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| *Title:* | **Improved Type Coding for SAO** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution proposes a modified sao\_type\_index for SAO. This scheme replaces unary binarization with truncated unary binarization for the index of a SAO type to remove coding redundancy in CABAC.

# Introduction

In the current HEVC specification [1], unary binarization is used for coding of SAO type although the SAO type is bounded. In order to remove coding redundancy, a truncated unary binarization is proposed to replace unary binarization for coding of the SAO type. The purpose is similar to [2], where truncated unary coding is adopted for SAO edge offset coding.

# Proposed Scheme

The current HM uses unary binarization as follows for SAO type coding.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Value of syntax element** | **Bin string** | | | | | |
| 0 | 0 |  |  |  |  |  |
| 1 | 1 | 0 |  |  |  |  |
| 2 | 1 | 1 | 0 |  |  |  |
| 3 | 1 | 1 | 1 | 0 |  |  |
| 4 | 1 | 1 | 1 | 1 | 0 |  |
| 5 | 1 | 1 | 1 | 1 | 1 | 0 |
| … |  |  |  |  |  |  |

On the other hand, the SAO type shall be in the range of 0 to 5. Therefore, 1-bin redundancy should exist when an SAO type is encoded. In order to remove coding redundancy, we propose to replace unary binarization with truncated unary binarization. An example of truncated unary binarization is shown in the following table when the maximum value of syntax element is equal to 5.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Value of syntax element** | **Bin string** | | | | | |
| 0 | 0 |  |  |  |  |  |
| 1 | 1 | 0 |  |  |  |  |
| 2 | 1 | 1 | 0 |  |  |  |
| 3 | 1 | 1 | 1 | 0 |  |  |
| 4 | 1 | 1 | 1 | 1 | 0 |  |
| 5 | 1 | 1 | 1 | 1 | 1 |  |

#### In the HEVC specification [1], sao\_type\_idx in the Table 9-34 should be changed as follows (yellow color).

Table 9-34 – Syntax elements and associated types of binarization, maxBinIdxCtx, ctxIdxTable, and ctxIdxOffset

| **Syntax element** | **initType** | **Type of binarization** | **maxBinIdxCtx** | **ctxIdxTable** | **ctxIdxOffset** |
| --- | --- | --- | --- | --- | --- |
| ….. |  | ….. |  |  |  |
|  |  |  |  |
|  |  |  |  |
| sao\_type\_idx | 0 | TU  cMax = 5 | 1 |  | 0 |
| 1 | 1 |  | 2 |
| 2 | 1 |  | 4 |
| ….. |  | ….. |  |  |  |
|  |  |  |  |
|  |  |  |  |

# Simulation & Results

The proposed scheme has been implemented on HM-7.0, and performance evaluation has been conducted using the common test configurations [2]. The following table shows results of the evaluation on the proposed scheme compared with the anchor. In most cases, there is no difference in luma BD-rates, but consistent improvements (-0.1 ~ -0.5 %) in chroma BD-rates are observed. In the “Low delay B Main” case, there are also improvements in luma (-0.1%: overall, -0.2%: class F).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main** | | | **All Intra HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | 0.0% | -0.1% | -0.3% | 0.0% | -0.1% | -0.2% |
| Class B | 0.0% | -0.2% | -0.3% | 0.0% | -0.2% | -0.3% |
| Class C | 0.0% | -0.2% | -0.2% | 0.0% | -0.2% | -0.2% |
| Class D | 0.0% | -0.1% | -0.1% | 0.0% | 0.0% | 0.0% |
| Class E | 0.0% | -0.3% | -0.4% | 0.0% | -0.2% | -0.2% |
| **Overall** | 0.0% | -0.2% | -0.3% | 0.0% | -0.1% | -0.2% |
|  | 0.0% | -0.2% | -0.3% | 0.0% | -0.1% | -0.2% |
| Class F | 0.0% | -0.2% | -0.2% | 0.0% | -0.3% | -0.3% |
| Enc Time[%] | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | |
|  |  |  |  |  |  |  |
|  | **Random Access Main** | | | **Random Access HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | 0.0% | -0.1% | -0.2% | 0.0% | -0.1% | -0.2% |
| Class B | 0.0% | -0.3% | -0.3% | 0.0% | -0.3% | -0.4% |
| Class C | 0.0% | -0.2% | -0.3% | 0.0% | -0.1% | -0.2% |
| Class D | 0.0% | -0.2% | -0.3% | 0.0% | -0.2% | -0.2% |
| Class E |  |  |  |  |  |  |
| **Overall** | 0.0% | -0.2% | -0.3% | 0.0% | -0.2% | -0.2% |
|  | 0.0% | -0.3% | -0.3% | 0.0% | -0.2% | -0.3% |
| Class F | 0.0% | -0.2% | -0.2% | 0.0% | -0.2% | -0.4% |
| Enc Time[%] | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B Main** | | | **Low delay B HE10** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | -0.1% | -0.4% | -0.5% | 0.0% | -0.2% | -0.1% |
| Class C | -0.1% | -0.5% | -0.4% | 0.0% | -0.2% | -0.2% |
| Class D | 0.0% | -0.2% | -0.3% | 0.0% | -0.2% | -0.1% |
| Class E | -0.1% | -0.5% | -0.4% | 0.0% | -0.5% | -0.3% |
| **Overall** | -0.1% | -0.4% | -0.4% | 0.0% | -0.3% | -0.2% |
|  | -0.1% | -0.4% | -12.7% | 0.0% | -0.2% | -0.1% |
| Class F | -0.2% | -0.5% | -0.4% | 0.1% | -0.1% | 0.6% |
| Enc Time[%] | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | |

# Conclusion

With the proposed method, this contribution replaces unary binarization with truncated unary binarization for coding of SAO type index to remove coding redundancy in the CABAC case. Coding performance of the proposed scheme is comparable to (mostly in luma), or a little better (some luma and most chroma cases) than the HM7.0 anchor. We propose these schemes to be adopted for further coding simplification.

# Patent rights declaration(s)

**LG Electronics 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).**

# Reference

[1] JCTVC-I1003, “High efficiency video coding (HEVC) text specification draft 7,” 9th JCT-VC Meeting, Geneva, CH, 27 April – 7 May 2012.

[2] JCTVC-I0066, “Non-CE1: Improved edge offset coding for SAO,” 9th JCT-VC Meeting, Geneva, CH, 27 April – 7 May 2012.