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| **Title** | **[MPEG-I Visual] EE Results on Dense Light Field Compression using VVC** |
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# 1 Introduction

AHG on MPEG-I Visual Technologies is proceeding with Exploration Experiments (EEs) on dense light field (DLF) compression. In the 132th meeting, the results of VVC and Class-F configuration clearly showed significant improvement of coding efficiency for three 'Nagoya' test sequences [1]. In response to this, this document provides the results of EEs for lenslet (EE_LL) video compressed by VVC (VTM-10.1) with all plenoptic 2.0 test sequences.

The evaluation compresses the lenslet videos converted to YUV420 format using FFMPEG [2] by VTM. And then, it converts the compressed lenslet video bitstreams to multiview video for evaluating all Plenoptic 2.0 test sequences under the CTC [3]. Figure 1 shows the evaluation framework of EE_LL.

The main purpose of this document is (1) to provide the EE_LL results of VVC and VVC+SCC for all plenoptic 2.0 test sequences, (2) and their QPs for target bitrate in CTC, (3) to discuss further studies in DLF EE.

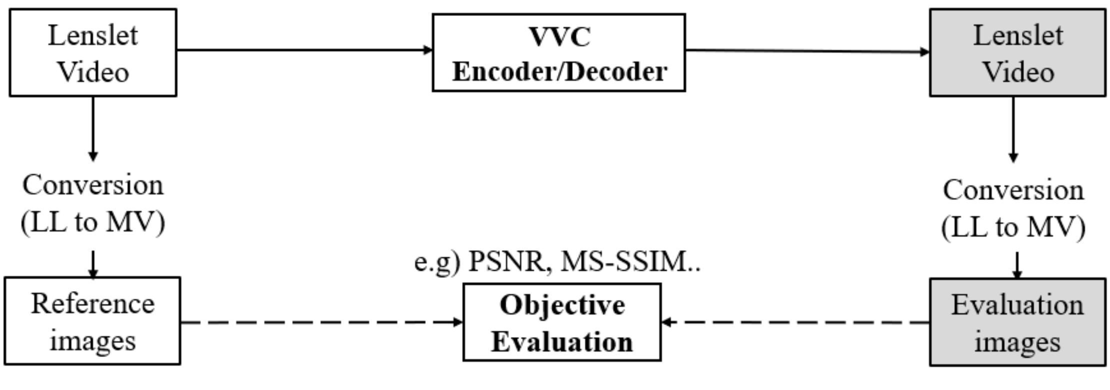


**Fig. 1.** Evalution framework of EE_LL (EE_compression 5)

## 2 Experimental Results

Because there is consensus about test condition of VTM in the MIV community, the reference software version in the experiment is VTM-10.1. Table 1 shows test conditions on the sequences. For the experiment, 30 frames are tested using default configuration files included in the reference software. Motivated by lenslet video contains a substantial number of repetitive patterns, EE has been conducted with SCC and intra block copy (IBC). Figure 2 illustrates the example of IBC in lenslet video.

**Table 1.** Test Conditions

| | |
|---|---|
| Frame count | 30 |
| QPs | [36, 40, 45, 49] |
| Reference software version | VTM-10.1 |
| Configuration file | encoder_intra_vtm.cfg (AI) / encoder_randomaccess_vtm.cfg (RA) (classSCC.cfg) |

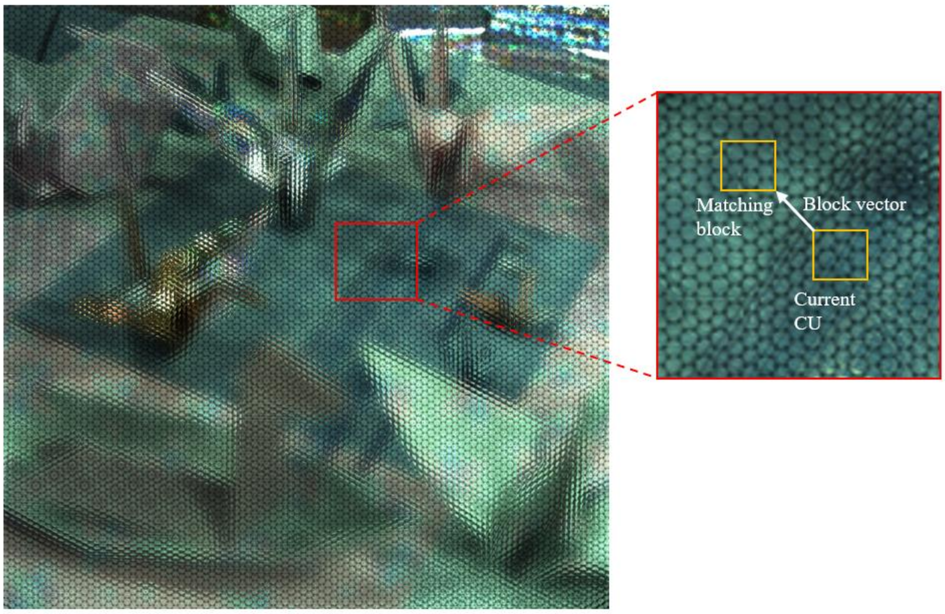


**Fig. 2.** Example of intra block copy (IBC) in lenslet video ('NagoyaOrigami')

Table 2 shows the results for plenoptic 2.0 test sequences under All Intra (AI) configuration and Random Access (RA) configuration, respectively. The results contain BD-rate gains (Y-PSNR and bitrate) and encoding complexity of each sequence under test conditions. The results clearly indicate that the use of the SCC configuration improves coding performance in VVC though encoding complexity is increased as well.

**Table 2.** BD-rate gain result for VVC+SCC v.s. VVC

| | VVC+SCC v.s. VVC | | | |
|---|---|---|---|---|
| | All Intra | Encoding time (%) | Random Access | Encoding time (%) |
| ChessPieces | -47.52% | 148% | -46.60% | 105% |
| Boxer | -49.48% | 178% | -48.51% | 123% |
| Tunnel_Train2 | -20.14% | 281% | -12.54% | 117% |
| DataLeading | -22.19% | 255% | -18.58% | 156% |
| Fujita | -4.55% | 310% | -2.83% | 146% |
| Origami | -4.21% | 287% | -2.69% | 158% |

The VVC results clearly indicate significant improvement of coding efficiency. Therefore, VVC is considered to EE compression. Based on current CTC documents of DLF, this document proposes the target bitrate and their QPs. Table 3 and 4 show the recommended target bitrate and revised QPs for EE_LL on VVC. The coding configuration is only random access.

**Table 3.** Target Bitrate (Kbps)

| Camera Type | Sequence Name | Coding configuration | | | |
|---|---|---|---|---|---|
| | | Random Access | | | |
| | | R1 | R2 | R3 | R4 |
| Plenoptic 2.0 | ChessPieces | **1600** | **800** | **400** | **200** |
| | Boxer | **6400** | **2600** | **1400** | **700** |
| | Tunnel_Train2 | **2400** | **1200** | **600** | **300** |
| | DataLeading | 1,600 | 800 | 400 | 200 |
| | Fujita | 2,400 | 1,200 | 500 | 250 |
| | Origami | 4,100 | 2,050 | 1,000 | 500 |
| | Boys | 5200 | 2600 | 1400 | 700 |
| | Experimenting | 6400 | 3200 | 1900 | 950 |
| | Cars | 3400 | 1700 | 1000 | 500 |
| | Matryoshka | 1600 | 800 | 400 | 200 |

**Table 4.** Revised QPs for EE_LL on VVC

| Camera Type | Sequence | R1 | R2 | R3 | R4 |
|---|---|---|---|---|---|
| Plenoptic 2.0 | ChessPieces | **37** | **41** | **45** | **49** |
| | Boxer | **33** | **40** | **45** | **49** |
| | Tunnel_Train2 | **35** | **40** | **45** | **49** |
| | Fujita | **36** | **40** | **45** | **49** |
| | Origami | **36** | **40** | **45** | **49** |
| | DataLeading | **38** | **43** | **49** | **51** |
| | Boys | **33** | **38** | **43** | **49** |
| | Experimenting | **32** | **38** | **42** | **48** |
| | Cars | **35** | **42** | **47** | **53** |
| | Matryoshka | **32** | **38** | **45** | **49** |

# 3 Discussion

## EE_MV using VVC

VVC supports scalability with reference picture resampling (RPR), which can be used to multiview coding. However, we did not provide results of VVC multi-layer(view) coding because the configuration is difficult to customize. But we observed the coding order structure affects on coding performance in multi-layer DLF coding and that should be investigated in VVC multiview coding.

## EE_MIV

With advantages of portable capturing light field (LF) camera and depth map extraction, DLF can be used in the test model for MPEG immersive video (TMIV) software. TMIV software can reduce decoder instantiations for multiview coding, but we could not conduct the experiment because camera parameters for multiview videos that are converted from lenslet video are not available.

## Objective Metrics

The sub-aperture images from lenslet video are has some artifacts with view synthesis process. Because of these artifacts, the compression evaluation should be conducted carefully with other metrics, such as MS-SSIM, VMAF, IV-PSNR.

# 4 Conclusion

This document provides the EE_LL results of VVC and VVC+SCC for all plenoptic 2.0 test sequences. And it also provides recommended QPs for target bitrates under CTC. It is clear to need further studies with VVC and other DLF EEs.

# 5 References


[1] Soonbin Lee, Jong-Beom Jeong, Eun-Seok Ryu, "[MPEG-I Visual] Report on Dense Light Field Compression in VVC", ISO/IEC JTC1/SC29/WG4 MPEG2020/M55013, Online.

[2] Fan Jiang, Xin Jin, Tingting Zhong, "[MPEG-I EE] Exploration Experiment of Plenoptic 2.0 test sequences for Dense Light Field Compression", ISO/IEC JTC1/SC29/WG11 MPEG2020/M53793, Alpbach, Austria.

[3] Mehrdad Teratani, Xin Jin, Gauthier Lafruit, Lu Yu, "Exploration Experiments and Common Test Conditions for Dense Light Fields", ISO/IEC JTC1/SC29/WG11 MPEG2020/N19223, Online