



# CREATING THE LIVING NETWORK™

JVET-G0089

EE3 Related: Adaptive quantization for JEM-based 360-degree video coding

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# Introduction

- Adaptive quantization methods for 360-degree video coding in the EE3
  - Adjust the QP value based on the weight derived for WS-PSNR
$$QP' = \min(51, \text{floor}(QP_0 - 3 \cdot \log_2(w)))$$
  - $QP_0$  is the slice QP for the luma component
  - The QP adaptation is performed at the CTU level
  - All the methods signal the QP offsets in bit-stream, i.e., encoder-only changes
- Identified issue on adaptive quantization for the chroma components
  - The adjusted chroma QP is based on mapping the adjusted luma QP into the corresponding chroma QP via a look-up table (LUT)
  - As the LUT is not one-to-one mapping, different QP offsets may be applied to the luma and chroma components
  - This means that the chroma QP is not directly adjusted according to the spherical sampling density

# The proposal

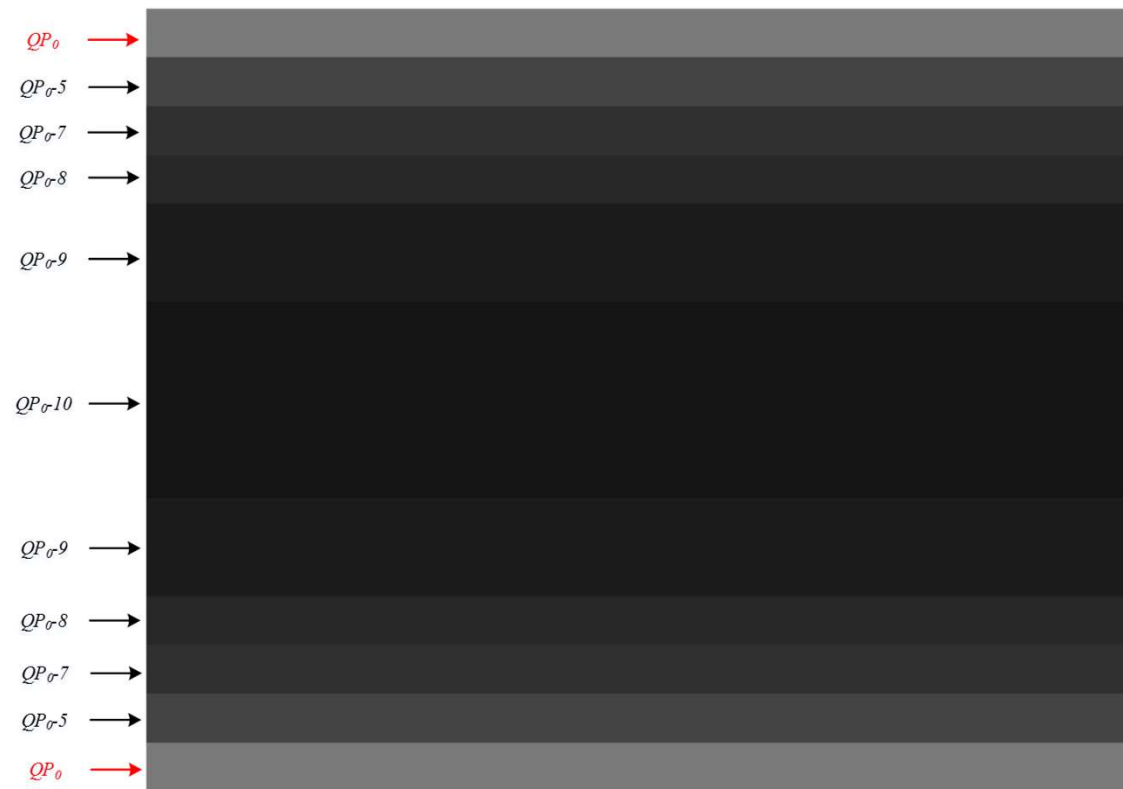
- The proposed adaptive quantization for JEM-based 360-degree video coding is built upon the same concept of the adaptive QP methods in EE3
  - Adaptively adjust the QP for each CTU according to the WS-PSNR weight
- Proposed changes include:
  - Avoid signaling delta QPs by applying the same QP derivation at both encoder and decoder
  - Remove the unnecessary clipping operation and use “round” function when calculating the adjusted QP for the luma component
  - Independently calculate chroma QP offset according to the WS-PSNR weight and apply a scaling factor to the chroma QP offsets

$$QP_L = \text{round}(QP_0 - 3 \cdot \log_2(w))$$

$$QP_c = \text{round}(QP_0^c - \mu_c \cdot 3 \cdot \log_2(w))$$

# The proposal

- Further, it is proposed to apply the slice QPs for the CTUs associated with the highest spherical sampling density and gradually decrease the QP values for the CTUs associated with lower spherical sampling density



# Simulation results: ERP

- Anchor: the ERP anchor of the JEM-6.0-360Lib-3.0
- Tested: the ERP with the proposed adaptive quantization implemented on JEM-6.0-360Lib-3.0

AQP_ERP vs. ERP	SPSNR-NN (End to End)			SPSNR-I (End to End)			CPP-PSNR (End to End)			WS-PSNR (End to End)		
	Y	U	V	Y	U	V	Y	U	V	Y	U	V
Trolley	-2.0%	-2.4%	-5.0%	-2.0%	-2.4%	-5.0%	-2.0%	-2.4%	-5.0%	-2.0%	-2.4%	-4.9%
GasLamp	-2.0%	-1.3%	3.6%	-2.1%	-1.5%	3.5%	-2.1%	-1.4%	3.6%	-2.1%	-1.3%	3.7%
Skateboarding_in_lot	-9.6%	-19.4%	-17.6%	-9.6%	-19.3%	-17.6%	-9.6%	-19.3%	-17.6%	-9.5%	-19.3%	-17.5%
Chairlift	-8.0%	-7.6%	-7.7%	-8.0%	-7.6%	-7.8%	-7.9%	-7.6%	-7.8%	-7.9%	-7.5%	-7.8%
KiteFlite	-3.5%	-3.7%	-6.3%	-3.5%	-3.8%	-6.3%	-3.5%	-4.0%	-6.4%	-3.5%	-3.9%	-6.4%
Harbor	-1.6%	-4.6%	-4.5%	-1.6%	-4.6%	-4.5%	-1.6%	-4.7%	-4.6%	-1.6%	-4.6%	-4.5%
PoleVault	-7.9%	-10.5%	-11.4%	-7.8%	-10.2%	-11.2%	-7.8%	-10.2%	-11.2%	-7.8%	-10.6%	-11.4%
AerialCity	-5.4%	-5.3%	-5.8%	-5.4%	-5.5%	-5.9%	-5.3%	-5.4%	-5.8%	-5.4%	-5.3%	-5.8%
DrivingInCity	-0.8%	1.4%	2.5%	-0.8%	1.3%	2.4%	-0.7%	1.3%	2.3%	-0.7%	1.5%	2.5%
DrivingInCountry	-9.3%	-14.2%	-15.8%	-9.2%	-14.3%	-15.8%	-9.2%	-14.4%	-15.9%	-9.3%	-14.3%	-15.8%
Overall	-5.0%	-6.8%	-6.8%	-5.0%	-6.8%	-6.8%	-5.0%	-6.8%	-6.8%	-5.0%	-6.8%	-6.8%

# Simulation results: CMP

- Anchor: the CMP anchor of the JEM-6.0-360Lib-3.0
- Tested: the CMP with the proposed adaptive quantization implemented on JEM-6.0-360Lib-3.0

AQP_CMP vs. CMP	SPSNR-NN (End to End)			SPSNR-I (End to End)			CPP-PSNR (End to End)			WS-PSNR (End to End)		
	Y	U	V	Y	U	V	Y	U	V	Y	U	V
Trolley	-2.7%	-8.2%	-7.5%	-2.6%	-8.3%	-7.6%	-2.6%	-8.2%	-7.4%	-2.6%	-8.1%	-7.4%
GasLamp	-2.2%	-10.1%	-10.8%	-2.2%	-10.1%	-10.9%	-2.3%	-10.0%	-10.8%	-2.3%	-9.9%	-10.8%
Skateboarding_in_lot	-2.8%	-12.2%	-13.9%	-2.8%	-12.3%	-13.9%	-3.0%	-12.4%	-14.1%	-3.0%	-12.4%	-14.1%
Chairlift	-3.8%	-13.4%	-12.2%	-3.8%	-13.4%	-12.2%	-3.7%	-13.2%	-12.1%	-3.7%	-13.1%	-12.1%
KiteFlite	-1.9%	-10.3%	-8.4%	-1.9%	-10.3%	-8.5%	-1.9%	-10.4%	-8.5%	-1.9%	-10.3%	-8.4%
Harbor	-2.1%	-7.8%	-8.3%	-2.0%	-7.8%	-8.3%	-2.2%	-8.0%	-8.4%	-2.1%	-7.9%	-8.4%
PoleVault	-1.4%	-10.7%	-14.0%	-1.3%	-10.5%	-13.8%	-1.4%	-10.6%	-13.8%	-1.4%	-10.8%	-14.1%
AerialCity	-2.9%	-13.9%	-12.4%	-2.9%	-14.0%	-12.5%	-3.0%	-14.1%	-12.3%	-3.0%	-13.9%	-12.3%
DrivingInCity	-2.3%	-9.7%	-9.3%	-2.3%	-9.8%	-9.3%	-2.6%	-9.9%	-9.6%	-2.5%	-9.8%	-9.5%
DrivingInCountry	-3.2%	-15.8%	-17.7%	-3.4%	-15.9%	-17.7%	-3.2%	-15.6%	-17.5%	-3.0%	-15.5%	-17.5%
Overall	-2.5%	-11.2%	-11.5%	-2.5%	-11.2%	-11.5%	-2.6%	-11.2%	-11.5%	-2.6%	-11.2%	-11.4%

# Simulation results: rotated ERP

- Anchor: the rotated ERP of the JEM-6.0-360Lib-3.0
- Tested: the rotated ERP with the proposed adaptive quantization implemented on JEM-6.0-360Lib-3.0

AQP_ERP_ROT vs. ERP_ROT	SPSNR-NN (End to End)			SPSNR-I (End to End)			CPP-PSNR (End to End)			WS-PSNR (End to End)		
	Y	U	V	Y	U	V	Y	U	V	Y	U	V
Trolley	-6.8%	-7.7%	-3.8%	-6.8%	-7.8%	-3.9%	-6.7%	-7.7%	-3.7%	-6.7%	-7.6%	-3.7%
GasLamp	-6.6%	-6.4%	-8.2%	-6.6%	-6.6%	-8.4%	-6.4%	-6.5%	-8.3%	-6.4%	-6.4%	-8.2%
Skateboarding_in_lot	-9.4%	-8.0%	-7.1%	-9.4%	-8.1%	-7.1%	-8.9%	-7.4%	-6.4%	-9.0%	-7.4%	-6.4%
Chairlift	-10.4%	-14.4%	-14.5%	-10.4%	-14.4%	-14.6%	-10.3%	-14.5%	-14.7%	-10.4%	-14.5%	-14.7%
KiteFlite	-8.3%	-8.3%	-6.8%	-8.3%	-8.4%	-6.9%	-8.0%	-7.9%	-6.4%	-8.0%	-7.9%	-6.3%
Harbor	-11.5%	-12.8%	-13.8%	-11.6%	-12.8%	-13.8%	-11.3%	-12.7%	-13.5%	-11.4%	-12.6%	-13.5%
PoleVault	-11.0%	-15.2%	-17.0%	-11.3%	-15.3%	-17.0%	-11.1%	-15.0%	-16.7%	-10.9%	-15.1%	-16.7%
AerialCity	-8.8%	-11.5%	-12.5%	-8.9%	-11.8%	-12.7%	-8.5%	-11.4%	-12.6%	-8.5%	-11.3%	-12.3%
DrivingInCity	-8.9%	-10.5%	-9.9%	-9.0%	-10.7%	-10.2%	-8.3%	-9.9%	-9.4%	-8.4%	-9.9%	-9.5%
DrivingInCountry	-8.3%	-13.6%	-6.2%	-8.7%	-13.7%	-6.5%	-8.5%	-13.6%	-6.3%	-8.2%	-13.5%	-6.1%
Overall	-9.0%	-10.8%	-10.0%	-9.1%	-11.0%	-10.1%	-8.8%	-10.7%	-9.8%	-8.8%	-10.6%	-9.7%

# Closing remarks

- An adaptive quantization method is proposed on top of JEM-6.0-360Lib-3.0
- Simulation results
  - Average {Y, Cb, Cr} gains of {5.0%, 6.8%, 6.8%} for the ERP format
  - Average {Y, Cb, Cr} gains of {2.6%, 11.2%, 12.4%} for the CMP format
  - Compared to the HM-based adaptive QP methods in EE3, the gains provided by the proposed JEM-based method are similar for the ERP (EE3 Test #1 and #2) and larger for the CMP (EE3 Test #5)
- It is suggested to add the adaptive quantization functionality in the next release of JEM-based 360Lib