|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  19th Meeting: Strasbourg, FR, 17–24 Oct. 2014 | Document: JCTVC-S0272 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **Intra Reference Prediction by Cross-Component Prediction** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | Kei Kawamura Sei Naito  2-1-15, Ohara, Fujimino-shi, Saitama, JAPAN | Tel: Email: | +81 49 278 7411 [ki-kawamura@kddi.com](mailto:ki-kawamura@kddi.com) |
| *Source:* | KDDI Corp. (KDDI R&D Laboratories, Inc.) | | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

Since HEVC version 1 standardization, luma-chroma prediction (LMChroma) was studied well. However, a cross-component dependency by the LMChroma was unacceptable for a hardware implementation. In this contribution, chroma intra-reference samples are predicted from the luma one by using cross component prediction in order to reduce the dependency. The relaxed dependency in this contribution is same as that by the cross-component prediction in RExt. BD-rate gains for RGB/YUV videos under lossy coding with G/Y, B/U, R/V of the all intra condition are as follows.

0.0%/0.0%/0.0% for RGB, text & graphics with motion, 1080p  
0.0%/-0.1%/-0.1% for RGB, text & graphics with motion,720p  
0.0%/-0.2%/-0.2% for RGB, mixed content, 1440p  
0.0%/-0.2%/-0.1% for RGB, mixed content, 1080p  
0.1%/-0.1%/-0.1% for RGB, Animation, 720p  
0.1%/-0.3%/-0.2% for RGB, camera captured, 1080p  
0.1%/-0.1%/0.0% for YUV, text & graphics with motion, 1080p  
0.4%/-0.9%/-0.7% for YUV, text & graphics with motion,720p  
0.6%/-1.2%/-1.0% for YUV, mixed content, 1440p  
0.6%/-0.4%/-0.4% for YUV, mixed content, 1080p  
0.6%/-2.9%/-2.3% for YUV, Animation, 720p  
0.3%/-2.0%/-2.2% for YUV, camera captured, 1080p

# Introduction

Since HEVC version 1 standardization, the luma chroma prediction was deeply and frequently discussed well. However a cross-component-data dependency issue for a hardware implementation was not solved. LMChroma was then not adopted to all extensions like RExt and SCC. Required samples and prediction target are shown in Figure 1. From this figure, it is confirmed that a reconstructed luma samples are required in advance to the chroma prediction.



Figure 1 Luma chroma prediction

On the other hand, cross-component prediction (CCP) for residual samples of 4:4:4 chroma format was adopted into the format range extensions. Compared to the LMChroma, CCP relaxes the data dependency. A key point of CCP is an independency between intra prediction and residual modification.

In this contribution, we propose the solution to relax the LMChroma framework by introducing a reference sample prediction based on the cross-component prediction.

# Proposed method

The chroma reconstruction with LMChroma can be formulated as follows,

where and means reconstructed and residual sample values. Parameters and are linear model parameters derived by the least square equation between luma and chroma reference samples. This formulation can be modified as follows,

where IntraPred and CCP means the regular intra prediction and the cross-component prediction defined in the specification documents, respectively. In this modification, the linearity of the IntraPred function is utilized. From this formulation, the cross-component data dependency of the intra prediction moves to the reference samples. The proposed cross-component reference-sample prediction (CRP) is shown in Figure 2. From this figure, it is confirmed that the luma reconstructed samples are no longer required.



Figure 2 Reference and target sample positions for the proposed cross-component reference-sample prediction.

It is noted that the CCP for intra prediction is restricted to DM mode; chroma intra prediction mode is same as luma one. The chroma intra prediction in CRP is also limited to the DM mode.

The parameter of CRP and CCP becomes independent. The parameter for CCP is explicitly signaled while that for CRP is implicitly signaled by the decoder derivation method which is same as LMChroma method.

# Experimental results

The both proposed methods are implemented on SCM-2.0. Table 1 presents the results under the common test conditions.

Table 1 Experimental results for CTC

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All Intra** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p | 0.0% | 0.0% | 0.0% |
| RGB, text & graphics with motion,720p | 0.0% | -0.1% | -0.1% |
| RGB, mixed content, 1440p | 0.0% | -0.2% | -0.2% |
| RGB, mixed content, 1080p | 0.0% | -0.2% | -0.1% |
| RGB, Animation, 720p | 0.1% | -0.1% | -0.1% |
| RGB, camera captured, 1080p | 0.1% | -0.3% | -0.2% |
| YUV, text & graphics with motion, 1080p | 0.1% | -0.1% | 0.0% |
| YUV, text & graphics with motion,720p | 0.4% | -0.9% | -0.7% |
| YUV, mixed content, 1440p | 0.6% | -1.2% | -1.0% |
| YUV, mixed content, 1080p | 0.6% | -0.4% | -0.4% |
| YUV, Animation, 720p | 0.6% | -2.9% | -2.3% |
| YUV, camera captured, 1080p | 0.3% | -2.0% | -2.2% |
| Enc Time[%] | 104% | | |
| Dec Time[%] | 101% | | |

# Conclusion

This contribution proposed the cross-component reference-sample prediction (CRP) to overcome the LMChroma data dependency. Instead of the luma reconstruction, we utilize both reference samples of intra prediction and cross-component prediction in RExt.

# References

1. R. Joshi, J. Xu, R. Cohen, S. Liu, Z. Ma, Y. Ye, “Screen content coding test model 1,” Document of Joint Collaborative Team on Video Coding, JCTVC-R1014, June 2014.
2. HM-15.0+RExt-8.0+SCM-2.0, https://hevc.hhi.fraunhofer.de/svn/svn\_HEVCSoftware/tags/HM-15.0+RExt-8.0+SCM-2.0
3. H. Yu, R. Cohen, K. Rapaka, J. Xu, “Common Test Conditions for Screen Content Coding,” Document of Joint Collaborative Team on Video Coding, JCTVC-R1015, June 2014.

# 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).**