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| *Title:* | **CE-6 (4.2): Color enhancement** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Report | | |
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# Abstract

The document reports simulation results of test 4.2 defined in CE6. It investigated the performance of applying the color enhancement process as post processing. Compared to the HDR/WCG anchor v3.2, an average BD rate reduction of 6.4% based on the DE100 metric is reported. BD rate reduction is also reported for other objective metrics that measure color fidelity. A small BD rate increase of 0.5% is reported for metrics that measure luma only.

# Introduction

Color enhancement method was proposed in [1]. The goal of color enhancement is to exploit the correlation between Y and Cb/Cr components. It estimates the impact of chroma quantization at the encoder and applies color enhancement filtering on the Cb and Cr components at the decoder to compensate for the impact. The color enhancement can alleviate the distortion caused by chroma quantization, thereby improving color performance. For each picture, the color enhancement filter is estimated at the encoder side using the YCbCr signal before encoding and the reconstructed YCbCr signal after encoding. The estimated color enhancement filters are signaled to the decoder with SEI message. The decoder applies the color enhancement filters to the reconstructed Y component to enhance the Cb and Cr components. The color enhancement filtering process is depicted in Equation (1).

C\_enh = C\_rec + Y\_rec filter\_Y4C (1)

Where, with C being either Cb or Cr component, filter\_Y4C is the color enhancement filter applied to the Y component to enhance the C component, Y\_rec is the reconstructed Y component, C\_rec is the reconstructed C component before filtering, and C\_enh is the enhanced C component after filtering. The color enhancement filter is applied to each sample of each C component using the collocated neighboring Y samples. The color enhancement filter is high pass in nature with the sum of all filter\_Y4C coefficients being equal to 0. Figure 1 shows the workflow of HDR reconstruction with color enhancement. The color enhancement is applied in 4:2:0 chroma format before chroma upsampling.



Figure 1. HDR reconstruction with color enhancement

# Simulation results

The simulation is performed based on latest HDR/WCG anchor [2]. The improvement is reported that BD rate of U and V components can be saved by 9.7% and 15.0% on average. The BD rate of DE100 is also improved by 6.4% on average.

Table . Color enhancement compared to HDR/WCG anchor

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | X | Y | Z | XYZ | tOSNR-XYZ | DE100 | PSNR  L100 | PSNR Y | PSNR U | PSNR V |
| class A | FireEaterClip4000r1 | -1.0% | 0.0% | -11.5% | -3.5% | -3.8% | -3.3% | 0.2% | 0.8% | -25.7% | -11.2% |
|  | Market3Clip4000r2 | 0.3% | 0.2% | -0.7% | -0.1% | -0.1% | -0.4% | 0.2% | 0.2% | -7.5% | -29.9% |
|  | SunRise | 0.3% | 0.7% | -0.7% | 0.0% | 0.1% | -1.7% | 0.6% | 0.7% | -6.0% | -26.6% |
| class B | BikeSparklers cut 1 | -0.3% | 0.0% | -2.9% | -1.1% | -0.8% | -6.0% | 0.0% | 0.1% | -11.5% | -11.4% |
|  | BikeSparklers cut 2 | -0.8% | 0.1% | -5.1% | -1.8% | -1.3% | -4.6% | 0.2% | 0.2% | -14.6% | -20.6% |
|  | GarageExit | 0.8% | 0.8% | -2.5% | -0.5% | -0.5% | -4.3% | 0.8% | 0.8% | -13.7% | -8.3% |
| class C | ShowGirl2Teaser | 0.9% | 1.1% | -7.4% | -1.9% | -2.0% | -14.1% | 0.8% | 1.1% | -19.6% | 6.1% |
| class D | StEM\_MagicHour cut 1 | 0.5% | 0.6% | -1.7% | -0.5% | -0.6% | -4.4% | 0.7% | 0.6% | -2.9% | -9.6% |
|  | StEM\_MagicHour cut 2 | 0.2% | 0.2% | -4.4% | -2.0% | -2.0% | -7.7% | 0.2% | 0.2% | -9.4% | -14.0% |
|  | StEM\_MagicHour cut 3 | 0.0% | 0.3% | -5.5% | -2.7% | -2.4% | -6.0% | 0.3% | 0.4% | -10.2% | -7.8% |
|  | StEM\_WarmNight cut 1 | 0.4% | 0.6% | -0.8% | 0.0% | -0.1% | -5.9% | 0.6% | 0.4% | -2.0% | -16.7% |
|  | StEM\_WarmNight cut 2 | 0.0% | 0.8% | -1.7% | -0.5% | -0.5% | -6.9% | 0.7% | 0.7% | -3.6% | -14.4% |
| class G | BalloonFestival | -0.7% | 0.3% | -2.7% | -1.3% | -1.1% | -2.9% | 0.2% | 0.3% | -10.4% | -6.6% |
| class H | EBU\_04\_Hurdles | -1.0% | 0.4% | -0.8% | -0.5% | -1.2% | -18.6% | 0.4% | 0.3% | -3.8% | -28.8% |
|  | EBU\_06\_Start | 1.4% | 1.2% | 0.8% | 1.1% | 0.9% | -9.2% | 1.2% | 1.1% | -4.7% | -24.9% |
|  | **Overall** | 0.1% | 0.5% | -3.2% | -1.0% | -1.0% | -6.4% | 0.5% | 0.5% | -9.7% | -15.0% |

# Patent rights declaration(s)

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# References

1. Y. He, L. Kerofsky, Y. Ye, “CE2 (2.1.2a): performing color enhancement process in 4:2:0 chroma format”, m37072, Geneva, CH, Oct. 2015.
2. R. Brondijk, S. Lasserre, Y. He, D. Rusanovskyy, “CE6 Post Processing”, m37542, Geneva, CH, Oct. 2015.