay B configuration with HE10 for YUV444 sequences.

Since the support of luma-chroma mode achieves solid coding gain with inter-plane dependency, we recommend adopting it in HEVC FrExt.

# References

1. J. Chen, V. Seregin, S. Lee, W. Han, J. Kim, B.M. Jeon, “CE6.a: Chroma intra prediction by reconstructed luma samples”, JCTVC-D350, Daegu, January, 2011.
2. J. Chen, V. Seregin, S. Lee, W. Han, J. Kim, B.M. Jeon, “CE6.a: Chroma intra prediction by reconstructed luma samples”, JCTVC-E266, Geneva, March, 2011.
3. B. Bross, et.al, “High efficiency video coding (HEVC) text specification draft 7”, JCTVC-I1003, Geneva, April, 2012.

# Patent rights declaration(s)

**KDDI Corporation may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**