

JCTVC-P0197 Non-SCE1: Improved color gamut scalability



invention | collaboration | contribution

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Introduction

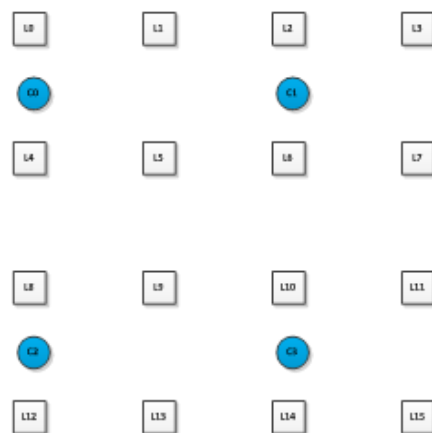
- P0063 proposed asymmetric 3D LUT
 - Reduce the 3D LUT size (vertices: 8x2x2x4)
 - Allow 3D LUT parameter update at picture level
 - Apply color gamut conversion after upsampling
 - Better coding efficiency compared with before upsampling
 - Higher computation complexity and memory bandwidth
- Main goal: reduce the complexity while keeping the performance
- The following changes are proposed based on P0063
 - Apply combined bit-depth and color gamut conversion (8-bit→10-bit) before upsampling
 - Apply simple filtering to align the chroma and luma sample positions

$$C(L4) = (C0*3 + C2 + 2) \gg 2$$

$$C(L5) = ((C0+C1)*3 + (C2+C3) + 4) \gg 3$$

$$C(L8) = (C0 + C2*3 + 2) \gg 2$$

$$C(L9) = ((C0+C1) + (C2+C5)*3 + 4) \gg 3$$



Simulations

- Two settings for simulations

Setting	the place of color gamut conversion	chroma alignment filtering
1	Before upsampling	Disabled
2	Before upsampling	Enabled

- SCE1 use case 2 was used

Simulation Results: setting1

	AI HEVC 2x 10-bit base			AI HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A+	-7.6%	-9.5%	-12.5%	-7.5%	-9.4%	-12.4%
Overall (Test vs Ref)	-7.6%	-9.5%	-12.5%	-7.5%	-9.4%	-12.4%
Overall (Test vs single layer)	9.5%	11.0%	3.6%	12.0%	12.8%	4.9%
Overall (Ref vs single layer)	18.5%	22.8%	18.1%	21.2%	24.7%	19.4%
EL only (Test vs Ref)	-15.2%	-16.6%	-19.6%	-15.1%	-16.6%	-19.5%
Overall (Test EL+BL vs single EL+BL)	-28.4%	-27.6%	-33.2%	-26.7%	-26.5%	-32.4%

	RA HEVC 2x 10-bit base			RA HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A+	-5.6%	-6.4%	-10.1%	-5.5%	-6.4%	-9.8%
Overall (Test vs Ref)	-5.6%	-6.4%	-10.1%	-5.5%	-6.4%	-9.8%
Overall (Test vs single layer)	20.2%	25.2%	13.9%	22.1%	26.8%	15.3%
Overall (Ref vs single layer)	27.5%	33.7%	26.9%	29.2%	35.2%	27.9%
EL only (Test vs Ref)	-10.7%	-11.0%	-14.7%	-10.5%	-10.9%	-14.3%
Overall (Test EL+BL vs single EL+BL)	-20.0%	-15.9%	-23.9%	-18.9%	-15.2%	-23.2%

Simulation Results: setting2

	AI HEVC 2x 10-bit base			AI HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A+	-8.3%	-10.0%	-13.0%	-8.2%	-10.0%	-12.8%
Overall (Test vs Ref)	-8.3%	-10.0%	-13.0%	-8.2%	-10.0%	-12.8%
Overall (Test vs single layer)	8.6%	10.3%	3.0%	11.2%	12.1%	4.3%
Overall (Ref vs single layer)	18.5%	22.8%	18.1%	21.2%	24.7%	19.4%
EL only (Test vs Ref)	-16.1%	-17.3%	-20.4%	-16.0%	-17.3%	-20.2%
Overall (Test EL+BL vs single EL+BL)	-29.0%	-28.0%	-33.6%	-27.3%	-26.9%	-32.8%

	RA HEVC 2x 10-bit base			RA HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A+	-6.1%	-6.9%	-10.7%	-5.9%	-6.9%	-10.4%
Overall (Test vs Ref)	-6.1%	-6.9%	-10.7%	-5.9%	-6.9%	-10.4%
Overall (Test vs single layer)	19.7%	24.6%	13.2%	21.5%	26.0%	14.5%
Overall (Ref vs single layer)	27.5%	33.7%	26.9%	29.2%	35.2%	27.9%
EL only (Test vs Ref)	-11.3%	-11.6%	-15.4%	-11.1%	-11.6%	-15.1%
Overall (Test EL+BL vs single EL+BL)	-20.4%	-16.3%	-24.5%	-19.3%	-15.6%	-23.9%

Comparison 1: setting2 compared to setting1

	AI HEVC 2x 10-bit base			AI HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A+	-0.7%	-0.6%	-0.6%	-0.7%	-0.6%	-0.5%
Overall (Test vs Ref)	-0.7%	-0.6%	-0.6%	-0.7%	-0.6%	-0.5%

	RA HEVC 2x 10-bit base			RA HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A+	-0.5%	-0.6%	-0.6%	-0.4%	-0.6%	-0.7%
Overall (Test vs Ref)	-0.5%	-0.6%	-0.6%	-0.4%	-0.6%	-0.7%

Comparison 2: setting2 compared to P0063

	AI HEVC 2x 10-bit base			AI HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A+	0.1%	1.7%	2.7%	0.2%	1.9%	2.8%
Overall (Test vs Ref)	0.1%	1.7%	2.7%	0.2%	1.9%	2.8%

	RA HEVC 2x 10-bit base			RA HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A+	0.5%	3.5%	4.3%	0.5%	3.5%	4.2%
Overall (Test vs Ref)	0.5%	3.5%	4.3%	0.5%	3.5%	4.2%

Conclusions

- Moving color gamut conversion before upsampling
 - Significantly reduces computation complexity and memory bandwidth
 - No need to change the upsampling process
 - Small performance loss
- Applying simple filtering to align the luma and chroma sample phases can improve performance
 - $\{-0.7\%, -0.6\%, -0.6\%\}$ for AI-2x
 - $\{-0.5\%, -0.6\%, -0.7\%\}$ for RA-2x