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Status **Input**
Title **[MPEG-I Visual] HEVC-SCC in TMIV**

1 Introduction

This document presents results of the application of HEVC Screen Content Coding, instead of plain HEVC, for coding of TMIV atlases. Results include the discussion on the usability of this technique in further immersive video explorations.

2 Overview of the experiment

The experiment was performed using TMIV2 [N18577].

The experiment followed Common Test Conditions [N18563], with one major change: HEVC encoding was performed on 8-bps atlases, as HEVC-SCC supports only 8 bit pixel depth:

input 10bps / 16bps	=> TMIV encoder	atlases 10bps	=>	atlases 8bps	=> HEVC	atlases 8bps	=>	atlases 10bps	=> TMIV decoder	output 10bps

The configuration of both tested video encoders was identical (excl. SCC-specific parameters).

3 Experimental results

The results of the performed experiment are presented in the table below:

Proposal vs. Low/High-bitrate Anchors

Test class	Sequence	Anchor (ff)	High-BR BD rate Y-PSNR	Low-BR BD rate Y-PSNR	Max delta Y-PSNR	High-BR BD rate VIF	Low-BR BD rate VIF	High-BR BD rate VMAF	Low-BR BD rate VMAF	High-BR BD rate MS-SSIM	Low-BR BD rate MS-SSIM	High-BR BD rate IV-PSNR	Low-BR BD rate IV-PSNR	Pixel rate ratio
CG	ClassroomVideo	AA97 (MIV)	-24.9%	-19.9%	4.38	-10.4%	-11.3%	-18.1%	-14.7%	-10.3%	-10.3%	-9.1%	-11.4%	0.00%
	TechnicolorMuseum	BA97 (MIV)	-8.4%	-7.3%	15.85	-4.3%	-3.8%	-10.1%	-7.4%	-4.9%	-4.1%	-4.9%	-4.6%	0.00%
	TechnicolorHijack	CA97 (MIV)	-23.1%	-16.5%	12.03	-16.5%	-13.3%	-23.2%	-16.9%	-19.2%	-12.6%	-10.7%	-7.7%	0.00%
	OrangeKitchen	JA97 (MIV)	-23.0%	-22.3%	20.31	-16.6%	-16.1%	-32.2%	-28.2%	-17.1%	-15.5%	-4.7%	-6.6%	0.00%
		MIV	-19.8%	-16.5%	20.31	-12.0%	-11.1%	-20.9%	-16.8%	-12.9%	-10.6%	-7.4%	-7.6%	0.00%
		All anchors	-19.8%	-16.5%	20.31	-12.0%	-11.1%	-20.9%	-16.8%	-12.9%	-10.6%	-7.4%	-7.6%	0.00%
NC	TechnicolorPainter	DA97 (MIV)	-3.7%	-3.0%	7.81	-4.1%	-3.4%	-3.5%	-2.4%	-3.9%	-2.9%	-3.8%	-2.9%	0.00%
	IntelFrog	EA97 (MIV)	-3.4%	-4.3%	7.52	-2.6%	-2.8%	-5.7%	-4.4%	-4.4%	-3.8%	-0.3%	-2.7%	0.00%
	PoznanFencing	LA97 (MIV)	-12.5%	-10.3%	14.98	-12.5%	-9.9%	-12.2%	-8.3%	-12.3%	-8.3%	-11.2%	-7.7%	0.00%
		MIV	-6.6%	-5.9%	14.98	-6.4%	-5.3%	-7.1%	-5.0%	-6.9%	-5.0%	-5.1%	-4.4%	0.00%
		All anchors	-6.6%	-5.9%	14.98	-6.4%	-5.3%	-7.1%	-5.0%	-6.9%	-5.0%	-5.1%	-4.4%	0.00%

Test class	Sequence	Anchor (ff)	High-BR BD rate Y-PSNR	Low-BR BD rate Y-PSNR	Max delta Y-PSNR	High-BR BD rate VIF	Low-BR BD rate VIF	High-BR BD rate VMAF	Low-BR BD rate VMAF	High-BR BD rate MS-SSIM	Low-BR BD rate MS-SSIM	High-BR BD rate IV-PSNR	Low-BR BD rate IV-PSNR	Pixel rate ratio
All		MIV	-14.1%	-11.9%	11.84	-9.6%	-8.7%	-15.0%	-11.8%	-10.3%	-8.2%	-6.4%	-6.2%	0.00%
		All anchors	-14.1%	-11.9%	11.84	-9.6%	-8.7%	-15.0%	-11.8%	-10.3%	-8.2%	-6.4%	-6.2%	0.00%

As the results show, HEVC-SCC clearly outperforms plain HEVC in TMIV application, especially for CG content.

Three consecutive tables present bitrate reduction for all sequences and all rates.

Bitrate reduction (overall)

	SA	SB	SC	SJ	SD	SE	SL
QP1	-1.6%	-3.3%	-10.6%	-11.9%	-3.5%	-1.0%	-9.4%
QP2	-4.0%	-3.3%	-10.0%	-12.6%	-4.5%	-2.1%	-12.8%
QP3	-8.3%	-3.4%	-7.3%	-12.9%	-4.6%	-2.9%	-13.6%
QP4	-9.7%	-3.4%	-3.8%	-12.0%	-3.8%	-2.3%	-9.2%
QP5	-4.6%	-2.0%	-1.7%	-11.5%	-1.2%	-0.8%	-0.5%
average	-5.6%	-3.1%	-6.7%	-12.2%	-3.5%	-1.8%	-9.1%

Bitrate reduction (texture)

	SA	SB	SC	SJ	SD	SE	SL
QP1	-0.1%	-2.1%	-6.6%	-6.8%	-0.4%	-0.3%	-0.5%
QP2	-0.3%	-2.2%	-6.9%	-6.7%	-1.4%	-0.9%	-0.7%
QP3	-1.5%	-2.3%	-6.3%	-5.7%	-1.9%	-1.4%	-0.7%
QP4	-2.7%	-2.5%	-4.6%	-4.4%	-1.5%	-1.7%	-0.7%
QP5	-1.7%	-1.9%	-1.8%	-3.3%	-0.9%	-1.5%	-0.5%
average	-1.3%	-2.2%	-5.2%	-5.4%	-1.2%	-1.2%	-0.6%

Bitrate reduction (depth)

	SA	SB	SC	SJ	SD	SE	SL
QP1	-23.0%	-19.5%	-23.7%	-27.1%	-5.0%	-2.3%	-15.7%
QP2	-19.4%	-15.3%	-16.4%	-25.5%	-5.5%	-4.0%	-17.5%
QP3	-18.3%	-13.0%	-8.0%	-24.1%	-5.4%	-5.6%	-17.4%
QP4	-15.6%	-8.8%	0.1%	-21.2%	-4.4%	-3.6%	-11.4%
QP5	-6.9%	-2.7%	2.9%	-19.8%	-1.3%	0.7%	-0.5%
average	-16.6%	-11.8%	-9.0%	-23.5%	-4.3%	-3.0%	-12.5%

In the last table, HEVC-SCC effectiveness for basic and additional atlases is compared.

Average bitrate reduction for atlases containing basic views and patches from additional views

	texture		depth	
	CG	NC	CG	NC
basic atlas	-0.72%	-0.27%	-10.40%	-5.71%
additional atlas	-4.43%	-1.17%	-15.91%	-5.20%

Also, the subjective quality of synthesized views is better when HEVC-SCC is used (Fig. 1), because of better preserved edges in depth atlases (Fig. 2).

Fig. 1. Fragments of synthesized virtual views (QP5).

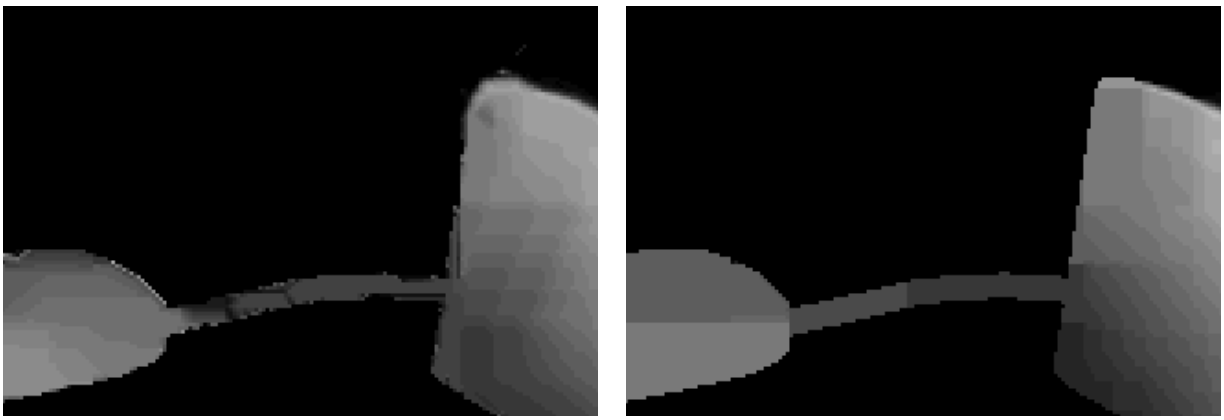

Fig. 2. Fragment of depth atlas (SA, QP5).

4 Attachments

1. Reporting template (A97),
2. Plain HEVC configuration file,
3. HEVC-SCC configuration file.

5 Acknowledgement

This work was supported by the Ministry of Science and Higher Education.

6 Recommendations

We recommend considering using HEVC-SCC for Immersive Video encoding.

7 References

[N18563] Common Test Conditions for Immersive Video,
ISO/IEC JTC1/SC29/WG11 MPEG/N18563, Göteborg, Sweden, July 2019

[N18577] Test Model 2 for Immersive Video,
ISO/IEC JTC1/SC29/WG11 MPEG/N18577, Göteborg, Sweden, July 2019