Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11
26th Meeting: Geneva, CH, 12–20 January 2017

Document: JCTVC-Z0041

Title:	**Experimental results for frame –compatible multiview video coding using HEVC SCC**
Status:	Input Document to JCT-VC
Purpose:	Information

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Abstract

The contribution presents application of the HEVC Screen Content Coding technology for frame-compatible compression of multiview video, including stereoscopic video. This single-layer coding technique may be an interesting alternative to the Multiview HEVC that is the dedicated state-of-the-art technique for multiview video compression. The experimental results are reported for comparison between the adapted Screen Content Coding codec and Multiview codec. The experiments also demonstrate that HEVC Screen Content Coding can be efficiently used for frame-compatible coding of stereoscopic video.

1 Introduction

The state-of-the-art multiview video coding technology is the multi-layer MV-HEVC technology [2]. The main new coding tool included in the MV-HEVC is the Disparity-Compensated Prediction (DCP) that exploits the similarities between encoded views to improve the overall compression capability for multiview video. It was already demonstrated that application of this tool is especially beneficial for intraframe coding. The experiments demonstrate that the inter-view DCP is mostly chosen as the optimum prediction mode for the video portions where intra-frame coding would be used otherwise. Unfortunately, the multi-layer profiles of coding standards are still not very successful on the market. For example, for stereoscopic video much more popular is frame-compatible coding using typical single-layer video codecs.

On the other hand, the new single-layer Screen Content Coding (SCC) [1,2] has a chance to be implemented in many consumer devices. For intraframe coding, the SCC provides the Intra Block Copy tool.

This contribution is motivated by a suggestion that SCC Intra Block Copy tool can substitute the Disparity-Compensated Prediction for intraframe coding of frame-packed multiview video.

2 Frame-compatible multiview video

For 4-view video, the frame packing variants are presented in Figure 1.

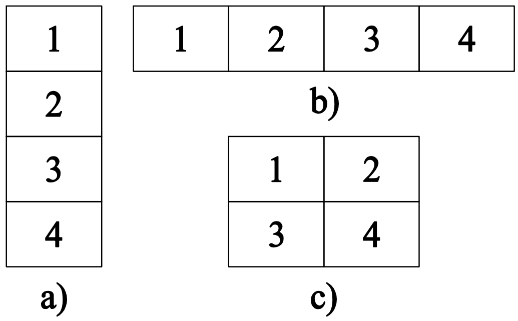

Fig. 1. Different view alignments: a) 1×4, b) 4×1, c) 2×2.

The experiments has demonstrated that the 4×1 view alignment provides the highest compression efficiency for frame-compatible coding using HEVC SCC. Therefore this variant was used as input for the remaining tests.

3 Condition and setup of the experiments

The goal of the experiments is to determine whether the frame-compatible multiview video cosing using HEVC SCC provides better compression efficiency than HEVC simulcast and if it is competitive to Multiview HEVC codec.

For experiments, Intra Boundary Filter was enabled, while Hash-Based IBC Search and Palette Mode were disabled. The changes were made only in the configuration – the reference Screen Content Coding software remained unmodified.

Three HEVC-based codecs were used in the experiments: HEVC Main, HEVC Screen Content Coding, Multiview HEVC. Each codec was compiled from the appropriate reference software, as shown in table 1. All codecs are based on the same version of HEVC (HM-16.9), therefore the results are not influenced by any differences other than Screen Content Coding or Multiview extension.

Table 1. Encoders and the corresponding software.

Encoder	Software
HEVC Main	HM-16.9 [3]
HEVC Screen Content Coding	HM-16.9+SCM-8.0 [4]
Multiview HEVC	HTM-16.2 [5]

The tests were performed on 100 frames of 4 views obtained from 6 commonly used multiview sequences [9-12]. For these sequences, the views correspond to real cameras with parallel optical axes. and most of them (except for Figure 3b) contain natural i.e. camera-captured content. Experiments were conducted in the *All Intra* configuration, while the experiments in Sections 6-7 were additionally performed in *Random Access* configuration with intra period equal to 24. The encoders were set up with respect to Common Test Conditions [6-8], using the appropriate configuration files provided together with the reference software.

The goal of each experiment was to compare two or more encoders in terms of the compression efficiency and the encoding times. The compression efficiency was calculated using Bjøntegaard metric for luma PSNR .

All the experiments were performed using a PC   computer with Intel Xeon 3GHz CPU.

4 Experimental results

4.1 Comparison of Screen Content Coding and Multiview codecs

Table 2. BD-rates against HEVC Main simulcast

	All Intra		Random Access	
	HEVC SCC side-by-side	Multiview HEVC	HEVC SCC side-by-side	Multiview HEVC
Balloons	-32.35%	-42.59%	-20.88%	-36.66%
BBB_Butterfly	-38.93%	-45.17%	-29.21%	-41.02%
Kendo	-33.19%	-44.97%	-22.71%	-41.07%
Newspaper	-23.98%	-31.13%	-18.06%	-30.79%
Poznan Hall 2	-15.16%	-26.70%	-9.98%	-22.18%
Poznan Street	-23.49%	-34.70%	-19.27%	-40.19%
average	**-27.85%**	**-37.54%**	**-20.02%**	**-35.32%**

Table 3. Encoding time against HEVC Main simulcast (negative values mean reduction in encoding time)

	All Intra		Random Access	
	HEVC SCC side-by-side	Multiview HEVC	HEVC SCC side-by-side	Multiview HEVC
Balloons	54.93%	120.80%	-9.72%	-2.76%
BBB_Butterfly	11.85%	51.80%	-5.08%	10.99%
Kendo	74.57%	152.19%	4.04%	9.59%
Newspaper	93.24%	157.34%	-9.03%	13.56%
Poznan Hall 2	38.58%	119.57%	-24.39%	8.52%
Poznan Street	110.56%	104.26%	-14.40%	5.18%
average	**63.96%**	**117.66%**	**-9.76%**	**7.51%**

4.2 *Comparison of Screen Content Coding and Main profile for compression of frame-compatible stereoscopic video*

Table 4. BD-rates against HEVC Main simulcast

	All Intra		Random Access	
	HEVC SCC side-by-side	Main side-by-side	HEVC SCC side-by-side	Main side-by-side
Balloons	-21.95%	0.03%	-13.65%	0.32%
BBB_Butterfly	-25.70%	-0.05%	-19.92%	-0.62%
Kendo	-23.36%	0.07%	-16.05%	0.37%
Newspaper	-17.75%	0.04%	-13.97%	-0.30%
Poznan Hall 2	-14.01%	0.04%	-8.65%	0.70%
Poznan Street	-20.49%	0.06%	-16.23%	-0.11%
average	**-20.07%**	**0.09%**	**-14.70%**	**0.12%**

Table 5. Encoding time against HEVC Main simulcast (negative values mean reduction in encoding time)

	All Intra		Random Access	
	HEVC SCC side-by-side	Main side-by-side	HEVC SCC side-by-side	Main side-by-side
Balloons	84.32%	2.82%	-1.45%	-4.94%
BBB_Butterfly	15.20%	-0.41%	-6.53%	6.20%
Kendo	55.26%	6.12%	11.51%	6.91%
Newspaper	113.25%	3.93%	-3.80%	7.88%
Poznan Hall 2	30.37%	2.07%	-30.11%	-5.90%
Poznan Street	103.75%	-1.27%	-20.92%	-3.68%
average	**67.51%**	**1.41%**	**-13.45%**	**-0.68%**

5 Conclusions

In this contribution, the authors presented an idea of using Screen Content Coding for compression of frame-compatible multiview video. The comparison of the proposed solution with other encoders showed that Screen Content Coding may be a reasonable alternative to the Multiview HEVC, especially in case of compression at short intra period (preferably *All Intra*). It is not as efficient as Multiview HEVC, but is much faster and still far more efficient than HEVC Main simulcast.

The proposed scheme was also applied for compression of stereoscopic video. Compared to the commonly used solution, Screen Content Coding reduces the bitrate by up to 20%. Therefore, devices supporting Screen Content Coding can be easily equipped with an efficient solution for camera-captured multiview video compression. Such functionality may be beneficial in many applications, such as Virtual Navigation, Free Viewpoint Television or Augmented Reality.

From the point of view of the applications considered, it would be also beneficial to have also subpixel intra-copy vectors in the further SCC versions.

Acknowledgement

The work has been supported by the public funds under the DS project from Poznań University of Technology.

References

[1] J. Xu, R. Joshi, and R. A. Cohen, "Overview of the Emerging HEVC Screen Content Coding Extension," in *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 26, no. 1, pp. 50-62, Jan. 2016.

[2] High Efficiency Video Coding, ITU-T Rec. H.265 and ISO/IEC IS 23008-2, 3rd Ed., Apr./June 2015.

[3] JCT-VC, HEVC reference software repository, *https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftware/tags/ HM-16.9.* Web. 15 Dec. 2016.

[4] JCT-VC, HEVC Screen Content Coding reference software repository, *https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftw are/tags/HM-16.9+SCM-8.0.* Web. 15 Dec. 2016.

[5] JCT-3V, Multiview HEVC reference software repository, *https://hevc.hhi.fraunhofer.de/svn/svn_3DVCSoftware/tags/ HTM-16.2.* Web. 15 Dec. 2016.

[6] F. Bossen, "Common Test Conditions and software reference configurations," *JCT-VC of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11 12th Meeting: Doc: JCTVC-L1100*, Geneva, CH, Jan. 2013.

[7] H. Yu, R. Cohen, K. Rapaka, J. Xu, "Common Test Conditions for Screen Content Coding," *JCT-VC of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11 21st Meeting: Doc. JCTVC-U1015r2*, Warsaw, PL, Jun. 2015.

[8] K. Müller, A. Vetro, "Common Test Conditions of 3DV Core Experiments," *JCT-3V of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11 7th Meeting: Doc. JCT3V-G1100*, San José, US, Jan. 2014.

[9] M. Tanimoto, T. Fujii, N. Fukushima, "1D parallel test sequences for MPEG-FTV," *ISO/IEC JTC1/SC29/WG11, MPEG Doc. M15378*, Archamps, France, Apr. 2008.

[10] P. T. Kovacs, "[FTV AHG] Big Buck Bunny light-field test sequences," *MPEG M35721*, Geneva, Feb. 2015.

[11] Y.S. Ho, E.K. Lee, C. Lee, "Multiview video test sequence and camera parameters," *ISO/IEC JTC1/SC29/ WG11 MPEG Doc. M15419*, Archamps, France, Apr. 2008.

[12] M. Domański, T. Grajek, K. Klimaszewski, M. Kurc, O. Stankiewicz, J. Stankowski, K. Wegner, "Poznań multiview video test sequences and camera parameters," *ISO/IEC JTC1/SC29/WG11 MPEG Doc. M17050*, Xian, China, Oct. 2009.