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| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  23rd Meeting: San Diego, USA, 19–26 February 2016 | Document: JCTVC-W0100 |

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| *Title:* | **HDR CE2-related: Results for combination of CE1 (anchor 3.2) and CE2** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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| *Source:* | Qualcomm Inc. | | |

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# Abstract

This document reports results of combining the software of anchor 3.2 that is the outcome of CE1 and the ETM that is the outcome of CE2. Results for the direct combination of the CE1 and CE2 software are provided. It is noted that CE1 and CE2 algorithms have some degree of overlap, so the direct combination could be improved by a proper adjustment of the parameters. Results obtained by adjusting the parameters are also provided.

# Introduction

HDR CE1 [1] has produced a new anchor (aka, anchor 3.2) with the following changes with respect to the CfE anchor:

1. Chroma QP offset
2. Luma adjustment (micro-grading)
3. Setting correct VUI/SEI parameters
4. Chroma sampling position (co-sited)
5. Average-luma controlled adaptive QP
6. Some bug-fixes of the above

This anchor substantially improves the subjective quality of the CfE anchor.

HDR CE2 [2] has produced a Test Model that describes the reshaper, which is an out-of-loop processing that modifies the signal characteristics to improve the coding efficiency of the existing HEVC Main 10 codec. The goals of the reshaper are:

1. Adaptive codeword re-distribution.
2. Re-quantization of luma and chroma signal components.

# Tests

First, a direct combination of the CE1 and CE2 software is performed. Table 1 shows the objective metrics of this combination with respect to the anchor 3.2 in CE1 with rate-matched bit-streams.

Table 1. Objective metrics for anchor 3.2 vs CE1+CE2 (i.e., anchor3.2 + ETM).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | X | Y | Z | XYZ | tOSNR-XYZ | DE100 | MD100 | PSNRL100 |
| class A | FireEaterClip4000r1 | -13.6% | -4.0% | -11.0% | -10.2% | -17.4% | -22.5% | -27.2% | 3.3% |
|  | Market3Clip4000r2 | 27.8% | 28.1% | 26.7% | 27.5% | 16.7% | 33.0% | -82.5% | -8.7% |
|  | SunRise | -2.8% | 0.4% | -3.3% | -2.2% | 0.6% | 7.4% | -51.0% | 6.4% |
| class B | BikeSparklers cut 1 | -5.9% | -4.7% | 2.9% | -2.6% | -3.0% | 1.6% | -29.2% | -0.7% |
|  | BikeSparklers cut 2 | -4.3% | -3.1% | 6.0% | -0.8% | -0.2% | 5.4% | -25.9% | 0.7% |
|  | GarageExit | 27.0% | 27.4% | 30.7% | 29.1% | 20.8% | 10.1% | -8.4% | 8.1% |
| class C | ShowGirl2Teaser | 12.4% | 14.5% | 19.4% | 15.4% | 29.6% | 4.2% | -2.7% | -0.8% |
| class D | StEM\_MagicHour cut 1 | -5.0% | 0.4% | 2.4% | -0.3% | -0.3% | -11.1% | 29.3% | 1.7% |
|  | StEM\_MagicHour cut 2 | -2.6% | 1.1% | -1.4% | -1.3% | -1.7% | -13.4% | -10.8% | 2.4% |
|  | StEM\_MagicHour cut 3 | -2.6% | 0.8% | 1.6% | 0.2% | -0.5% | -8.2% | 13.7% | 2.6% |
|  | StEM\_WarmNight cut 1 | -4.2% | -0.5% | 0.7% | -1.2% | -1.5% | -11.5% | 1.1% | 1.6% |
|  | StEM\_WarmNight cut 2 | -2.7% | 3.6% | -3.1% | -1.5% | -0.9% | -14.9% | -27.4% | 0.9% |
| class G | BalloonFestival | 34.4% | 45.0% | 23.7% | 33.0% | 21.5% | 7.6% | -30.0% | -2.6% |
| class H | EBU\_04\_Hurdles | 28.4% | 16.7% | 30.9% | 25.9% | 14.6% | 81.5% | 115.9% | -12.1% |
|  | EBU\_06\_Start | 45.8% | 39.0% | 42.0% | 42.2% | 28.7% | 66.7% | 45.5% | -6.6% |
|  | **Overall** | 8.8% | 11.0% | 11.2% | 10.2% | 7.1% | 9.1% | -6.0% | -0.3% |

Subjectively, the anchor performs better than the combination, because the reshaper codeword redistribution and the CE1 luma QP adjustment attempt to tackle the same issue. As a consequence, the bright areas of the combination look very good, but at the cost of a poor representation of the dark areas. Similarly, the chroma QP adjustment and the single chroma scaling also attempt to improve the same issue, that is, the color artifacts.

In order to harmonize the combination, two changes are performed:

1. Average-luma controlled adaptive QP is set to be considerably less aggressive than in CE1
   1. The input table to HM with the QP adjustments is modified accordingly:

[0 0; -1 159; 0 447; 1 519; 2 611]

1. Chroma QP offset is disabled

With these changes, the performance of the combination is improved. Table 2 shows the objective metrics.

Table 2. Objective metrics for anchor 3.2 vs combination of CE1+CE2 with modified luma and chroma QP adjustments.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | X | Y | Z | XYZ | tOSNR-XYZ | DE100 | MD100 | PSNRL100 |
| class A | FireEaterClip4000r1 | -13.2% | -4.3% | -9.5% | -9.6% | -16.6% | -21.7% | -23.5% | 2.7% |
|  | Market3Clip4000r2 | 28.7% | 29.1% | 27.8% | 28.4% | 17.5% | 35.8% | -82.2% | -8.1% |
|  | SunRise | -2.5% | 0.5% | -2.9% | -1.9% | 0.9% | 8.3% | -47.0% | 6.4% |
| class B | BikeSparklers cut 1 | -6.3% | -5.5% | 2.5% | -3.0% | -3.5% | 0.8% | -38.8% | -2.0% |
|  | BikeSparklers cut 2 | -4.0% | -3.1% | 6.5% | -0.5% | 0.2% | 5.9% | -23.1% | 0.3% |
|  | GarageExit | 28.5% | 29.0% | 30.6% | 30.1% | 21.5% | 10.0% | -13.6% | 9.5% |
| class C | ShowGirl2Teaser | 14.1% | 15.8% | 22.5% | 17.6% | 32.0% | 5.8% | -2.0% | 0.5% |
| class D | StEM\_MagicHour cut 1 | -4.6% | 0.1% | 1.6% | -0.4% | -0.5% | -12.0% | 11.5% | 1.3% |
|  | StEM\_MagicHour cut 2 | -2.4% | 0.7% | -0.7% | -1.0% | -1.3% | -12.5% | -7.9% | 1.8% |
|  | StEM\_MagicHour cut 3 | -2.0% | 0.8% | 2.2% | 0.8% | 0.2% | -7.9% | 15.0% | 2.5% |
|  | StEM\_WarmNight cut 1 | -3.2% | -0.2% | 1.9% | -0.2% | -0.4% | -9.4% | 0.1% | 1.6% |
|  | StEM\_WarmNight cut 2 | -2.2% | 3.5% | -2.2% | -0.8% | -0.4% | -14.1% | -23.7% | 0.9% |
| class G | BalloonFestival | 35.7% | 48.0% | 21.9% | 33.2% | 20.2% | 7.6% | -28.2% | -1.8% |
| class H | EBU\_04\_Hurdles | 26.7% | 14.5% | 30.3% | 24.5% | 12.9% | 87.8% | 134.6% | -13.8% |
|  | EBU\_06\_Start | 45.4% | 38.6% | 41.7% | 41.9% | 28.7% | 69.8% | 39.5% | -6.1% |
|  | **Overall** | 9.3% | 11.2% | 11.6% | 10.6% | 7.4% | 10.3% | -6.0% | -0.3% |

# References

[1] J. Strom, J. Sole, Y. He, “Report of HDR Core Experiment 1”, JCTVC-W0021, San Diego, USA, Feb. 2016.

[2] D. Rusanovskyy, E. Francois, L. Kerofsky, T. Lu, K. Minoo, “HDR CE2: Report of HDR Core Experiment 2”, JCTVC-W0022, San Diego, USA, Feb. 2016.

# Patent rights declaration(s)

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