

JVET-G0073

ADAPTIVE QUANTIZATION AND DENOISING FOR FUTURE VIDEO CODING CFP AND CTC

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INTRODUCTION



- › Video codec development in MPEG/ITU has been done using:
 - Input sequences without preprocessing, sometimes with camera noise
 - Improvements measured using PSNR and static QP values within each picture
- › Commercial encoders typically optimize for subjective quality, e.g. by using:
 - Pre-processing such as denoising
 - Adaptive quantization where the QP value varies within pictures
- › Main question
 - Would standardization using a more subjectively optimized test model produce a more efficient standard for commercial encoder use?
- › In this contribution we have investigated the effects of denoising and variance-based adaptive QP for JEM 6.0. We also tested the effects of re-noising.

CAMPFIREPARTY 2160P VS PARTYSCENE 480P



JVET-G007

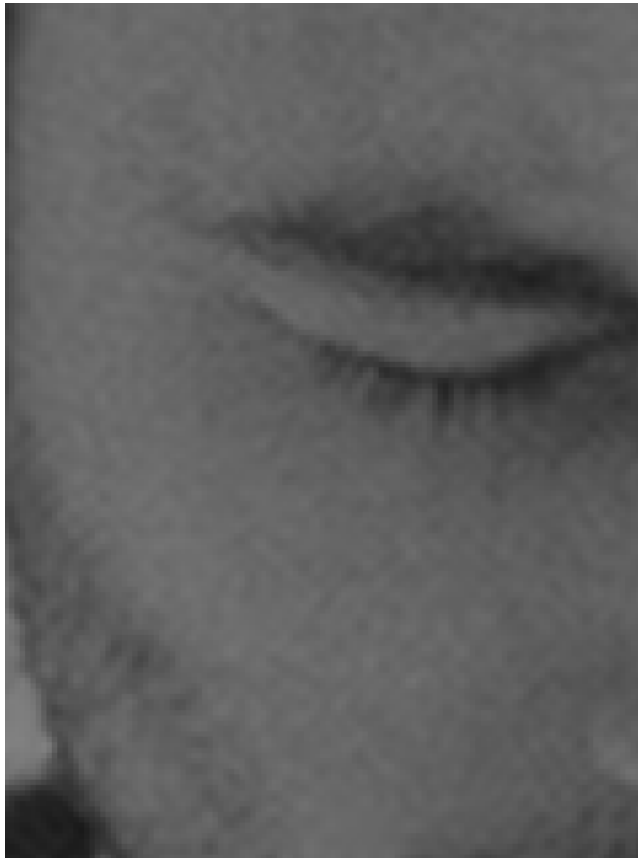
CLASS A1 AND A2 SOURCES (4K)



Tango



Drums100



CampfireParty



CLASS A1 AND A2 SOURCES (4K)



ToddlerFountain



CatRobot



TrafficFlow



CLASS A1 AND A2 SOURCES (4K)



DaylightRoad



Rollercoaster



DENOISING



- › Noise is hard to code due to lack of correlation
- › We studied the effect of denoising before encoding using the Avisynth tool MC_Spudsmo
 - This tool performs motion compensated filtering but supports only 8-bit video
 - Both luma and chroma components were filtered
- › A configuration consisting of the following steps was used
 - 10 bit source sequences were downscaled to 8 bits
 - The denoising filter was applied
 - Sequences were encoded and decoded using JEM 6.0.
 - PSNR and MS-SSIM values were calculated against the CTC source sequences
 - › All measurements were done vs the source before denoising

DENOISING – RANDOM ACCESS



- › Anchor: JEM 6.0
- › Test: JEM 6.0 with denoising before encoding

	Y psnr	U psnr	V psnr	Y ms-ssim	U ms-ssim	V ms-ssim	EncT	DecT
Class A1	-0.93%	27.24%	13.40%	-2.20%	-4.57%	-7.90%	87%	92%
Class A2	-1.85%	21.72%	18.18%	-5.50%	-10.76%	-10.22%	87%	86%
Class B	-4.29%	-10.45%	-10.06%	-2.95%	-9.08%	-8.32%	93%	97%
Class C	0.47%	-2.36%	-2.40%	0.02%	-2.58%	-2.52%	97%	102%
Class D	1.31%	-1.44%	-1.40%	-0.01%	-1.79%	-1.99%	99%	102%
Class E								
Overall (Ref)	-1.21%	6.12%	2.89%	-2.17%	-5.91%	-6.29%	93%	96%
Class F (optional)	1.21%	-2.41%	-2.35%	1.43%	-1.81%	-2.49%	96%	101%

ADAPTIVE QP



- › Using a fixed quantizer within a picture is good when optimizing for PSNR
 - But the human eye is more sensitive to relative errors
- › Many commercial encoders change the QP values within pictures to optimize for subjective quality
 - BD-PSNR is generally worse but subjective quality is improved
 - The subjective gains may be measured more accurately by MS-SSIM
- › An example of an adaptive quantization algorithm can be found in the x264 AVC encoder
 - It sets macroblock QP values based on the variance of the macroblock luma samples
- › We studied the effect of adaptive QP by implementing a similar algorithm in JEM 6.0
 - We change QP values on 16x16 block level

ADAPTIVE QP – RANDOM ACCESS



- › Anchor: JEM 6.0
- › Test: JEM 6.0 with adaptive quantization

	Y psnr	U psnr	V psnr	Y ms-ssim	U ms-ssim	V ms-ssim	EncT	DecT
Class A1	13.57%	12.15%	19.60%	-3.76%	6.63%	11.16%	100%	91%
Class A2	20.04%	26.53%	30.61%	0.65%	21.78%	25.78%	103%	89%
Class B	15.36%	25.16%	30.60%	-8.99%	16.40%	20.07%	107%	101%
Class C	6.93%	7.24%	6.31%	-11.01%	0.86%	0.55%	103%	101%
Class D	5.42%	8.82%	6.86%	-14.49%	30.43%	29.08%	102%	102%
Class E								
Overall (Ref)	12.41%	16.42%	19.36%	-7.59%	15.28%	17.46%	103%	97%
Class F (optional)	8.55%	9.63%	10.03%	-18.84%	-2.91%	-1.69%	105%	102%

ADAPTIVE QP – RANDOM ACCESS



- › Anchor: JEM 6.0
- › Test: JEM 6.0 with adaptive quantization and denoising before encoding

	Y psnr	U psnr	V psnr	Y ms-ssim	U ms-ssim	V ms-ssim	EncT	DecT
Class A1	9.85%	31.65%	28.77%	-8.31%	-5.20%	-2.76%	91%	91%
Class A2	13.05%	44.36%	43.85%	-7.90%	3.05%	6.53%	94%	89%
Class B	4.31%	2.19%	5.57%	-15.05%	-2.23%	0.83%	99%	100%
Class C	5.96%	2.98%	2.31%	-11.66%	-3.00%	-2.84%	99%	102%
Class D	5.42%	4.91%	4.39%	-15.26%	1.26%	1.90%	101%	100%
Class E								
Overall (Ref)	7.56%	16.50%	16.44%	-11.80%	-1.27%	0.74%	97%	97%
Class F (optional)	8.88%	5.79%	5.88%	-17.72%	-5.84%	-4.76%	102%	100%

ADAPTIVE QP – RANDOM ACCESS



- › Anchor: JEM 6.0
- › Test: JEM 6.0 with adaptive quantization and denoising before encoding

		BD-rate (piecewise cubic)					
		Y psnr	U psnr	V psnr	Y ms-ssim	U ms-ssim	V ms-ssim
Class A1	Tango	14.84%	63.99%	37.67%	-5.66%	-6.69%	-10.49%
4K	Drums100	5.49%	22.26%	32.26%	-19.99%	-4.22%	1.85%
	CampfireParty	11.05%	6.84%	17.76%	-5.99%	-0.15%	-13.83%
	ToddlerFountain	8.02%	33.49%	27.39%	-1.61%	-9.72%	11.45%
Class A2	CatRobot	17.67%	22.31%	22.65%	-4.40%	-3.34%	0.18%
4K	TrafficFlow	6.68%	96.06%	105.80%	-16.14%	27.26%	23.54%
	DaylightRoad	7.75%	40.85%	20.06%	-9.35%	-5.60%	2.58%
	Rollercoaster	20.12%	18.24%	26.89%	-1.70%	-6.11%	-0.20%
Class B	Kimono	5.40%	3.49%	11.76%	-5.39%	0.07%	6.94%
1080p	ParkScene	1.69%	4.42%	8.09%	-12.99%	0.67%	5.05%
	Cactus	4.42%	3.02%	4.17%	-9.42%	-3.79%	-3.35%
	BasketballDrive	11.67%	2.41%	4.41%	-14.67%	-6.00%	-4.83%
	BQTerrace	-1.61%	-2.37%	-0.59%	-32.77%	-2.08%	0.33%
Class C	BasketballDrill	4.78%	9.76%	9.72%	-13.84%	-1.40%	0.77%
WVGA	BQMall	6.50%	2.63%	0.38%	-11.96%	-0.67%	-2.27%
	PartyScene	5.65%	4.90%	5.36%	-9.32%	-0.15%	1.45%
	RaceHorses	6.91%	-5.39%	-6.21%	-11.54%	-9.80%	-11.31%
Class D	BasketballPass	5.99%	2.59%	3.33859%	-11.92%	-1.92%	0.11%
WQVGA	BQSquare	6.97%	13.44%	11.45%	-31.73%	13.15%	13.01%
	BlowingBubbles	2.91%	2.79%	2.86%	-8.07%	-1.51%	0.41%
	RaceHorses	5.80%	0.81%	-0.07%	-9.31%	-4.67%	-5.93%

ANCHOR 113KBPS



DENOISING AND ADAPTIVE QP
110KBPS
BD-PSNR: +7%
BD-MS-SSIM: -32%



RE-NOISING



- › A video encoder should preserve the source video signal as closely as possible
 - Adding generated noise after decoding is beneficial if the source is noisy
 - The Film grain characteristics SEI message is supported in both AVC and HEVC and can be used
- › We investigated the effect of re-noising and found subjective improvements
 - The effect of re-noising is mostly temporal therefore not well captured in still pictures

SUBJECTIVE VIEWING



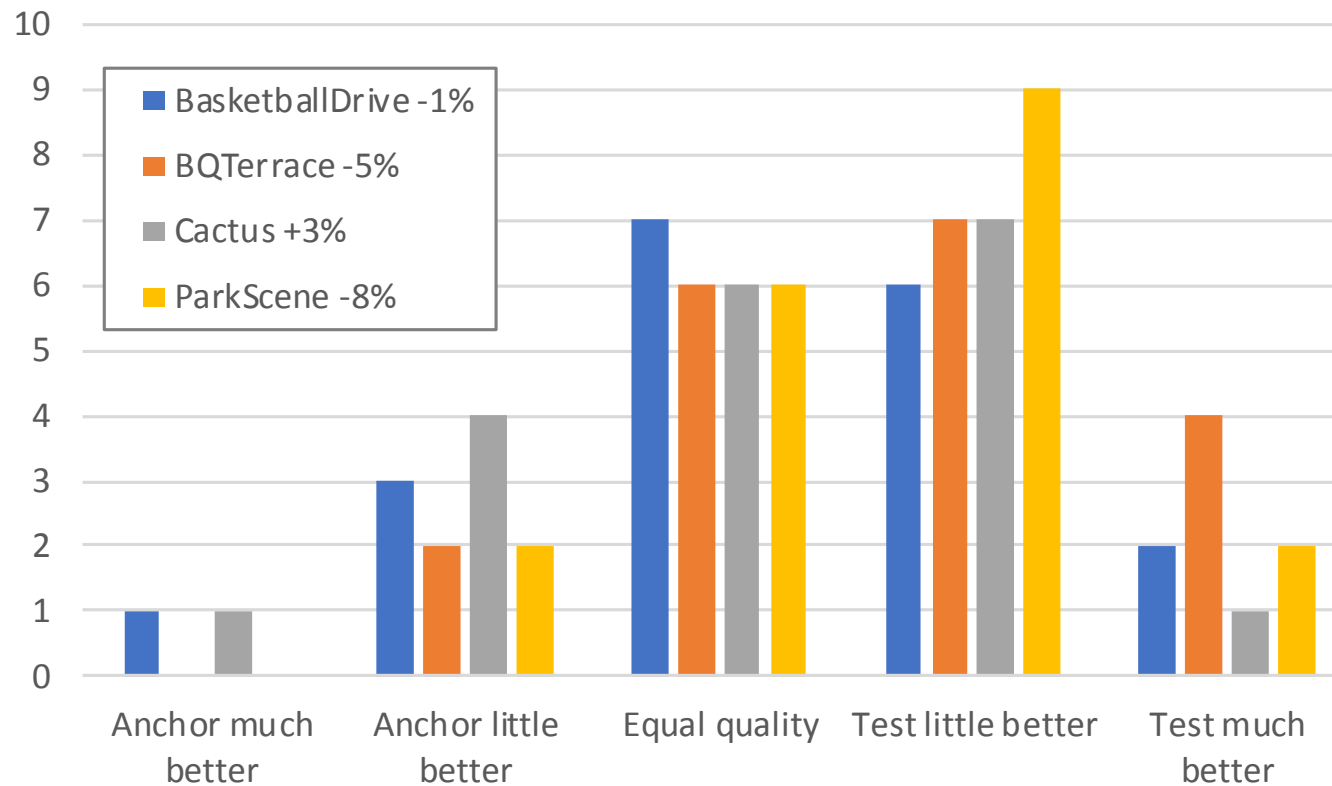
- › We prepared some decoded sequences for viewing at the Torino meeting as shown below
 - JEM 6.0 Anchor
 - Test: JEM 6.0 with denoising, adaptive QP and renoising
- › An informal viewing was held at the Torino meeting on four out of five 1080p sequences in the CTC. Kimono was omitted due to the scene change since the re-noiser implementation use same parameters for the whole sequence.

Sequence	QP	JEM-6.0 [kbps]	Test [kbps]	Diff [%]
BasketballDrive	37	1092.16	1078.79	-1%
BQTerrace	37	799.88	759.07	-5%
Cactus	37	992.21	1024.13	+3%
ParkScene	37	573.50	528.23	-8%

SUBJECTIVE VIEWING



19 persons voting



	BD-rate (piecewise cubic)	
	Y psnr	Y ms-ssim
ParkScene	1.69%	-12.99%
Cactus	4.42%	-9.42%
BasketballDrive	11.67%	-14.67%
BQTerrace	-1.61%	-32.77%

PROPOSAL 1



- › We propose that inclusion of adaptive QP and denoising tools is considered for the test model and common test conditions for the future video coding project.
- › Motivation
 - Develop a codec under the best publicly known settings for subjective quality simply makes sense
 - Requiring results for e.g. a class where adaptive QP is turned on should help tune all tools towards common practical encoder usage of the standard
 - May help the future standard reach its goal of 50% bitrate reduction at the same subjective quality
 - Maintain a public test model encoder that is better subjectively and can be used in comparisons with other formats
- › Potential problem
 - We do not have an agreed metric that is better than PSNR so we can't measure (small) subjective improvements
 - › However, PSNR number may still be very useful when adaptive QP is on
 - › Also, work towards better metrics may accelerate if we have adaptive QP in our CTC (see HDR progress)
 - › We can start by using MS-SSIM together with PSNR

PROPOSAL 2



- › We propose that a test class for SDR video where pre processing and adaptive quantization is allowed is included in the CfP for future video coding.
- › Motivation
 - Get responses with proposals for pre processing and adaptive quantization at an early stage
 - Get subjective results between traditional and optimized encoders
 - › Can be used to compute correlations between metrics and MOS scores
 - › Measure the bitrate savings (or losses) in BD-MOS between traditional and optimized encoders
- › Potential problem
 - May make sorting out whether gains come from encoder settings or coding tools more difficult
 - › Using sequences from restricted class and mandate to supply results for both for responses to the free class may help
 - › We need to take some risks to move forward, and we should not promise to take any particular action in advance

SUMMARY



- › We propose that inclusion of adaptive QP and denoising tools is considered for the test model and common test conditions for the future video coding project. No action needed at this meeting.
- › We propose that a test case for SDR video where denoising and adaptive quantization is allowed is included in the CfP for future video coding.



ERICSSON