JCTVC-O0159

SCE4 - Color Gamut & Bit-Depth Scalability with CLUT

Results on 5.3-test1 and 5.3-test2

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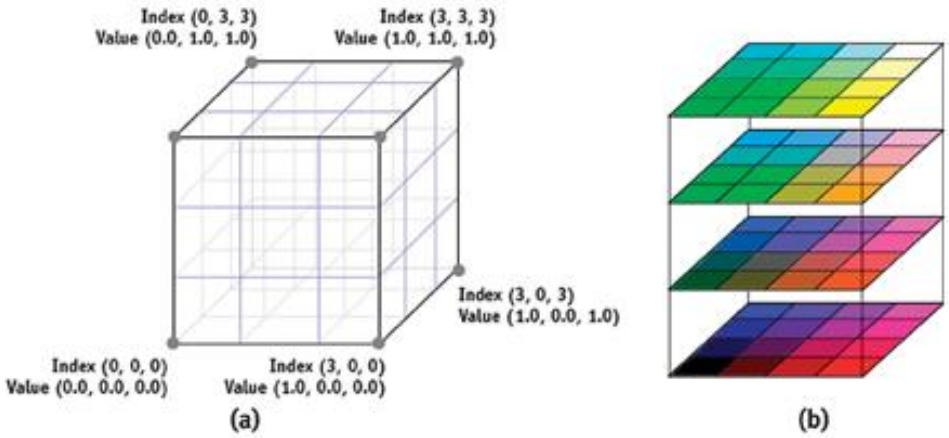
BL to EL Color prediction with CLUT

- **Basics: use of CLUT**



- **Rationale: generic model that does not preclude the future video formats**
  - The future video content formats (Wide Color Gamut, HDR) are still under discussion at DVB-UHDTV, MPEG-XYZ…
  - The cameras capabilities and the display technologies (LCD-back-light, OLED) are evolving rapidly, and we don't know what format will be finally adopted.
  - Then CGS scheme should be flexible enough to address these new formats.

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Main advantages

- Color grading is a non-deterministic process
  - Color grading is Display reference, not scene reference:

    => Color Space 1 vs Color Space 2 conversion is a non-deterministic transfer function in general

- Many Color processing tools use 3D LUTs to represent and save their intermediate and final color grading operations. In these cases, the 3D LUT information can be made available to the encoder easily

- The 3D LUT size (number of vertices in one direction), and the sample bit-depth precision are parameters read in the bit-stream (PPS). In that way, the encoder may choose the best trade-off between "Color Predictor" module accuracy and encoding cost

- 3D color LUT interpolation module for color conversion is implemented in many STBs and display devices (graphics card).

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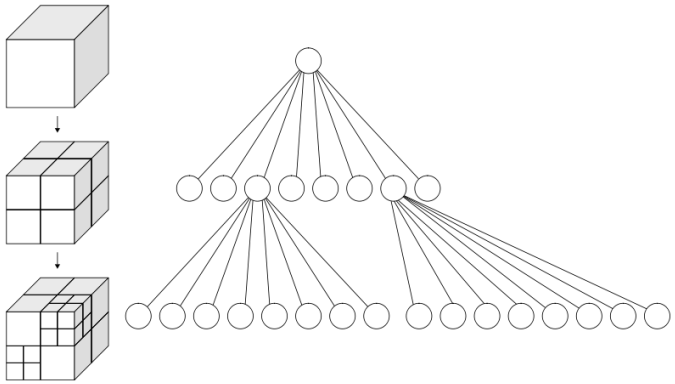
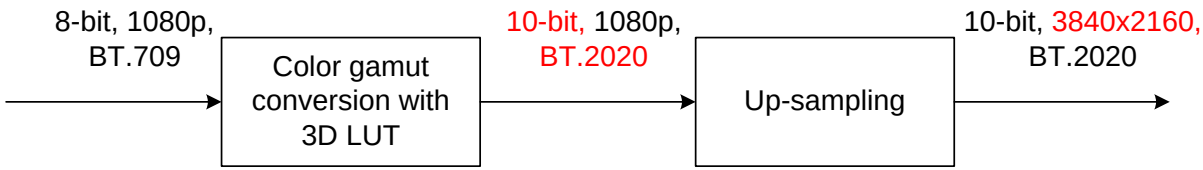
Implementation

Octree based coding using DPCM coding of YUV color vertices

- Unused (or less used) 3D color space regions are encoded with coarsely lattice size
- Each color component of a vertex is predicted with previously encoded color components of neighboring parent octant vertices



- **CLUT tetra-hedral interpolation**



SCE4 - 5.3 - test1 & test2

5.3-test1 (BL 8-bit, EL 10-bit)

5.3-test2 (BL 10-bit, EL 10-bit)

	AI HEVC 2x 10-bit base			AI HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A+	-12.2%	-9.6%	-14.9%	-12.3%	-9.9%	-16.0%
Overall (Test vs Ref)	-12.2%	-9.6%	-14.9%	-12.3%	-9.9%	-16.0%
Overall (Test vs single layer)	11.2%	16.8%	9.8%	13.7%	18.8%	11.0%
Overall (Ref vs single layer)	26.8%	29.4%	28.9%	29.8%	32.1%	32.1%
Overall (Test EL+BL vs single EL+BL)	-27.1%	-23.5%	-28.5%	-25.4%	-22.3%	-27.8%
EL only (Test vs Ref)	-22.3%	-19.6%	-24.5%	-22.7%	-20.2%	-25.8%
Enc Time[%]		97.9%			98.0%	
Dec Time[%]		95.8%			90.1%	

	RA HEVC 2x 10-bit base			RA HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A+	-8.5%	-3.4%	-10.1%	-8.2%	-3.0%	-9.9%
Overall (Test vs Ref)	-8.5%	-3.4%	-10.1%	-8.2%	-3.0%	-9.9%
Overall (Test vs single layer)	20.9%	31.0%	19.3%	22.7%	32.5%	20.3%
Overall (Ref vs single layer)	32.3%	35.5%	33.0%	33.8%	36.4%	33.9%
Overall (Test EL+BL vs single EL+BL)	-19.4%	-12.1%	-19.8%	-18.3%	-11.5%	-19.5%
EL only (Test vs Ref)	-15.2%	-9.7%	-16.2%	-15.0%	-9.4%	-16.0%
Enc Time[%]		98.7%			98.9%	
Dec Time[%]		101.9%			91.8%	

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SCE4 - 5.3 - test1 & test2

Comparison with SHM3.0.1 Anchors:

5.3 with CGS-CLUT achieves same performance as SHM with regular (no CGS) content !

	AI HEVC 2x 10-bit base			AI HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A						
Class B						
Overall (Test vs Ref)						
Overall (Test vs single layer)	**12.8%**	**14.9%**	**14.6%**	**12.8%**	**14.9%**	**14.6%**
Overall (Ref vs single layer)						
Overall (Test EL+BL vs single EL+BL)	**-21.9%**	**-20.3%**	**-20.7%**	**-21.9%**	**-20.3%**	**-20.7%**
EL only (Test vs Ref)						
Enc Time[%]						
Dec Time[%]						

	RA HEVC 2x 10-bit base			RA HEVC 2x 8-bit base		
	Y	U	V	Y	U	V
Class A						
Class B						
Overall (Test vs Ref)						
Overall (Test vs single layer)	**19.2%**	**33.3%**	**32.0%**	**19.2%**	**33.3%**	**32.0%**
Overall (Ref vs single layer)						
Overall (Test EL+BL vs single EL+BL)	**-17.2%**	**-7.6%**	**-8.6%**	**-17.2%**	**-7.6%**	**-8.6%**
EL only (Test vs Ref)						
Enc Time[%]						
Dec Time[%]						

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Conclusions

- **CGS with CLUT is a generic model scalable in complexity and in accuracy:**
  - Allows addressing low complexity use cases (linear models)
  - Allows addressing more general use cases where the Color mapping function in between the BL and EL is more complex (non linear, HDR tone mapping, clamping…)
  - CLUT is a common processing tool (content creation)
  - CLUT interpolation implemented in many STBs and display devices (graphics card)

- **Allows to achieves high efficiency**
  - BD-rate of CGS-2x is equivalent to BD-rate of SHVC-2x without CGS
  - Enc/Dec times are equal or below reference
  - CGS-CLUT has room to encoder/content optimization depending on the application (see JCTVC-O0161)

- **Propose to adopt CGS with CLUT in SHVC**

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