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| *Title:* | **Improved Weighted Prediction** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution presents a modified weighted prediction process for bi-prediction. The modified WP process improves accuracy by performing rounding operation only once for bi-prediction. Using the fading sequences provided by the weighted prediction AhG at the July meeting, it is reported that, in the RA\_LC setting, on average 0.3 to 0.6% of BD rate reduction is achieved for luma, and 1.1% to 1.5% of BD rate reduction for chroma; in the LD\_LC setting, on average 0.6 to 0.8% of BD rate reduction is achieved for luma, and 3.6 to 4.6% of BD rate reduction for chroma. The proposed modification does not affect the weighted prediction process for input signal with bit depth larger than 8 bits.

# Introduction

Weighted prediction [2][3][4] was adopted in the July 2011 meeting, with essentially the same WP process as in H.264. Specifically, the weighted prediction process for bi-prediction is described as follows:

 (1)

# Proposed modifications

The weighted bi-prediction as in (1) may create a forced round-up in some cases. As described below:

 (2)

To alleviate such cases when a round-up operation is forced, it is proposed to replace (2) with the following process in (3), such that rounding can be applied in the usual manner:

 (3)

Note that equation (3) is not equivalent to the following equation (4), which is less accurate and also shown by simulations to be less efficient.

 (4)

# Change to WD

The current weighted prediction process in WD4 (not yet available in F803 [1] at the time when this document is written)

predPartC[ x, y ] = ( ( predPartL0C[ x, y ] \* w0 + predPartL1C[ x, y ] \* w1 + (1 << wshift ) )   
 >> ( wshift + 1 ) ) + ( ( o0 + o1 + 1 ) >> 1 )

is changed to

predPartC[ x, y ] = ( predPartL0C[ x, y ] \* w0 + predPartL1C[ x, y ] \* w1 +

( ( o0 + o1 + 1) << wshift ) ) >> ( wshift + 1 )

# Simulation Results

The proposed modification is implemented in the HM4.0 branch HM-4.0-dev-weighted-prediction under the macro WEIGHT\_PRED\_IMP. Simulation results were gathered with two macros (OL\_USE\_WPP and TILES) disabled.

Table 1 to Table 3 summarize the simulation results according to the common testing conditions [5], for black-fade, white-fade, and regular HEVC test sequences. The black-fade and white-fade sequences were generated using the fading tools provided by weighted prediction AhG [2] at the July meeting. Only random access and low-delay B cases are included as the proposed modification does not change weighted uni-prediction.

Table 1. BD-Rate[%] and relative encoding/decoding time[%] for black-fade sequences

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access HE** | | | **Random Access LC** | | |
|  | Y | U | V | Y | U | V |
| Class A | 0.0% | 0.0% | 0.0% | -0.1% | -0.8% | -1.8% |
| Class B | 0.0% | 0.0% | 0.0% | -0.4% | -1.6% | -1.0% |
| Class C | 0.0% | 0.0% | 0.0% | -0.4% | -1.2% | -0.7% |
| Class D | 0.0% | 0.0% | 0.0% | -0.2% | -1.9% | -2.0% |
| Class E |  |  |  |  |  |  |
| **Overall** | 0.0% | 0.0% | 0.0% | -0.3% | -1.4% | -1.3% |
| Enc Time[%] | 94% | | | 99% | | |
| Dec Time[%] | 96% | | | 102% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B HE** | | | **Low delay B LC** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 0.0% | 0.0% | 0.0% | -0.5% | -5.0% | -7.6% |
| Class C | 0.0% | 0.0% | 0.0% | -0.3% | -0.9% | -1.3% |
| Class D | 0.0% | 0.0% | 0.0% | -0.2% | -3.9% | -2.2% |
| Class E | 0.0% | 0.0% | 0.0% | -2.0% | -5.2% | -6.9% |
| **Overall** | 0.0% | 0.0% | 0.0% | -0.6% | -3.7% | -4.5% |
| Enc Time[%] | 98% | | | 95% | | |
| Dec Time[%] | 101% | | | 100% | | |

Table 2. BD-Rate[%] and relative encoding/decoding time[%] for white-fade sequences

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access HE** | | | **Random Access LC** | | |
|  | Y | U | V | Y | U | V |
| Class A | 0.0% | 0.0% | 0.0% | -0.4% | -1.3% | -1.2% |
| Class B | 0.0% | 0.0% | 0.0% | -0.9% | -1.1% | -2.1% |
| Class C | 0.0% | 0.0% | 0.0% | -0.4% | -0.8% | -1.2% |
| Class D | 0.0% | 0.0% | 0.0% | -0.5% | -1.2% | -1.2% |
| Class E |  |  |  |  |  |  |
| **Overall** | 0.0% | 0.0% | 0.0% | -0.6% | -1.1% | -1.5% |
| Enc Time[%] | 106% | | | 102% | | |
| Dec Time[%] | 113% | | | 124% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B HE** | | | **Low delay B LC** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 0.0% | 0.0% | 0.0% | -0.9% | -5.3% | -8.5% |
| Class C | 0.0% | 0.0% | 0.0% | -0.3% | -0.8% | -0.8% |
| Class D | 0.0% | 0.0% | 0.0% | -0.3% | -3.2% | -2.1% |
| Class E | 0.0% | 0.0% | 0.0% | -1.7% | -5.2% | -6.8% |
| **Overall** | 0.0% | 0.0% | 0.0% | -0.8% | -3.6% | -4.6% |
| Enc Time[%] | 105% | | | 105% | | |
| Dec Time[%] | 109% | | | 121% | | |

Table 3. BD-Rate[%] and relative encoding/decoding time[%] for common test sequences

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access HE** | | | **Random Access LC** | | |
|  | Y | U | V | Y | U | V |
| Class A | 0.0% | 0.0% | 0.0% | 0.0% | -0.5% | -0.2% |
| Class B | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class C | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class D | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% |
| Class E |  |  |  |  |  |  |
| **Overall** | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% | -0.1% |
| Enc Time[%] | 93% | | | 100% | | |
| Dec Time[%] | 79% | | | 119% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B HE** | | | **Low delay B LC** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% |
| Class C | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.3% |
| Class D | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | -0.1% |
| Class E | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% |
| **Overall** | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | -0.1% |
| Enc Time[%] | 102% | | | 89% | | |
| Dec Time[%] | 99% | | | 72% | | |

Under common testing conditions, the high efficiency (HE) settings encode video sequences at 10 bits. For these >8 bits video, since the weighted prediction offsets in HEVC are calculated as in (5), the proposed modification obtains identical results as in HM-4.0-dev-weighted-prediction.

 (5)

To further validate the proposed modification, the RA\_HE and LD\_HE settings were kept the same except to set InternalBitDepth = 8. Simulations were repeated for RA\_HE and LD\_HE with 8-bit signal, and the results are summarized in Table 4 and Table 5. As shown, the proposed modification achieves similar BD rate reductions in high efficiency setting and low complexity setting for 8-bit input video.

Table 4. BD-Rate[%] and relative encoding/decoding time[%] for black-fade sequences

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Random Access HE-8bit** | | |
|  | Y | U | V |
| Class A | -0.1% | -0.7% | -1.5% |
| Class B | -0.3% | -1.4% | -0.5% |
| Class C | -0.2% | -0.9% | -0.4% |
| Class D | -0.3% | -1.1% | -1.4% |
| Class E |  |  |  |
| **Overall** | -0.2% | -1.0% | -0.9% |
| Enc Time[%] | 101% | | |
| Dec Time[%] | 103% | | |
|  |  |  |  |
|  | **Low delay B HE-8bit** | | |
|  | Y | U | V |
| Class A |  |  |  |
| Class B | -0.6% | -4.9% | -7.6% |
| Class C | -0.2% | -0.7% | -0.8% |
| Class D | -0.3% | -3.8% | -2.8% |
| Class E | -1.8% | -4.9% | -7.1% |
| **Overall** | -0.6% | -3.6% | -4.6% |
| Enc Time[%] | 101% | | |
| Dec Time[%] | 101% | | |

Table 5. BD-Rate[%] and relative encoding/decoding time[%] for white-fade sequences

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Random Access HE-8bit** | | |
|  | Y | U | V |
| Class A | -0.4% | -1.0% | -0.8% |
| Class B | -0.7% | -1.1% | -1.5% |
| Class C | -0.3% | -1.1% | -0.9% |
| Class D | -0.5% | -1.4% | -1.6% |
| Class E |  |  |  |
| **Overall** | -0.5% | -1.2% | -1.2% |
| Enc Time[%] | 104% | | |
| Dec Time[%] | 104% | | |
|  |  |  |  |
|  | **Low delay B HE-8bit** | | |
|  | Y | U | V |
| Class A |  |  |  |
| Class B | -0.9% | -4.5% | -8.5% |
| Class C | -0.4% | -1.0% | -1.1% |
| Class D | -0.4% | -3.6% | -3.3% |
| Class E | -2.0% | -5.8% | -6.6% |
| **Overall** | -0.9% | -3.7% | -5.0% |
| Enc Time[%] | 98% | | |
| Dec Time[%] | 98% | | |

# References

1. B. Bross, W.-J. Han, J.-R. Ohm, G. J. Sullivan, T. Wiegand. WD4: Working Draft 4 of High-Efficiency Video Coding. Document no JCTVC-F803. July 2011.
2. P. Bordes, T.K. Tan, “JCT-VC AHG report: Weighted prediction (AHG 18)”, Document no JCTVC-F018, July 2011.
3. A. Tanizawa, T. Chujoh, T. Yamakage, “Explicit Weighted Prediction with simple WP parameter estimation”, Document no JCTVC-F326, July 2011.
4. P. Bordes, “Weighted Prediction”, Document no JCTVC-F265, July 2011.
5. F. Bossen, “Common test conditions and software reference configurations”, Document no JVCVC-F900, Torino, July 2011.

# Patent rights declaration(s)

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