|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  9th Meeting: Geneva, CH, 27 April – 7 May 2012 | Document: JCTVC-I0183 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **Non-CE1: On SAO parameters reduction for Chroma** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | Guillaume LAROCHE  Tangi POIRIER  Christophe GISQUET  Patrice ONNO  Canon Research Centre France Rue de la Touche Lambert  35510 CESSON-SEVIGNE, FRANCE | Tel: Email: | +33(0)299876800 [guillaume.laroche@crf.canon.fr](mailto:guillaume.laroche@crf.canon.fr)  christophe.gisquet@crf.canon.fr  [patrice.onno@crf.canon.fr](mailto:patrice.onno@crf.canon.fr) |
| *Source:* | Canon Research Centre France | | |

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

# Abstract

In this contribution, a method to reduce the SAO parameters for the Chroma components is presented. The proposed technique consists in providing only one set of SAO parameters that is valid for the both Chroma components instead of 2 sets for the current HM6.0. It is reported that the number of SAO parameters to be encoded in the bitstream for Chroma is divided by 2 leading to a memory reduction of 33% for the SAO parameters. In terms of coding efficiency, it is reported that a coding efficiency gain of 0.2%, 0.9%, 1.5% for Y, U and V color components for LCU size 64x64 are obtained compared to the CE1 anchors.

# Introduction

This contribution presents a simplification of the SAO tools to reduce the number of SAO parameters encoded in the bitstream for the Chroma components in order to save memory for the storage of the SAO parameters.

# Technology description

## Current HM6.0 SAO parameters representation

In the current HM6.0, SAO parameters are encoded in the bitstream by using the “sao\_offset\_cabac” syntax element for the LCU mode or the “sao\_offset\_vlc” for the APS mode. These syntax elements are represented in the following Figure 1 for the LCU mode. The difference between these two syntax elements is just the way the SAO parameters are coded.

|  |  |
| --- | --- |
| sao\_offset\_vlc( rx, ry, cIdx ) { | Descriptor |
| **sao\_type\_idx**[ cIdx ][ rx ][ ry ] | ue(v) |
| if( sao\_type\_idx[ cIdx ][ rx ][ ry ] = =5 ) { |  |
| **sao\_band\_position**[ cIdx ][ rx ][ ry ] | u(5) |
| for( i = 0; i < 4; i++ ) |  |
| **sao\_offset**[ cIdx ][ rx][ ry ][ i ] | se(v) |
| } else if( sao\_type\_idx[ cIdx ][ rx ][ ry ] != 0 ) |  |
| for( i = 0; i < 4; i++ ) |  |
| **sao\_offset**[ cIdx ][ rx][ ry ][ i ] | ue(v) |
| } |  |

Table 1: SAO parameters syntax in HM6.0 for the APS mode.

In this Figure 1, three distinct SAO parameters are encoded for each triplet (*rx*, *ry* and *cIdx*) which corresponds to the current coding treeblock at position *rx* and *ry* and for the colour component *cIdx*. Here are the definitions of these 3 parameters:

1. The SAO type index is indicated by the syntax element **sao\_type\_idx**[cIdx][rx][ry] and has the following meaning:

|  |  |
| --- | --- |
| **sao\_type\_idx[ cIdx ][ rx ][ ry ]** | **SAO type** |
| 0 | Not applied |
| 1 | 1D 0-degree edge |
| 2 | 1D 90-degree edge |
| 3 | 1D 135-degree edge |
| 4 | 1D 45-degree edge |
| 5 | Band |

1. When the SAO type index corresponds to the SAO Band Offset (sao\_type\_idx[ cIdx ][ rx ][ ry ] is equal to 5) a parameter indicates the position of the band offset for this mode: **sao\_band\_position**[cIdx][rx][ry].
2. Then whatever the SAO type index is, 4 offsets are encoded: **sao\_offset**[ cIdx ][ rx][ ry ][ i ]

## Proposed simplification

In this contribution, we are proposing to encode only one set of parameters for the two color (U and V) components in order to reduce the memory to store the SAO parameters for both APS and LCU mode. The proposed change enables to have the same SAO type, share the same band position (when the SAO type index is Band Offset) and share the same SAO offsets for the two color components for each coding treeblock at position *rx* and *ry*. More precisely when the *cIdx* value varied from [0,2] in HM6.0, in our proposal the *cIdx* is limited to the range [0,1] where the SAO parameters for the U and V components are represented by *cIdx*=1.

In the worst case, where SAO is performed on all the coding treeblocks, the memory reduction is about 33% compared to the HM6.0 since one third of the memory can be saved.

In addition, this modification enables to simplify the SAO process in both the LCU and the APS modes by considering the same SAO parameters for the both color component.

### SAO offset derivation for Band Offset for Chroma component

For the first color component (U) and for each treeblock at position *rx* and *ry*, there is no modification compared to HM6.0 to get the SAO offsets and the band position related to the U component. For the second color component (V), the offset values for the treeblock at position *rx* and *ry* are derived from the U component according to the following relations. For the band position, we also introduce a relationship between the two components U and V. It is important to note that in this proposal, the same Band Offset SAO filtering process is performed as in HM6.0:

These relations show that the offsets for the second component (V) are obtained by inverting the order of the offsets value. In addition, the SAO\_band\_position for V is determined so that the middle of the band for the V component and the middle of the band for U are symmetric with respect to the center of the full band as depicted in Figure 1.



Figure 1: Graphical interpretation of the relationships between SAO offsets of the V component and the U component proposed in that contribution.

### SAO offset derivation for Edge Offset for Chroma component

Regarding the Edge Offset case, for each treeblock at position *rx* and *ry,* there is no modification to get the 4 offsets for the first color component (U): the offsets for the U components are those decoded when *cIdx*=1. For the second color component (V), the offset values for the treeblock at position *rx* and *ry* are derived from those of the U component according to the following relations. It is important to note that in this proposal, the same SAO Edge Offset filtering process is performed as in HM6.0:

Similarly to the Band Offset case, the SAO parameters for the Edge Offset for the V component are derived by inverting the order of the offsets. As for the HM6.0, the sign of the offset is inferred according to the Edge Offset type and no change has been introduced here.

### Decoding process for the Luma component

Regarding the Luma component, **no** change has been introduced in that proposal and Luma decoding process remains perfectly unchanged.

## Joint selection at the encoder

In order to find the best SAO parameters in a jointly manner for the U and V component, the encoder has been slightly modified to find the SAO parameters. The main change is about a joint search to minimize the rate distortion cost for both U and V components. Please note this is a simple modification and that there is no additional complexity related to this joint SAO parameter search at the encoder side. As shown in Section 3, there is no impact on the encoding time.

# Results

Simulations results were performed on a Linux platform according to the CE1 common test conditions [1]. The results are reported for interleaving mode based on low delay B configurations for 3 LCU sizes: 64x64, 32x32 and 16x16.

Table 2 shows the results of the proposed coding of SAO Chroma parameters. For LCU size 64x64 the average BDR gains are respectively 0.2%, 0.9% and 1.5% for Y, U and V color components. For LCU size 32x32, the average BDR gains for the three color components are 0.3% 0.9% 1.4% and for LCU size 16x16 the average BDR gains are 0.7% 0.7% 0.6%. Except for the LCU size 16x16 the gain is higher for Chroma components with more than 1% bitrate savings for LCU size 64x64.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main LCU 16x16** | | | **Low delay B HE10 LCU 16x16** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | -0.4% | -0.5% | -0.1% | -0.4% | -0.5% | -0.4% |
| Class C | -0.3% | -0.3% | -0.3% | -0.3% | -0.4% | 0.1% |
| Class D | -0.4% | -0.8% | -0.7% | -0.4% | -0.3% | -0.3% |
| Class E | -2.0% | -1.7% | -1.8% | -2.0% | -1.8% | -1.6% |
| **Overall** | -0.7% | -0.8% | -0.6% | -0.7% | -0.7% | -0.5% |
|  | -0.7% | -0.8% | -0.7% | -0.7% | -0.7% | -0.5% |
| Class F | -0.9% | -1.7% | -1.8% | -0.8% | -1.4% | -1.5% |
| Enc Time[%] | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 101% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B Main LCU 32x32** | | | **Low delay B HE10 LCU 32x32** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | -0.1% | -0.7% | -1.8% | -0.1% | -0.3% | -0.4% |
| Class C | -0.1% | -1.1% | -1.6% | -0.1% | -0.4% | -0.8% |
| Class D | -0.3% | -1.3% | -1.6% | -0.2% | -0.6% | -1.2% |
| Class E | -1.0% | -2.4% | -3.1% | -1.0% | -1.0% | -1.3% |
| **Overall** | -0.3% | -1.3% | -1.9% | -0.3% | -0.5% | -0.9% |
|  | -0.3% | -1.2% | -1.9% | -0.3% | -0.6% | -0.8% |
| Class F | -0.5% | -0.4% | -2.8% | -0.4% | -2.5% | -2.6% |
| Enc Time[%] | 100% | | | 100% | | |
| Dec Time[%] | 99% | | | 100% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B Main LCU 64x64** | | | **Low delay B HE10 LCU 64x64** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | -0.1% | -0.7% | -1.2% | -0.1% | -1.2% | -1.6% |
| Class C | -0.1% | -0.2% | -0.8% | -0.1% | -0.5% | -1.2% |
| Class D | -0.3% | -0.3% | -0.4% | -0.2% | -1.3% | -1.1% |
| Class E | -0.7% | -1.9% | -3.6% | -0.6% | -1.2% | -2.7% |
| **Overall** | -0.3% | -0.7% | -1.4% | -0.2% | -1.0% | -1.6% |
|  | -0.3% | -0.7% | -1.3% | -0.2% | -1.1% | -1.6% |
| Class F | -0.3% | -0.6% | -0.7% | -0.2% | -0.2% | -0.6% |
| Enc Time[%] | 99% | | | 99% | | |
| Dec Time[%] | 100% | | | 101% | | |

Table 2 Simulation results of the proposed modification compared to the CE1 Anchors.

# Conclusion

This contribution is about a simple modification for SAO consisting is transmitting only one set of SAO parameters of the two Chroma components. The goal is to reduce the SAO parameters memory without affecting the coding efficiency. The results show a coding efficiency gain of 0.2%, 0.9% and 1.5% for Y, U and V color components for LCU size 64x64 under the common test conditions of CE1 while reducing by 33% the memory to store the SAO parameters.

According to the coding efficiency performance and complexity memory reduction related to joint coding of SAO Chroma parameters, we proposed to adopt this simplification in the HM7.0.

# References

1. Y.-W. Huang, E. Alshina, I. S. Chong, W. Wan, and M. Zhou, “Description of Core Experiment 1 (CE1): Sample adaptive offset filtering”, ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Document JCTVC-H1101, Feb. 2012.

# CD text

To be updated

# Patent rights declaration(s)

**Canon Research Centre France 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).**