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| *Title:* | **Improvement of Adaptive Intra Smoothing by switching interpolation filters** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

In this document a method is described to improve the performance of Adaptive Intra Smoothing algorithms. In this method, a set of new 4-tap interpolation filters is proposed to be used in the Intra prediction process instead of the linear interpolation when Intra smoothing is set to off. The method is tested on both hybrid and (fixed) mode dependant Intra smoothing techniques [1] and showed, on average, 0.3% and 0.4% improvements over the results in [1, 2] for HE and LC settings, respectively.

# Algorithm description

Existing AIS techniques adaptively switch between a numbers of available low-pass filters [1, 3] which are used to filter the full-pel locations of the reconstructed boundaries of the block to be predicted. However, in this document we propose to also switch between interpolation filters for non-integer locations. The current TMuC software uses a linear interpolation for all non-integer locations regardless of the AIS flag. In our proposal, when AIS flag is on, the same low-pass filters (as in JCTVC-D282 or other AIS proposals) are used for the integer-pel, and the default linear interpolation is used for the non-integer locations. On the other hand, when AIS flag is off, the set of 4-tap filters shown below (Table 3) is used for fractional-pel locations. No filtering is applied to the full-pel locations as before.

It should be also noted that, for a more simplified implementation, for both cases of AIS on or off, one can design a set of 4-tap filters for all locations (full and fractional pel locations) and just switch between them according to the AIS flag such that the overall effect of the filters becomes equivalent to the method described above. In other words, instead of having two branches, one with a 3-tap filter for the full-pel locations and a linear interpolation and the other with no full-pel filtering and a set of 4-tap interpolation filters, one can envisage a single branch with two (or perhaps more) sets of switching 4-tap filters with the same performance.

We implemented this technique in the hybrid AIS source code we received from Qualcomm. In addition to the switching between AIS filters (for full-pel locations) as described in JCTVC-D282, we also allowed switching between interpolation methods as described above according to the AIS flag for that block. Results are shown in and for the cases of QC\_MFIS and QC\_MDHIS, respectively. These two operational modes are defined as [1]:

* QC\_MFIS:           mode dependent Intra Smoothing without signaling
* QC\_MDHIS:        hybrid signaled adaptive and mode dependent intra smoothing.

As it can be seen from the results, the average BD-rates of high efficiency (HE) and low complexity (LC) settings improved by 0.3% and 0.4% , respectively (for both QC\_MFIS and QC\_MDHIS), without any significant increase in the encoding or decoding times. This observation can be made by comparing results of and to the cross-verification results presented in [2].

Table 3. Interpolation filters for the case of no Intra smoothing (values scaled by 256).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fractional-pel location | Filter coefficient | | | |
| 0/32 | 0 | 256 | 0 | 0 |
| 1/32 | -3 | 252 | 8 | -1 |
| 2/32 | -5 | 247 | 17 | -3 |
| 3/32 | -7 | 242 | 25 | -4 |
| 4/32 | -9 | 236 | 34 | -5 |
| 5/32 | -10 | 230 | 43 | -7 |
| 6/32 | -12 | 224 | 52 | -8 |
| 7/32 | -13 | 217 | 61 | -9 |
| 8/32 | -14 | 210 | 70 | -10 |
| 9/32 | -15 | 203 | 79 | -11 |
| 10/32 | -16 | 195 | 89 | -12 |
| 11/32 | -16 | 187 | 98 | -13 |
| 12/32 | -16 | 179 | 107 | -14 |
| 13/32 | -16 | 170 | 116 | -14 |
| 14/32 | -17 | 162 | 126 | -15 |
| 15/32 | -16 | 153 | 135 | -16 |
| 16/32 | -16 | 144 | 144 | -16 |
| *i*/32, *i* | Mirror of filter for (32-*i*)/32 | | | |

Table 4. Results of QC\_MFIS with switching interpolation method.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Intra | | | Intra LoCo | | |
| Y BD-rate | U BD-rate | V BD-rate | Y BD-rate | U BD-rate | V BD-rate |
| Class A | -0.5 | -0.6 | -0.7 | -1.3 | -0.8 | -0.8 |
| Class B | -0.7 | -0.5 | -0.6 | -1.3 | -0.7 | -0.6 |
| Class C | -0.4 | -0.4 | -0.4 | -0.6 | -0.5 | -0.6 |
| Class D | -0.5 | -0.6 | -0.6 | -0.8 | -0.6 | -0.6 |
| Class E | -0.8 | -0.8 | -1.0 | -1.8 | -0.9 | -0.8 |
| All | -0.6 | -0.6 | -0.6 | -1.1 | -0.7 | -0.7 |
| Enc Time[%] | 103% | | | 102% | | |
| Dec Time[%] | 100% | | | 101% | | |

Table 5. Results of QC\_MDHIS with switching interpolation method.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Intra | | | Intra LoCo | | |
| Y BD-rate | U BD-rate | V BD-rate | Y BD-rate | U BD-rate | V BD-rate |
| Class A | -0.7 | -0.7 | -0.9 | -1.6 | -0.8 | -0.9 |
| Class B | -0.9 | -0.9 | -0.9 | -1.4 | -0.8 | -1.0 |
| Class C | -0.6 | -0.6 | -0.7 | -0.9 | -0.6 | -0.7 |
| Class D | -0.6 | -0.7 | -0.6 | -0.8 | -0.6 | -0.6 |
| Class E | -1.2 | -1.2 | -1.2 | -2.0 | -1.2 | -1.0 |
| All | -0.8 | -0.8 | -0.9 | -1.3 | -0.8 | -0.8 |
| Enc Time[%] | 104% | | | 108% | | |
| Dec Time[%] | 101% | | | 102% | | |

# References

1. [Y. Zheng](mailto:zhengy@qualcomm.com), [M. Coban](mailto:mcoban@qualcomm.com), and [M. Karczewicz](mailto:martak@qualcomm.com), “CE13: Mode Dependent Hybrid Intra Smoothing”, Doc. JCTVC-D282, Daegu, Korea Jan. 2011.
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# Patent rights declaration(s)

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