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| *Title:* | SCE1: Crosscheck report of SCE1 test 2 (JCTVC-P0186) | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Report | | |
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# Abstract

Performance of combined bit-depth and color gamut conversion with 3D LUT for SHVC color gamut scalability (JCTVC-P0186) is verified in this report. The simulation results match those provided by the proponents. In average 3,5% Luma and 5,7% Chroma BD-rate gain is confirmed for use case 1 and 7,0% Luma and 9,4% Chroma BD-rate gain is confirmed for use case 2.

# Introduction

In verified contribution color gamut conversion is merged with bit-depth conversion. This is additional to re-sampling step in inter-layer processing. One more additional filtering process is indicated by the macros CGS\_LUMA\_ENH and CGS\_CHROMA\_ENH in the software provided by proponent, this was not the part of original proposal.

For color gamut conversion both test 1 and test2 in SCE1 use 3D LUT methods, and so have following common features:

1. There is additional step (color gamut conversion) during inter-layer processing
2. This additional step is cross-color filtering (both 3 components are input for each color plan processing):

YBT2020=g00Y BT709+ g01Cb BT709+ g02Cr BT709+o0

CbBT2020=g10Y BT709+ g11Cb BT709+ g12Cr BT709+o0

CrBT2020=g20Y BT709+ g21Cb BT709+ g22Cr BT709+o0

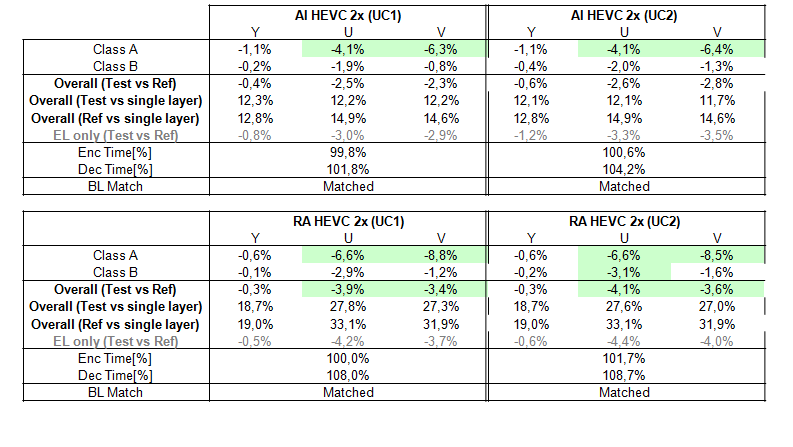
1. This cross-color filter coefficients (g, o) are supposed to have non-linear dependency on Y,Cb,Cr position in color space.

So 3D LUT technique is especially effective if mapping between two color gamuts is essentially nonlinear. From the other hand if we carry out linear multi regression analysis for videos which are shown on fig. 1, where luma and two chroma components of base layer will be independent variables and for example corresponding luma component on enhancement layer will be dependent variable. For this experiment R-square statistic is 0.994 which means that linear model for current content is very precise in spite of it was applied for whole frame. This means that at least for original signal linear model (g and o do not depend on Y,Cb,Cr position in color space) should be enough for color gamut conversion. This variant was not studied in SCE1.

Fig 1. Left BT2020\_Parakeets\_3840x2160\_50\_10bit.yuv, right BT709\_Parakeets\_1920x1080\_50\_zerophase\_0.9pi.yuv

Another important feature of this technique is adaptability. It means that current method can be interpreted as adaptive cross-color inter-layer filter and can provide some gain even if both videos belong to same color space. As was expected experiment results are definitely confirmed this assumption. The application of CGS 3D LUT to usual content shows noticeable gain especially for chroma components. It should be mentioned that essentially higher gain was demonstrated by cross-color inter-layer filtering in previous SCE3-4. Table 1 reports additional tests results. Int his test verified s/w was tested under common test condition, using test sequences with the same gaumt on base and enhancement layers.

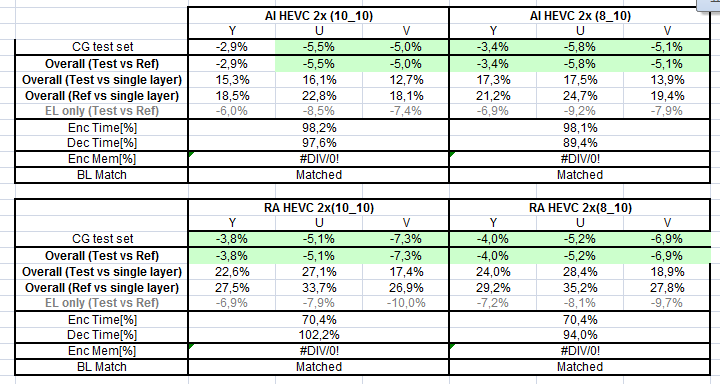


# Experimental results

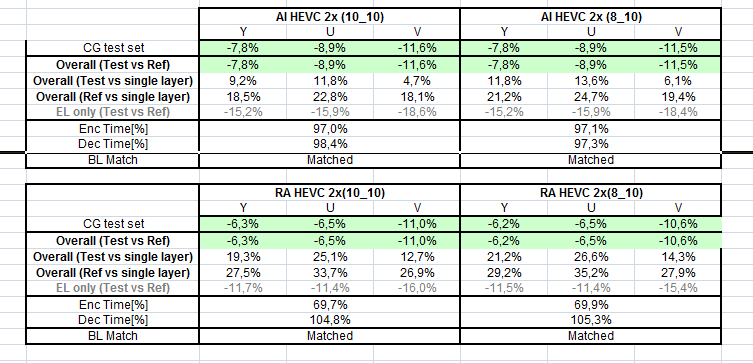
We received the source code from the proponents, implemented in SHM-4.0 SCE1 anchor, and did a code study to verify whether the proposed method was implemented as described. We ran simulations for the cases of AI-2x, RA-2x with SCE4 test sequences[1]. We also should mention that SCE1 s/w [1] crashes if one try to run it in low-delay configuration.

The results matched what were provided by the proponents and are summarized as follows

## Use case 1



## Use case 2



# Conclusion

The performance of combined bit-depth and color gamut conversion with 3D LUT for SHVC color gamut scalability (JCTVC-P0186) is verified in this report. The simulation results match those provided by the proponents. In average 3,5% Luma and 5,7% Chroma BD-rate gain is confirmed for use case 1 and 7,0% Luma and 9,4% Chroma BD-rate gain is confirmed for use case 2.

# References

1. P. Bordes, Y. Ye, E. Alshina, X. Li, S.-H. Kim, A. Duenas, K. Ugur, K. Sato, “Description of HEVC Scalable Extensions Core Experiment SCE1: Color Gamut and Bit-Depth Scalability”, JCTVC-O1101, Oct. 2013, CH