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| *Title:* | **Non-SCE1: Encoder improvements for weighted prediction** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution proposes several encoder improvements on weighted prediction so that it suits better to color gamut scalability. The encoder classifies pixels of inter-layer reference frame into two classes and finds separate weight and offset parameters for each class. Then, the inter-layer reference pictures are placed in both lists and different weight parameters are signaled for each inter-layer reference picture. Then encoder selects the best mode and reference picture for each block based on rate-distortion cost. The simulation results show that this technique brings average BD-rates of -1.6% (AI×1), -1.2% (AI×2), -2.1% (RA×1) and -1.1%( RA×2) under SCE1 test conditions.

# Introduction

At the 16th JCTVC meeting, SCE1 [1] was established to test improved tools for color gamut scalability. As an anchor SCE1 uses weighted prediction for color conversion during inter-layer prediction. Weighted prediction operates the same way as gain-offset model for color gamut scalability [2] and provides 6,6% (AIx2), 3,7% (RAx2) gain [3] compared to prediction scheme w/o color conversion. In this contribution, we propose an encoder only algorithm‎ that improves the coding efficiency of weighted prediction enabled in SHVC for inter-layer reference when it is used for color gamut scalability.

The proposed encoder algorithm works as follows:

1. Each pixel in (upsampled) inter-layer reference picture is classified into two classes based on their U&V values as follows:

*C* = (u[i] + v[i]) < *threshold* , (1)

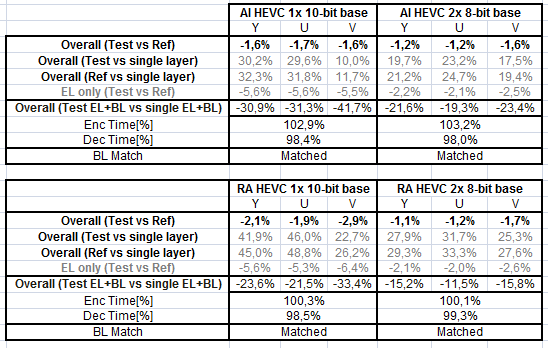
*threshold* = DCCb+DCCr, and DCCb+DCCr here are mean value of Cb and Cr on inter-layer reference frame.

1. Two sets of weight & offset parameters are calculated using the pixel values belonging to each class *C* and corresponding pixels in the enhancement layer frame.
2. Inter-layer reference picture is placed in both lists and the weight and offset parameters found in step-2 are used for each list.
3. Encoder selects the best mode and reference picture for each block based on rate-distortion cost.

# Experimental results

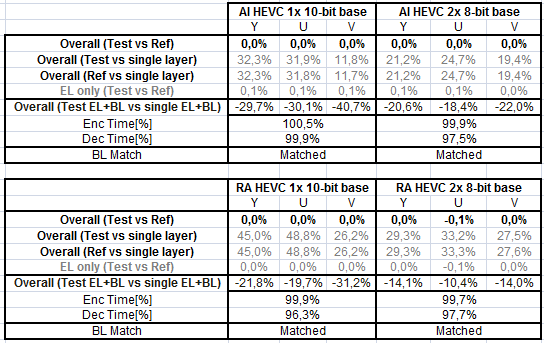
Tests were performed using 2 layers with different color-gamut (BT709 for base layer and BT2020 for enhancement layer) according to SCE1 description [1]. Results are summarized in Table 1. Regardless some additional logic for weighted prediction parameters calculation at encoder side there is no impact for encoding time. Performance impact of proposed encoder modifications is 1,2-1,6% for AI test cases and 1,1-2,1% for RA.

**Table 1.** Brief summary of test results for proposed improved inter-layer weighted prediction.



Proposed modification of inter-layer weighted prediction requires the usage of 2 inter-layer reference frames. But performance impact from adding one extra inter-layer reference and allowing bi-directional precision between them is negligible (as shown in Table 2).

**Table 2.** Brief summary of test results for 2 inter-layer reference frames.

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# Further Improvements

It should be noted that there are still further room for improvement to improve the weighted prediction, such as:

* Currently all the pixels in inter-layer reference picture are used to determine the weight and offset parameters. The performance could be further improved if weight parameters are refined by only using pixels referenced in enhancement layer.
* Currently, pixels of inter-layer reference picture are divided into two classes and weight and offset parameters are found for each one. However, when inter-layer reference picture is placed in both list, encoder could use bi-prediction where both reference pictures are inter-layer reference. This means, there are three sets of weight and offset parameters the encoder could use (parameters for list0, list1 and average values). This fact is not considered in parameter calculation.
* More inter-layer reference pictures can be added to reference picture lists and separate weight and offset parameters could be signaled for each one of those pictures. This way encoder could divide the values of pixels to more classes.
* Separation criteria (1) is very simple and utilizes only Chroma information, taking into account the triplet of Luma and Chroma values should lead to more accurate separation.

# Conclusion

Based on reported results

1.6% (AI×1), 1.2% (AI×2), 2.1% (RA×1) and 1.1%( RA×2) BD-rate gain under SCE1 test conditions

Nokia and Samsung suggest using proposed encoder only modification for inter-layer weighted prediction for color-gamut scalability support in SHVC reference s/w.

# References

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2. J. Zhao, S. Deshpande, K. Misra, S. H. Kim “SCE4 Test 5.2: Color prediction with Gain-Offset model” Document of Joint Collaborative Team on Video Coding, JCTVC-O0201, Oct. 2013.
3. A. Aminlou, K. Ugur , M. M. Hannuksela (Nokia), E. Alshina, A. Alshin (Samsung) “SCE4: Test 5.1 results on bit-depth and color-gamut scalability” Document of Joint Collaborative Team on Video Coding, JCTVC-O0194, Oct. 2013.

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