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Title:	**CE 7: Adaptive quantization via perceptually optimized QP adaptation (Test 7.2.6)**
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Purpose:	Proposal
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Abstract

In JVET-H0047, the authors proposed a CTU-wise subjectively optimized QP adaptation (QPA) along with a correspondingly weighted PSNR (WPSNR) distortion measure. This QPA approach was further improved in JVET-K0206 and accepted for integration into (and optional activation in) the VTM/BMS software. Note that this is a non-normative encoder optimization – the delta-QP values are signaled in a HEVC-like fashion.

This document reports on Bjøntegaard delta (BD) PSNR and MS-SSIM results gathered from comparative measurements between VTM 2.0.1 with activated perceptual QPA and VTM 2.0.1 with fixed-QP encoding.

1 Experimental Results

The subjectively optimized QPA method introduced in [1] and further improved in [2] was activated on top of VTM 2.0.1 [3] and its effect in terms of Bjøntegaard delta [5] PSNR and MS-SSIM metric was evaluated. To this end, the default VTM 2.x encoder configuration was extended by the following encoding parameters in order to activate QPA and delta-QP signaling according to K0206 for both the luma and chroma channels:

--*PerceptQPA* = 1, --*SliceChromaQPOffsetPeriodicity* = 1.

Tables 1 and 2 reflect the results for encoding according to the SDR-category Common Test Conditions [4]. Note that, for Table 1, the anchor (i. e., VTM 2.0.1 with fixed-QP coding) was operated with the CTC default chroma QP offsets of *CbQpOffset* = 0, *CrQpOffset* = 0, while for Table 2, it was run with *CbQpOffset* = 1, *CrQpOffset* = 1 for a more meaningful comparison to the subjective optimized QPA tuning characteristic in the random access (RA) and low delay (LB/LP) configurations. As expected, the observed BD-PSNR losses coincide with almost equivalent MS-SSIM gains due to the QPA, and the results are similar to those reported in [2]. Two Excel sheets with more detailed statistics are provided in the Zip file containing this document.

It is worth noting that a QPA related correction to the ALF encoding algorithm has been proposed in JVET-L0181 as an input document to the present JVET meeting [6], which is likely to improve the results slightly.

2 Summary and Conclusion

This contribution reported on the BD PSNR an MS-SSIM statistics collected for CE 7 test 7.2.6. The results indicate very similar (in fact, slightly improved) MS-SSIM gains as previously documented in JVET-K0206 [2] in the context of VTM and BMS 1. The encoder and decoder run-time overheads also remain very minor.

***Table 1**. Bjøntegaard delta (BD) [5] PSNR (left) and MS-SSIM (right) results for adaptive-QP VTM 2.0.1 vs. fixed-QP VTM 2.0.1 coding with non-dual-tree chroma QP offsets of **0**, for the SDR category CTCs [4].*

	All Intra Main10									
	Over VTM 2.0.1 (metric: PSNR)					Over VTM 2.0.1 (metric: MS-SSIM)				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	4,95%	-11,81%	-13,44%	123%	103%	-1,22%	-8,41%	-13,47%	123%	103%
Class A2	0,28%	2,28%	4,54%	102%	101%	-9,08%	-0,69%	2,48%	102%	101%
Class B	2,78%	-5,28%	-7,16%	115%	102%	-7,28%	-3,75%	-8,08%	115%	102%
Class C	3,83%	-1,70%	-3,23%	108%	105%	-5,08%	-1,88%	-4,69%	108%	105%
Class E	5,21%	-7,64%	-8,21%	125%	107%	-4,05%	-8,73%	-9,42%	125%	107%
Overall	3,37%	-4,70%	-5,56%	114%	104%	-5,54%	-4,43%	-6,69%	114%	104%
Class D	0,04%	-4,37%	-5,13%	101%	97%	0,04%	-1,44%	-1,97%	101%	97%

	Random Access Main10									
	Over VTM 2.0.1 (metric: PSNR)					Over VTM 2.0.1 (metric: MS-SSIM)				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-1,07%	6,15%	2,41%	112%	101%	-7,01%	9,00%	0,09%	112%	101%
Class A2	-1,89%	18,80%	19,89%	101%	101%	-12,47%	13,70%	15,42%	101%	101%
Class B	7,93%	13,27%	9,94%	96%	99%	-8,64%	14,06%	7,42%	96%	99%
Class C	7,09%	12,03%	11,02%	100%	97%	-5,44%	13,27%	11,26%	100%	97%
Class E										
Overall	3,94%	12,62%	10,71%	101%	99%	-8,23%	12,76%	8,58%	101%	99%
Class D	0,14%	4,34%	4,84%	88%	96%	-0,87%	8,82%	9,13%	88%	96%

	Low delay B Main10									
	Over VTM 2.0.1 (metric: PSNR)					Over VTM 2.0.1 (metric: MS-SSIM)				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1										
Class A2										
Class B	3,93%	13,30%	9,31%	111%	101%	-9,07%	14,46%	8,24%	111%	101%
Class C	5,14%	14,73%	14,53%	105%	101%	-3,15%	17,78%	16,05%	105%	101%
Class E	15,76%	11,18%	7,47%	126%	110%	1,31%	10,11%	5,61%	126%	110%
Overall	7,29%	13,25%	10,59%	112%	104%	-4,50%	14,48%	10,19%	112%	104%
Class D	-0,12%	15,82%	15,07%	96%	98%	-0,37%	19,22%	19,50%	96%	98%

	Low delay P Main10									
	Over VTM 2.0.1 (metric: PSNR)					Over VTM 2.0.1 (metric: MS-SSIM)				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1										
Class A2										
Class B	3,03%	13,91%	9,51%	111%	101%	-9,60%	14,92%	8,07%	111%	101%
Class C	4,63%	14,61%	14,15%	106%	102%	-3,87%	17,94%	15,81%	106%	102%
Class E	16,26%	11,25%	9,17%	130%	113%	1,35%	9,75%	7,53%	130%	113%
Overall	6,87%	13,48%	10,97%	114%	104%	-4,95%	14,63%	10,51%	114%	104%
Class D	-0,14%	16,24%	15,61%	96%	97%	-0,40%	20,67%	20,05%	96%	97%

Table 2. *Bjøntegaard delta (BD) [5] PSNR (left) and MS-SSIM (right) results for adaptive-QP VTM 2.0.1 vs. fixed-QP VTM 2.0.1 coding with non-dual-tree chroma QP offsets of* ***1****, for the SDR category CTCs [4].*

	All Intra Main10									
	Over VTM 2.0.1 (metric: PSNR)					Over VTM 2.0.1 (metric: MS-SSIM)				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	6,97%	-23,12%	-23,28%	123%	104%	0,64%	-19,13%	-22,97%	123%	104%
Class A2	3,32%	-8,83%	-7,35%	103%	101%	-6,44%	-11,80%	-8,91%	103%	101%
Class B	3,97%	-17,48%	-19,48%	115%	104%	-6,26%	-16,16%	-20,37%	115%	104%
Class C	5,09%	-12,08%	-13,64%	108%	104%	-4,05%	-12,95%	-15,65%	108%	104%
Class E	6,21%	-17,98%	-18,81%	125%	106%	-3,13%	-19,30%	-20,18%	125%	106%
Overall	4,98%	-15,86%	-16,68%	114%	104%	-4,13%	-15,74%	-17,81%	114%	104%
Class D	1,17%	-14,24%	-14,70%	101%	99%	1,00%	-12,54%	-12,90%	101%	99%

	Random Access Main10									
	Over VTM 2.0.1 (metric: PSNR)					Over VTM 2.0.1 (metric: MS-SSIM)				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	0,84%	-4,82%	-7,65%	114%	99%	-5,10%	-1,75%	-9,93%	114%	99%
Class A2	0,37%	3,72%	4,88%	103%	99%	-10,46%	-1,41%	0,36%	103%	99%
Class B	8,83%	-4,82%	-7,69%	97%	98%	-7,90%	-3,72%	-9,82%	97%	98%
Class C	8,06%	-1,50%	-1,70%	100%	97%	-4,56%	-0,87%	-2,48%	100%	97%
Class E										
Overall	5,34%	-2,22%	-3,57%	102%	98%	-6,96%	-2,10%	-5,85%	102%	98%
Class D	0,89%	-8,54%	-7,76%	88%	94%	-0,06%	-4,81%	-4,97%	88%	94%

	Low delay B Main10									
	Over VTM 2.0.1 (metric: PSNR)					Over VTM 2.0.1 (metric: MS-SSIM)				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1										
Class A2										
Class B	4,89%	-8,61%	-11,63%	113%	101%	-8,29%	-7,10%	-12,50%	113%	101%
Class C	6,28%	-1,46%	-0,94%	105%	95%	-2,07%	0,95%	-0,21%	105%	95%
Class E	16,58%	-9,03%	-13,52%	126%	106%	1,78%	-10,28%	-14,87%	126%	106%
Overall	8,28%	-6,33%	-8,54%	113%	100%	-3,70%	-5,21%	-9,00%	113%	100%
Class D	0,69%	-3,82%	-4,31%	96%	94%	0,39%	-1,76%	-2,92%	96%	94%

	Low delay P Main10									
	Over VTM 2.0.1 (metric: PSNR)					Over VTM 2.0.1 (metric: MS-SSIM)				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1										
Class A2										
Class B	4,03%	-9,06%	-12,39%	114%	103%	-8,83%	-7,78%	-13,75%	114%	103%
Class C	5,76%	-2,03%	-2,00%	106%	98%	-2,90%	0,57%	-1,23%	106%	98%
Class E	16,67%	-9,05%	-12,16%	131%	112%	1,42%	-10,00%	-13,97%	131%	112%
Overall	7,77%	-6,72%	-8,87%	115%	103%	-4,29%	-5,55%	-9,63%	115%	103%
Class D	0,67%	-3,29%	-3,82%	96%	95%	0,40%	0,15%	-2,50%	96%	95%

3 References

[1] S. Bosse, C. Helmrich, H. Schwarz, D. Marpe, T. Wiegand, "Perceptually Optimized QP Adaptation and Associated Distortion Measure," JVET-H0047, Macao, China, Oct. 2017.

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[3] B. Bross, J. Chen, S. Liu, "Versatile Video Coding (Draft 2)," JVET-K1001, ver. 6/7, Sep./Oct. 2018.

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[5] G. Bjøntegaard, "Calculation of Average PSNR Differences between RD-Curves," VCEG-M33, Austin, USA, Mar. 2001.

[6] C. Helmrich, B. Bross, J. Erfurt, "Corrected operation of ALF encoding with perceptually optimized QP adaptation," JVET-L0181, Macao, China, Oct. 2018.

4 Patent Rights Declaration(s)

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