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| *Title:* | **Non-SCE1: De-noising of inter-layer reference** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution presents test results for de-noising of inter-layer reference frame for color-gamut scalability. De-noising is achieved by filtering “zero-phase” positions by 2D separable FIR consistent with SHVC re-sampling filter. Under SCE1 test conditions algorithm shows 2.0% (AI×1), 1.1% (RA×1), 0.3% (AI×2), 0,3% (RA×2) BD-rate gain.

# Introduction

De-noising filter for inter-layer reference frame was proposed in several variations: non-switchable, Picture based on/off or PU-based on/off [1], [2] and studied SCEs. For example, this is known that this tool doesn’t increase the worst case memory access. De-noising effect is achieved by filtering integer pel positions during inter-layer reference frame creation. The highest gain from this tool was shown in SNR test: 1,3% (non-switchable), 1,5% (Picture based on/off) and 1,9% (PU based on/off) average BD-rate gain. If both bit-depth, resolution and color-gamut are the same for enhancement and base layers then no inter-layer processing is needed (SNR test for non CGS content). But in SCE1 [3] color-gamut scalability is studied and even layers have the same spatial re-solution inter-layer processing is required due to difference in bit-depth or color gamut.

This contribution presents test results for the simplest (non-switchable) implementation of de-noising. Filter coefficient are the same with [1]. So this tool is well known and was extensively studied during SHVC development. New tests were performed using SCE1 test conditions (different color gamut for base and enhancement layers and all-intra ×1 tests were not studied before).

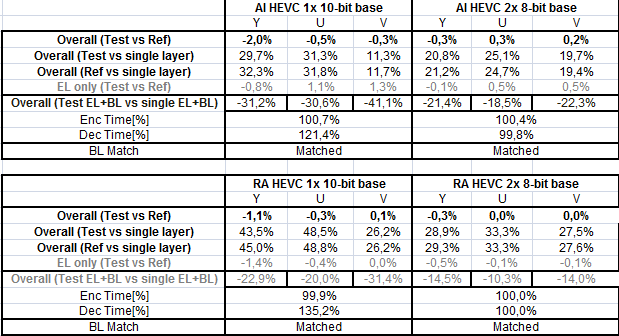
# Experimental results

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. Gain shown by de-noising of inter-layer reference frame in RA×1 test is consistent with performance demonstrated for non CGS content [1]. For all-intra (AI×1) configuration tool is tested for the first time and gain is twice higher than in RA×1 test.

Before de-noising of reference frame show good performance is resolutions of base and enhancement layers are the same. But for CGS content tool appears to be useful even for spatial scalability test.

Increment of decoding time in ×1 test comes due to picture based inter-layer processing in the reference s/w. As it was proved in demonstrated SCE rounds with proper implementation w/o redundant inter-layer processing this tool should not critically increase decoding time even in×1 test.

**Table 1.** Brief summary of test results.



# Further Improvements

It should be noted that there are still further room for improvement. For example Picture based on/off shall provide ~0,2% performance improvement and reduce actual decoding complexity since sometimes de-noising will be not used.

# Conclusion

De-noising of reference frame by filtering of “zero-phase” positions appears to be useful in term of performance improvement for both ×1 and ×2 cases if color-gamut is different between layers. Under SCE1 test conditions algorithm shows 2.0% (AI×1), 1.1% (RA×1), 0.3% (AI×2), 0.3% (RA×2) BD-rate gain.

# References

1. A. Alshin and E. Alshina, “SCE4: **De-noising filter for SNR scalability**,” JCTVC-M0087, Incheon, KR, 18–26 Apr. 2013
2. W. Pu, V.Seregin, ,J.Chen, X.Li, M. Karczewicz . A. Alshin and E. Alshina, “**Non-SCE4: Switchable Filter on Integer Position**,” JCTVC-M0273, Incheon, KR, 18–26 Apr. 2013.
3. A. Duenas, P. Andrivon, E. Alshina, Y. Ye, K. Ugur, X. Li (CE coordinators), “**HEVC Scalable Extensions Core Experiment SCE1 description: Colour Gamut and Bit Depth Scalabi**lity,” Document of Joint Collaborative Team on Video Coding, JCTVC-P1101, Jan. 2014.

# Patent rights declaration(s)

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