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| **Joint Collaborative Team on 3D Video Coding Extension Development**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  1st Meeting: Stockholm, SE, 16–20 July 2012 | Document: JCT2-A0001 |

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# Abstract

This document is an ad-hoc group report on 3D video coding.

1. **Mandates**
2. Discuss and finalize the texts for WD and test models.
3. Maintain and coordinate SW integration
4. Maintain the software for depth map and view generation
5. Evaluate results of core experiments.
6. Study possible changes to test conditions.
7. Improve the White Paper on 3D video state of the art
8. Prepare viewing for 101st meeting
9. Study the benefit of alternative data formats, consider how they can be integrated with the 3DV standardization framework, and establish suitable test conditions.
10. **Meetings**

A meeting was held on the Saturday and Sunday before the 101st MPEG meeting.

1. **General**

The 3D Video group was established to investigate 3D Video Coding towards a standard that targets serving a variety of 3D displays.

Starting in the 81st MPEG meeting, initially general requirements for Free Viewpoint TV (FTV) were investigated and an ad-hoc group on FTV requirements established. From that the 3D Video group evolved to investigate efficient coding approaches for multiview video scenarios that go beyond current approaches e.g. coding all available views as in multi-view video coding (MVC). For this, a Call for Proposals on 3D Video Coding Technology has been issued at the 96th MPEG meeting and responses evaluated at the 98th MPEG meeting.

1. **Work Status and Comments**

A total of approximately 166 3D video related input documents have been registered, and 4 of these have been withdrawn. With the exception of the 17 input documents on high-level syntax and approximately 11 other input contributions, all other documents have been reviewed during the AHG meeting with primary focus on CE results, CE related contributions and documents that were specifically related to the mandates of this AHG. A brief summary of the progress on each mandate and notes on the input documents that were reviewed is given below.

Mandate 1: Discuss and finalize the texts for WD and test models.

The associated documents have been finalized and uploaded to the MPEG web site.

Mandate 2: Maintain and coordinate SW integration.

The 3D-ATM and 3D-HTM software packages have been updated and made available for core experiments and further testing.

Mandate 3: Maintain the software for depth map and view generation.

No updates to the depth map generation and view synthesis software have been made.

Mandate 4: Evaluate results of core experiments.

The results of CEs have been evaluated during the ad-hoc group meeting. The main highlights from each CE are summarized below. Further details on the related contributions can be found later in the report.

* CE1: View synthesis and inter-view prediction
  + Good progress on developing block-based synthesis that provides significant reduction in implementation complexity and memory bandwidth (AVC only).
  + Coding efficiency improvements achieved by enabling sub-MB skip/direct modes and adaptive illumination compensation (AVC only).
  + New input on applying view synthesis prediction in HEVC.
* CE2: Depth representation and coding
  + Lack of input, likely to discontinue.
* CE3: Depth map resampling and filtering
  + Experiments reveal that substantial gains can be achieved with non-normative pre/post-processing of depth maps – planning subjective quality evaluation during the week.
  + Contributions on in-loop depth filtering are reporting gains, but need to assess whether the complexity increase justifies the coding gain.
* CE5: Motion/mode parameter prediction
  + New method of motion/mode parameter prediction for dependent views reporting significant gain in the range of 7-9% (AVC only).
  + Several contributions on various simplifications that substantial reduce implementation complexity without coding loss (AVC/HEVC).
  + A number of other proposals – continues to be an active area of study.
* CE6: Depth intra prediction (HEVC only)
  + Several contributions aiming to reduce complexity, e.g., fast search strategies
  + Also some contributions that report coding efficiency improvements, including new prediction modes and residual coding methods specific to depth.
* CE7: Global depth and view prediction
  + New framework that utilizes global view and global depth with residual has been studied.
  + Discussed possibility to specify data representation and non-normative processing, e.g., as an amendment to MPEG-C Part 3.
* CE8: RD Optimization
  + New contribution on adding depth fidelity term to improve the optimization, i.e., preserving fidelity of depth while maintaining coding gains.
  + Also received input on techniques that achieve notable complexity reduction.

Mandate 5: Study possible changes to test conditions.

There were input contributions related to depth map quality and the impact of VSO. There was also a contribution on enabling parallel encoding of multiview video sequences.

Mandate 6: Improve the White Paper on 3D video state of the art.

There have not been any activities or input contributions to improve the white paper. Work will be carried out during the week.

Mandate 7: Prepare viewing for 101st meeting.

The test room (NL359) is set up for 3D video viewing and viewing will be performed during the week.

Mandate 8: Study the benefit of alternative data formats, consider how they can be integrated with the 3DV standardization framework, and establish suitable test conditions.

In addition to the study conducted in CE7 on global view and global depth, there were also a contribution that offered warp data and corresponding view synthesis software as a first step to enable further evaluation of this data format representation.

1. **Recommendations**

The AHG on 3D Video Coding recommends to

1. Discuss the CE results and related input contributions
2. Discuss possible changes to the test conditions
3. Discuss software integration plans
4. Coordinate subjective viewing
5. **AHG Reports**

[**JCT2-A0001**](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=7)**/ m25277 Ad hoc on 3D Video Coding [Karsten Müller, Anthony Vetro] [miss]**

[**JCT2-A0006**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=12)**/** [**m25766**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=38926&id_meeting=153) **Ad hoc on 3D Video Coding High Level Syntax [Ying Chen, Thomas Rusert, Heiko Schwarz] [miss]**

1. **Core Experiments (xx):**
   1. ***CE1.a: View synthesis and inter-view prediction***
      1. **Summary**

[**JCT2-A0011**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=17)**/**[**m25805**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=38965&id_meeting=153) **CE1.a summary report: View synthesis and inter-view prediction [Dong Tian (MERL)]**

The tools investigated in this CE use the decoded texture and depth information to compute a prediction signal for a dependent view. The following objectives were established.

* Study block-based view synthesis
* Study benefit of depth up-sampling in combination with VSP
* Inter-view and view synthesis prediction with adaptive luminance compensation
* Evaluate benefit of not transmitting MV info and building context
* Evaluate benefit of sub-MB skip/direct
* Evaluate benefit of reference picture refinement
* Further evaluation of variable precision synthesis

The following CE contributions have been submitted:

JCT2-A0015 (Samsung)

JCT2-A0022 (NTT)

JCT2-A0035 (Samsung)

JCT2-A0055 (Zhejiang Univ)

JCT2-A0103 (Qualcomm)

JCT2-A0107 (Nokia)

JCT2-A0158 (Samsung/NTT)

Several CE related contributions have also been submitted:

JCT2-A0023 (NTT)

JCT2-A0036 (Samsung)

JCT2-A0050 (MediaTek)

JCT2-A0056 (Zhejiang Univ)

A summary of the above contributions relative to each objective of the CE can be found in the report.

* + 1. **CE Contributions**

[**JCT2-A0015**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=21)**/**[**m25851**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39011&id_meeting=153) **3D-CE1.a results on inter-view coding with adaptive luminance compensation by Samsung [Alexey Fartukov, Igor Kovliga, Mikhail Mishurovskiy, Jaejoon Lee, Konstantin Dubkov (Samsung)]**

This contribution proposes an auxiliary mode to account for luminance differences between views, which is enabled with a flag in the sequence level and signalled with a 1-bit flag after mb\_type at the macroblock level. It is proposed that this auxiliary mode is applied for view synthesis prediction only, and not for inter-view prediction based on the simulation results observed. The compensation method is applied to texture only and has no impact on depth coding. The proponents report a 1.03% bit rate reduction on the coded data and 0.59% bit rate reduction on the synthesized data with 102.98% encoded time, and 103.43% decoding time.

[**JCT2-A0024**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=124)**/**[**m26095**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39256&id_meeting=153) **3D-CE1.a: Cross-check report of JCT2-A0015 on inter-view coding with adaptive luminance compensation [Shinya Shimizu (NTT)]**

[**JCT2-A0022**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=122)**/**[**m26093**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39254&id_meeting=153) **CE1.a results on adaptive illumination compensation [Shinya Shimizu, Shiori Sugimoto, Hideaki Kimata (NTT)]**

This contribution presents the simulation results of the adaptive illumination compensation technique that was previously proposed in m22616 and is related to JCT-A0015 (Samsung). In the proposed method, the parameters for the illumination compensation are derived locally at the decoder by minimizing the differences between the decoded picture and the prediction picture. Two compensation models, a linear function and a 2D filter with offset, are evaluated in the experiments. For the texture coding, average BD-rate improvements of 0.25% and 0.04% were obtained with the linear function and 2D filter with offset, respectively. The maximum gain was 0.98% for the Kendo sequence with the linear function. The primary differences from JCT2-A0015 are in the signalling, parameter estimation, motion estimation and templates for sub-MBs.

[**JCT2-A0152**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=168)**/**[**m26172**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39333&id_meeting=153) **3D-CE1.a: Cross check on NTT's adaptive illumination compensation (JCT2-A0022) [Alexey Fartukov, Igor Kovliga, Mikhail Mishurovskiy, Jaejoon Lee, Konstantin Dubkov (Samsung)]**

[**JCT2-A0035**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=27)**/**[**m25879**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39039&id_meeting=153) **3D-CE1.a results on dilation based view synthesis prediction with upsampling [Seok Lee Seungsin Lee Ho-Cheon Wey Jaejoon Lee Du Sik Park (Samsung)]**

In this contribution, dilation-based view synthesis prediction with upsampling is proposed. The document reports 0.23% bit rate reduction on coded data and 0.26% bit rate reduction on synthesized views with 150% decoding time. Due to the high decoding time of the proposed method, an alternative approach with simpler computations is proposed in JCT2-A0036.

[**JCT2-A0058**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=50)**/**[**m25937**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39097&id_meeting=153) **3D-CE1.a cross check report of dilation based view synthesis prediction with upsampling by Samsung (m25879/JCT2-A0035) [Yin Zhao (Zhejiang Univ.)]**

[**JCT2-A0055**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=47)**/**[**m25932**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39092&id_meeting=153) **3D-CE1.a results on flexible rendering precision [Yin Zhao, Lu Yu (Zhejiang Univ.)]**

This contribution presents a sequence-level signaling of the rendering precision that is used to generate a view synthesis picture. Three look-up tables are proposed (integer, half-pel and quarter-pel) to enable the rendering. The selection of different precision is made based on a frame-level RD optimization process at the encoder. On average, the proposed method maintains similar RD performance while reducing decoding time by 5%.

Discussion: There was a question on whether this proposed method helps with the worst case decoder. It was noted that quarter-pel accuracy still needs to be supported in the worst case, so it was suggested that the claimed benefit may not be significant.

Discussion: There was also a question on how the precision is determined. It was stated by the proponent that the first AU is coded three times at different precisions. Encoding time was not reported in the contribution, but it can be expected to increase. It was noted that practical encoders would need to take this additional encoding requirement into account. A more practical means to determine the precision that did not incur large processing or latency would be needed.

[**JCT2-A0062**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=54)**/**[**m25985**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39145&id_meeting=153) **3D-CE1.a: Cross check on synthesis with fractional disparity of Zhejiang Univ.(JCT2-A0056) [Ilsoon Lim, Jin Young Lee (Samsung)]**

[**JCT2-A0130**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=146)**/**[**m26118**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39279&id_meeting=153) **3D-CE1.a: Cross check of JCT2-A0055 on flexible rendering precision [X. Zhao (Qualcomm)] [miss] [late]**

[**JCT2-A0103**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=95)**/**[**m26058**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39218&id_meeting=153) **3D-CE1.a: Generalized view synthesis prediction (GVSP) mode [X. Zhao, L.Zhang, Y.Chen, M. Karczewicz (Qualcomm)]**

This contribution proposes to change the signaling of View Synthesis Prediction (VSP) so that a VSP picture is not added into a reference picture list and the motion vectors to the other reference pictures are not used to predict the motion to a VSP picture. Instead, zero motion is always assumed for a block predicted from a co-located block of a VSP picture and a flag is used to indicate such prediction. This proposal is technically identical to m24940, but integrated to the latest 3D-ATM software. Without complexity increase, the proposed method gives 0.8% gain in a stable CE configuration (i.e., with Asymmetric VSP turned off).

Discussion: There was a remark on the benefits of the different aspects of this proposal, which was also noted in the CE summary report. Specifically, the results do not provide a separate evaluation, e.g., related to the benefit of excluding the VSP picture from the reference picture list. In the absence of such results, no conclusions on this potential benefit could be drawn.

[**JCT2-A0138**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=154)**/**[**m26136**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39297&id_meeting=153) **3D-CE1.a: Cross-check of generalized view synthesis prediction (GVSP) from Qualcomm by Nokia [Dmytro Rusanovskyy (Nokia)] [miss] [late]**

[**JCT2-A0146**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=162)**/**[**m26164**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39325&id_meeting=153) **3D-CE1.a: Cross check report of JCT2-A0103 on Generalized view synthesis prediction (GVSP) mode of Qualcomm [G. Bang (ETRI), K.Y. Kim, Y.S. Heo, G.H. Park(KHU), W.S. Cheong, N.H. Hur(ETRI)] [late]**

[**JCT2-A0107**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=99)**/**[**m26069**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39229&id_meeting=153) **3DV-CE1.a: Block-based View Synthesis Prediction for 3DV-ATM [Wenyi Su (USTC), Dmytro Rusanovskyy (Nokia), Miska M. Hannuksela (Nokia)]**

The current implementation of View Synthesis Prediction (VSP) in 3DV-ATM utilizes a forward warping to produce a complete reference image (VSP frame). An asserted drawback of such frame-level implementation is its high complexity at the decoder side and its incompatibility with a block-based processing architecture which is traditionally utilized for decoder.

This contribution proposes a block-based VSP implementation (B-VSP) which is based on a backward warping process. With the B-VSP, texture pixels of a dependent view are predicted not from the synthesized VSP-frame, but directly from the texture pixels of the base view. Displacement vectors required for this process are produced from the depth map data of the dependent view. It is asserted that B-VSP reduces the complexity of view synthesis prediction considerably and avoids the need to allocate a frame buffer for the VSP reference frame.

The presented simulation results show that proposed B-VSP scheme achieves a 0.4% bit rate reduction for coded texture views and a 0.7% bit rate reduction for synthesized views. It is asserted that the estimated decoding time for B-VSP is approximately 20% lower on average than the decoding time of the anchor. When considering the execution time of the VSP modules only, B-VSP reportedly provides 70% complexity reduction.

In contrast to JCT2-A0050, a related contribution by MediaTek, a single disparity vector is calculated for each 2x2 block rather than each 4x4 block. In this contribution, it is also proposed to disable the DMC tool and reduce the resolution of D-MVP. It was reported by the proponents that these changes incur very minimal impact on coding performance and some reduction in decoding time.

Discussion: It was unclear where the gains are coming from since block-based backward warping is not expected to improve the coding efficiency. It was asserted by some members that the gains come from bug fixes. Revisit: a cross-check of intermediate configurations will be done during the week to confirm the results.

Discussion: Group members expressed positive support for this general direction, mainly due to the complexity reduction.

[**JCT2-A0019**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=111)**/**[**m26086**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39246&id_meeting=153) **3D-CE1.a: Cross check on Nokia Proposal on Block based View Synthesis Prediction JCT2-A0107 [Feng Zou, Dong Tian, Anthony Vetro (MERL)]**

[**JCT2-A0145**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=161)**/**[**m26163**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39324&id_meeting=153) **3D-CE1.a: Cross check report of JCT2-A0107 on Block based View Synthesis Prediction of Nokia [G. Bang (ETRI), K.Y. Kim, Y.S. Heo, G.H. Park(KHU), W.S. Cheong, N.H. Hur(ETRI)]**

[**JCT2-A0158**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=175)**/**[**m26198**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39359&id_meeting=153) **3D-CE1.a results on joint proposal of Samsung and NTT [Seok Lee (Samsung), Shinya Shimizu (NTT), Seungsin Lee (Samsung), Shiori Sugimoto (NTT), Ho-Cheon Wey (Samsung), Hideaki Kimata (NTT), Jin Young Lee (Samsung), Jaejoon Lee (Samsung)] [late]**

This contribution reports the results of a combined proposal based on JCT2-A0036 (Samsung) and JCT2-A0023 (NTT). The combined gains are reported to achieve a 0.62% reduction in bit rate reduction on the coded data, and 0.66% bit rate reduction on the synthesized views with no increase in decoding time and a 4.2% increase in encoding time.

[**JCT2-A0061**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=53)**/**[**m25984**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39144&id_meeting=153) **3D-CE1.a: Cross check on sub-pel VSP simplification of NTT [Seok Lee, Jin Young Lee (Samsung)]**

[**JCT2-A0165**](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=187)**/m26285 3D-CE1.a: Cross check of JCT2-A0158 results on joint proposal of Samsung and NTT [X. Zhao (Qualcomm)]**

* + 1. **Related Contributions**

[**JCT2-A0036**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=28)**/**[**m25882**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39042&id_meeting=153) **3D-CE1.a related results on dilation based view synthesis prediction without upsampling [Seok Lee Jin Young Lee Seungsin Lee Ho-Cheon Wey Jaejoon Lee Du Sik Park (Samsung)]**

This contribution presents an improvement to JCT2-A0035. In this proposal, the dilation operation is replaced by a max operation on a small set of neighboring pixel positions. This method is reported to achieve a 0.18% bit rate reduction on the coded data, and a 0.22% bit rate reduction on the synthesized views with 101% decoding time. This method is also proposed in a joint contribution with NTT.

[**JCT2-A0025**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=125)**/**[**m26096**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39257&id_meeting=153) **3D-CE1.a related: Cross-check report of JCT2-A0036 on dilation based view synthesis prediction without upsampling [Shinya Shimizu (NTT)]**

[**JCT2-A0050**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=42)**/**[**m25921**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39081&id_meeting=153) **3D-CE1.a related: Interview skip/direct mode with sub-partition scheme [Chi-Ling Wu, Yu-Lin Chang, Yu-Pao Tsai, Shawmin Lei (MediaTek)]**

In this contribution, an inter-view skip mode is reported. In AVC-based 3D video coding, View Synthesis Prediction (VSP) is a tool to use the reference from the synthetic frame to improve coding efficiency. However, it is costly in terms of number of computations and amount of required storage to perform per-pixel warping. An inter-view skip mode is proposed to eliminate full frame view synthesis for reducing the computational complexity, memory bandwidth, and buffer. When turning off VSP and utilizing the proposed inter-view skip mode, the experimental results reportedly show an average of 10% decoding time saving with 0.21% BD-rate reduction for synthesized pictures over the total bit-rate.

In contrast to VSP and VSP skip/direct, the proposed approach avoids full-frame view synthesis and uses block-level motion compensation instead. This method is only applied to the texture of dependent views and determines 4x4 disparity vectors based on depth data from the dependent view.

Discussion: There was a question on the decoding order for texture and depth view components. It was noted by the proponents that that decoding order must be depth-first for the dependent views.

[**JCT2-A0063**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=55)**/**[**m25987**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39147&id_meeting=153) **3D-CE1.a: Cross check on interview skip/direct mode with sub-partition scheme of MediaTek (JCT2-A0050) [Ilsoon Lim, Jin Young Lee (Samsung)] [late]**

[**JCT2-A0056**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=48)**/**[**m25933**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39093&id_meeting=153) **3D-CE1.a related: improvement on NTT’s synthesis with fractional disparity [Yin Zhao, Lu Yu (Zhejiang Univ.)]**

This contribution proposes a method to derive the sub-pel disparities depending on whether a sample falls along depth edges and within a non-edge area. This method aims to improve the geometric accuracy of warped pixels at depth discontinuities, and may be a potential replacement of the boundary-aware splatting process in the current view synthesis software. It is reported that the method provides a 0.1% bit rate reduction for texture coding with negligible change in decoding time.

Discussion: It was remarked that this method is already supported in the rendering software used for HEVC-based experiments, and there appears to be support to add this into the AVC-based rendering software as well since the method has could improve the subjective quality (as a post-process). However, the benefits of applying this approach within the loop are not clear and there were concerns on adopting this method as an in-loop operation.

[**JCT2-A0023**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=123)**/**[**m26094**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39255&id_meeting=153) **CE1.a related results on the modification of in-loop view synthesis [Shinya Shimizu, Shiori Sugimoto, Hideaki Kimata (NTT)]**

This contribution presents a simplified warping process for view synthesis prediction. This technique was previously proposed in m25195 and implemented in the view synthesis reference software (VSRS-1D-Fast). In the proposed method, the processing direction of the pixel-wise warping is inverted. Also, the hole-filling and inpainting is simplified. Experimental results on the common test condition show that there is negligible impact on encoding or decoding time, but it is reported that the proposed method can reduce memory requirements since no z-buffering is necessary. When applied for texture coding of dependent views, an average BD-rate improvement of 0.53% was reported since more accurate disparities become available to be utilized. The maximum gain was 1.12% for Undo\_Dancer sequence.

* + 1. **Conclusions**

Revisit potential adoptions and future CE plans

* 1. ***CE1.h: View synthesis prediction***
     1. **Summary**

[**JCT2-A0009**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=15)**/**[**m25801**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=38961&id_meeting=153) **3D-CE1.h summary report: View synthesis and inter-view prediction [Fabian Jäger (RWTH Aachen University)]**

The summary report notes one CE contribution from NTT/Mitsubishi (JCT2-A0018), which reports improvements in coding efficiency and complexity reductions, as well as one CE related contribution (JCT2-A0086) from LG.

* + 1. **CE Contributions**

[**JCT2-A0018**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=109)**/**[**m26085**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39245&id_meeting=153) **3D-CE1.h Results on View Synthesis Prediction [Shinya Shimizu, Shiori Sugimoto, Hideaki Kimata (NTT), Dong Tian, Feng Zou, Anthony Vetro (MERL)]**

View synthesis prediction (VSP) is a technique to remove inter-view redundancies when coding multiview video information, which uses a synthetic picture as a reference picture to predict the current picture. This contribution first proposes inserting synthetic pictures to reference picture lists, consistent with the scheme in ATM. This document reports an average bitrate saving of -2.6% and -0.4% for the dependent views, with maximum gains of -9.9% and -5.8% for these views. The benefit of VSP for depth coding has also been investigated, but the result is not yet conclusive.

This contribution further proposes a VSP skip mode which enables the skip mode relative to the synthetic reference picture. There are two methods to achieve this: additional block-level signalling as done in ATM, and utilizing the existing merge syntax in HEVC. The first approach has been implemented, but degrades performance. The second approach is expected to have better performance, but the implementation has not been completed yet. In general, further study is required to evaluate the different skip mode designs.

Lastly, when VSP is enabled, this contribution proposes to simplify the rendering process in HTM, which would reduce the decoding time by 4% if VSP is only applied to texture, or 20% if VSP is applied to both texture and depth.

This proposal recommends: 1) adopting VSP by adding the view synthesis picture to the reference picture lists for texture and depth into HTM; 2) adopting the simplified rendering process into HTM; 3) continue to study VSP skip in CE1.h; and 4) explore further simplifications of the rendering process.

Discussion: Remark that we should be cautious in adopting this proposal since the gains are mixed with non-negligible increase in decoder time. However, it was mentioned that block-level synthesis and backward warping approaches explored in ATM could also apply in this context.

Discussion: Remark that stereo compatibility would also be lost if this proposal were adopted. However, this is something that could be considered as part of a profiling discussion.

[**JCT2-A0092**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=84)**/**[**m26024**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39184&id_meeting=153) **3D-CE1.h: Cross check on Mitsubishi-NTT joint proposal [Jin Young Lee, Byung Tae Oh, Ilsoon Lim (Samsung)] [late]**

* + 1. **Related Contributions**

[**JCT2-A0086**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=78)**/**[**m26038**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39198&id_meeting=153) **3D-CE1.h related: Illumination Compensation for Dependent Views Coding [Hongbin Liu (LG Electronics)]**

Presenters not available (Saturday AM)

[**JCT2-A0154**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=171)**/**[**m26185**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39346&id_meeting=153) **3D-CE1.h related: Cross-check report of JCT2-A0086 on Illumination Compensation for Dependent Views Coding [Shinya Shimizu (NTT)] [miss] [late]**

* + 1. **Conclusions**

Revisit recommended adoptions from JCT2-A0018.

* 1. ***CE2: Depth representation and coding***
     1. **Summary**

[**JCT2-A0089**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=81)**/**[**m26045**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39205&id_meeting=153) **CE2 summary report: depth representation and coding [Olgierd Stankiewicz (Poznan Univ. of Technology)]**

The summary report notes that there is one contribution from KWU and ETRI registered as JCT2-A0016, but this method reports a loss. As a result, these organizations propose to discontinue the CE.

Discussion: It was noted that this is the second meeting without substantial contribution on this CE. Although some proponents (namely, Poznan and Samsung) propose to continue the CE, it was believed that there is not sufficient justification to continue the CE and that any new results should be submitted when they become available.

* + 1. **CE Contributions**

[**JCT2-A0016**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=107)**/**[**m26082**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39242&id_meeting=153) **3DV-CE2.h adaptive quantization for depth map (AQD) [Junghak Nam, Sunmi Yoo, Hyomin Choi, Hyunho Jo, Donggyu Sim(KWU), Gun Bang, Won-Sik Cheong, Namho Hur(ETRI)] [late]**

This contribution reported the results of adaptive quatization for depth map (AQD) that was proposed at the previous meeting. Experimental results are reported that achieve bitrate increases of approximately 0.1% and 0.1% for 3-view and 2-view cases in terms of synthesized quality, respectively. Given this performance, the proposal was withdrawn.

* + 1. **Conclusions**

Due to the lack of contribution and progress for two consecutive meeting cycles, it is recommended that this CE be discontinued. Further contributions in this area are encouraged.

* 1. ***CE3: Depth map resampling and filtering***
     1. **Summary**

[**JCT2-A0106**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=98)**/**[**m26068**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39228&id_meeting=153) **3D-CE3 summary report: Depth resampling and filtering [Dmytro Rusanovskyy (Nokia)]**

CE3 was established to evaluate depth map resampling and filtering solution for improved coding efficiency and to resolve problems with visual artifacts introduced to synthesized views due to resampling of the depth map data.

Two proposals related to normative tools were submitted:

* JCT2-A0037 presents an adaptive range filter as an in-loop filter to improve coding efficiency. This filter replaces the current deblocking filter of AVC. Reported results are -0.6% bit rate reduction for coded views, 6% bit rate reduction for depth map data and 1.7% bit rate reduction for synthesized views. The estimated decoding time of the proposed method was reported to be in the range of 104% to 110% when the deblocking filter was disabled.
* JCT2-A0108 proposes to enable the existing AVC deblocking filter for depth map coding. Reported results are 0.2% bit rate reduction for coded views, 6.8% bit rate reduction for depth map data and 0.7% bit rate reduction for synthesized views. The estimated decoding time was reported as 104% of the anchor.

It was also reported that a combination of non-normative pre- and post-processing (i.e., depth resampling) provides an average of 5.9% bit rate reduction, while the combination with existing deblocking filter enabled for depth provides an average bit rate reduction of 6.6%. A notable reduction in visual artifacts was shown on sample frames, but visual results for video need to be confirmed with viewing during the week.

* + 1. **CE Contributions**

[**JCT2-A0037**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=29)**/**[**m25884**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39044&id_meeting=153) **3D-CE3.a results on region based adaptive loop filter [Ilsoon Lim Ho-Cheon Wey Jaejoon Lee Du Sik Park (Samsung)]**

This contribution present a new depth map coding scheme to improve coding efficiency. For this purpose, an adaptive range filter that restores the coded depth maps in accordance with the estimated noise variance is proposed. More specifically, each pixel is classified in such a way that the distortion cost is minimized and is restored depending on local noise level. The restored picture is used for the motion-compensated prediction of future pictures with the aim to improve coding efficiency. The document reports results that show a 0.60% bit rate reduction on coded data and a 1.70% bit rate reduction on synthesized views. Additional results were reported that the proposed method provides additive gains when combined with a post-processing filter (e.g., the dilation filter proposed in a related contribution).

Discussion: It was remarked that the existing normative deblocking method provides 0.44% gain on decoded views, while the proposed method provides 0.6% gain with deblocking disabled, so it was therefore considered incremental relative to the capabilities of existing tools.

[**JCT2-A0147**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=163)**/**[**m26165**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39326&id_meeting=153) **3D-CE3.a: Cross check report of JCT2-A0037 on region based adaptive loop filter of Samsung [G. Bang (ETRI), K.Y. Kim, Y.S. Heo, G.H. Park(KHU), W.S. Cheong, N.H. Hur(ETRI)] [late]**

[**JCT2-A0108**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=100)**/**[**m26070**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39230&id_meeting=153) **3DV-CE3: Enabling H.264/AVC deblocking for depth map coding in 3DV-ATM [Dmytro Rusanovskyy (Nokia), Payman Aflaki (TUT), Miska M. Hannuksela (Nokia)]**

This contribution proposes to enable the existing AVC deblocking filter for coding depth map data. The simulation results presented in this document show that the deblocking results achieve a bit rate reduction of 6.7% for depth map data. It was asserted that the improved quality depth map achieves a 0.3% bit rate reduction on the texture and a 0.7% bit rate reduction on the synthesized views.

[**JCT2-A0038**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=30)**/**[**m25885**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39045&id_meeting=153) **3D-CE3.a results on dilation filter for depth post processing [Seok Lee Seungsin Lee Ho-Cheon Wey Jaejoon Lee Du Sik Park (Samsung)]**

A depth post-filtering using dilation filter is evaluated in this proposal. It is reported that the proposed post-filter achieves a 4.47% bit rate reduction on the synthesized views with the deblocking filter enabled, and a 4.35% bit rate reduction with the deblocking filter disabled. It was also asserted that the post filtering with dilation filter also improves the visual quality of synthesized views at boundary regions.

[**JCT2-A0136**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=152)**/**[**m26134**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39295&id_meeting=153) **3DV-CE3: Cross-check of Samsung proposal for 3DV-ATM Post-Processing by Nokia [Payman Aflaki, Dmytro Rusanovskyy (Nokia)]**

[**JCT2-A0060**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=52)**/**[**m25967**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39127&id_meeting=153) **3D-CE3.a results on depth boundary filtering as post-processing by GIST [Yunseok Song, Cheon Lee, Yo-Sung Ho (GIST)] [late]**

The proposed filter aims to refine depth boundary regions to improve the quality of synthesized images. The filter is applied as post-processing of depth upsampling. Due to an unexpected memory error, 1920x1088 sequences were not tested by the proponents. A bit rate reduction of 2.32% and 2.59% on the synthesized views were achieved when the deblocking filter was enabled and disabled for depth, respectively. However, a large increase in decoder time of approximately 350-400% was observed.

[**JCT2-A0066**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=58)**/**[**m25990**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39150&id_meeting=153) **3D-CE3.a: Cross check on depth boundary filter of GIST [Ho-Cheon Wey, Seok Lee, Seungsin Lee, Ilsoon Lim (Samsung)] [late]**

The cross check report from Samsung indicates a match for SD sequences. In this report, synthesized gains were 3.18% and 3.53% for deblocking enabled/disabled when including HD sequences.

* + 1. **Related Contributions**

[**JCT2-A0039**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=31)**/**[**m25887**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39047&id_meeting=153) **3D-CE3.a related results on depth hybrid post filter [Seok Lee Seungsin Lee Ho-Cheon Wey Jaejoon Lee Du Sik Park (Samsung)]**

A hybrid post-filtering method is proposed that utilizes a dilation filter and a filter based on a local segmentation. The document asserts that coding performance can be improved by identifying the type of depth maps using a proper method and by applying the proposed hybrid filter. The proposed post filter achieves a bit rate reduction of 5.69% on synthesized views with the deblocking filter turned on, and a 5.69% bit rate reduction with the deblocking filter turned off. However, a notable increase in decoder complexity was observed: 193.7% and 177.6% decoding time for deblocking filter on and deblocking filter off, respectively. It was noted that the proposal has not been cross-checked. Also, the proponents are considering further improvements and report that these may be submitted to the next meeting.

[**JCT2-A0109**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=101)**/**[**m26071**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39231&id_meeting=153) **3DV-CE3.a: Non-linear Depth Map Upsampling for 3DV-ATM Coding [Payman Aflaki (TUT), Dmytro Rusanovskyy (Nokia), Miska Hannuksela (Nokia)]**

3DV-ATM utilizes coding of depth map data at reduced spatial resolution. After decoding of depth map it is upsampled to its original resolution prior to rendering of virtual views. In the current implementation, a basic bi-linear up-sampling is utilized at the post-processing stage of 3DV-ATM. This contribution proposes a non-linear depth map up-sampling method as a post-processing. Simulation results show that proposed method achieved a 0.96% bit rate reduction on synthesized views when the AVC deblocking filter is disabled for depth. When the AVC deblocking is enabled, the proposed scheme achieves a 1.13% bit rate reduction on synthesized views. In addition to the objective gain, it is asserted by the proponent that proposed method provides a reduction in visual artifacts of synthesized views comparing with the anchor approach (i.e. bi-linear up-sampling).

[**JCT2-A0064**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=56)**/**[**m25988**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39148&id_meeting=153) **3D-CE3.a: Cross check on depth post processing of Nokia [Ho-Cheon Wey, Seok Lee, Seungsin Lee, Ilsoon Lim (Samsung)] [late]**

[**JCT2-A0110**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=102)**/**[**m26072**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39232&id_meeting=153) **3DV-CE3: Non-linear Depth Map Downsampling for 3DV-ATM Coding (Pre-processing) [Payman Aflaki (TUT), Dmytro Rusanovskyy (Nokia), Miska M. Hannuksela (Nokia)]**

3DV-ATM utilizes coding of depth map data at reduced spatial resolution. After decoding, depth map is upsampled to its original resolution and utilized for rendering of virtual views. The CTC specifies that a low resolution depth map data is produced with the JSVM down-sampling filters. Such a low pass filter can introduce an over-smoothing in the depth map and lead to noticeable visual artifacts in the synthesized views.

This contribution proposes to replace the downsampling method for depth map with a non-linear downsampling. Results show that proposed downsampling method provides a bit rate reduction of 4.5% for synthesized views. When combined with non-anchor depth map up-sampling method, these non-normative tools improve provide a 5.9% bit rate reduction. Additionally, it is asserted that proposed non-normative tool significantly reduce visual artifacts that results from downsampling of the depth map.

[**JCT2-A0065**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=57)**/**[**m25989**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39149&id_meeting=153) **3D-CE3.a: Cross check on depth pre/post processing of Nokia [Ho-Cheon Wey, Seok Lee, Seungsin Lee, Ilsoon Lim (Samsung)] [late]**

[**JCT2-A0155**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=172)**/**[**m26188**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39349&id_meeting=153) **Sampling filters for depth map video for 3DV (CE3 related) [W Dai, M Krishnan, P Topiwala (FastVDO)] [late]**

Presenters not available (Saturday AM)

* + 1. **Conclusions**

Plan CE3 viewing based on inputs from Samsung, Nokia and GIST (non-normative tool combinations) – Monday evening, target 7pm

Revisit proposed adoptions including non-normative adoptions to test model and reference software, as well as normative tools.

* 1. ***CE5.a: Motion/mode parameter prediction***
     1. **Summary**

[**JCT2-A0043**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=35)**/**[**m25912**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39072&id_meeting=153) **3D-CE5.a summary report: motion/mode parameter prediction [Yu-Lin Chang (MediaTek)]**

The summary report notes that there was one CE contribution from MediaTek (JCT2-A0045) and four CE related contributions from Samsung (JCT2-A0040/A0041), MediaTek (JCT2-A0046) and Nokia (JCT2-A0111). The main aspects of these contributions are summarized below.

* JCT2-A0045 (MediaTek): This proposal explicitly signals the MVP index to the decoder. The contribution reports a 9.2% BD-Rate reduction for texture and a 7.2% BD-Rate reduction for coded and synthesized views with slight reduction in decoding complexity.
* JCT2-A0040 (Samsung): This contribution proposes to change the coefficient of the depth-to-disparity function to a shifting parameter.
* JCT2-A0041 (Samsung): This contribution proposes to employ the corresponding and reference depth maps with quarter resolution.
* JCT2-A0041 (MediaTek): This contribution proposes a simplification to derive the disparity vector from a maximum depth value of four corner depth samples.
* JCT2-A0111 (Nokia): This contribution proposes to disable DMC for VSP as a simplification to reduce the decoding time.

The summary report recommends adopting the MV competition-based skip/direct mode with explicit signaling of the MVP index as proposed in m24847 with the size of the MVP list fixed to 1. It was noted that this method provides best performance and avoids the complexity and memory access bandwidth issue caused by the depth-based motion vector competition (DMC) in the ATM. The summary report also suggests further investigating other related ideas in a continued CE. There was favorable support from the group on these recommendations and no objections or concerns were raised.

* + 1. **CE Contributions**

[**JCT2-A0045**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=37)**/**[**m25916**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39076&id_meeting=153) **3D-CE5.a results on motion vector competition-based Skip/Direct mode with explicit signaling [Jian-Liang Lin, Yi-Wen Chen, Yu-Lin Chang, Yu-Pao Tsai, Yu-Wen Huang, Shawmin Lei (MediaTek)]**

This contribution reports the results of various tests to confirm the efficiency of the proposed motion prediction tool proposed in m24847 compared to the existing depth-based motion vector competition (DMC) tool in the ATM. The anchor used in the tests turns DMC off for the skip and direct modes, which falls back to the median-based derivation of the motion vector predictor (MVP) as done in AVC.

The results are summarized as follows. In experiments T01 and T02, the MV competition-based skip/direct mode with explicit signaling of the MVP index as proposed in m24847 is tested with the size of the MVP list fixed to 1 and 2, respectively. In T01, which fixes the size of the MVP list to 1, 9.2% BD-Rate reduction can be achieved for texture coding and 7.2% BD-Rate reduction can be achieved for synthesized pictures over the total bit-rate (texture + depth). In T02, which fixes the size of the MVP list to 2, BD-Rate reductions of 5.1% and 3.2% are achieved for texture coding and synthesized results, respectively. T03 is conducted to evaluate the performance of DMC for the skip and direct modes. The results show that DMC for the skip and direct modes achieves 2.5% and 2.3% BD-Rate reduction for texture coding and synthesized results, respectively.

Discussion: It was requested that specification text be provided so that all aspects of this proposal are clear. The proponents agreed to provide the text during this week for review.

**[JCT2-A0020](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=112)/**[**m26087**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39247&id_meeting=153) **3D-CE1.a: Cross check on MediaTek Proposal on Motion Vector Competition-Based Skip/Direct Mode JCT2-A0045 [Dong Tian, Anthony Vetro (MERL)]**

[**JCT2-A0078**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=70)**/**[**m26023**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39183&id_meeting=153) **3D-CE5.a: Cross check on motion vector competition-based skip/direct mode with explicit signaling (JCT2-A0045) [Jin Young Lee (Samsung)]**

[**JCT2-A0101**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=93)**/**[**m26056**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39216&id_meeting=153) **3D-CE5.a: cross-check result on JCT2-A0045 [Tadashi Uchiumi, Yoshiya Yamamoto, Tomohiro Ikai (Sharp)]**

[**JCT2-A0129**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=145)**/**[**m26117**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39278&id_meeting=153) **3D-CE5.a: Cross check of JCT2-A0045 on motion vector competition-based Skip/Direct mode with explicit signaling [X. Zhao (Qualcomm)] [miss] [late]**

[**JCT2-A0148**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=164)**/**[**m26166**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39327&id_meeting=153) **3D-CE5.a: Cross check report of JCT2-A0045 on motion vector competition-based Skip/Direct mode with explicit signaling of MediaTek [G. Bang (ETRI), K.Y. Kim, Y.S. Heo, G.H. Park(KHU), W.S. Cheong, N.H. Hur(ETRI)]**

* + 1. **Related Contributions**

[**JCT2-A0040**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=32)**/**[**m25889**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39049&id_meeting=153) **3D-CE5.a related results on improved skip and direct motion vector prediction [Jin Young Lee, Jaejoon Lee, Du-Sik Park (Samsung), Tadashi Uchiumi, Yoshiya Yamamoto (Sharp)]**

This proposal presents an improved skip and direct motion vector prediction on the top of the current depth-based motion vector prediction and the new competition-based skip and direct motion vector prediction. It is reported that the proposed method reduces the bit rate by 0.2% on coded date with 4% reduction in decoding complexity due to modifying the depth-to-disparity function to a shift operation.

This was considered by the group to be a relatively minor change and there were no objections or concerns raised on adopting this change.

[**JCT2-A0051**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=43)**/**[**m25924**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39084&id_meeting=153) **Cross-check report for M25889 on CE5.a related: improved skip and direct motion vector prediction [Yi-Wen Chen, Jian-Liang Lin, Yu-Wen Huang (MediaTek)] [miss] [late]**

[**JCT2-A0028**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=128)**/**[**m26099**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39260&id_meeting=153) **3D-CE5.a related: Cross-check report of JCT2-Axxxx on Samsung's proposal1 [Shinya Shimizu (NTT)]**

[**JCT2-A0041**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=33)**/**[**m25890**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39050&id_meeting=153) **3D-CE5.a related results on depth-based motion vector prediction for asymmetric texture and depth resolutions [Jin Young Lee Jaejoon Lee Du Sik Park (Samsung)]**

This contribution proposes to remove the up-sampling process when the D-MVP process is invoked. The method is also evaluated with respect to the recently proposed competition-based skip and direct motion vector prediction proposed in JCT2-A0045. It is demonstrated that the proposed method reduces the decoding complexity by 11% in the current ATM and by 4% with the method of JCT2-0045, with negligible impact on coding performance.

Discussion: A related contribution suggests a 6% reduction by removing the up-sampling. The proponents noted that the discrepancy was likely due to the difference in computing platforms, but the group thought that this was a larger difference than expected.

[**JCT2-A0052**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=44)**/**[**m25925**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39085&id_meeting=153) **Cross-check report for M25890 on CE5.a related: depth-based motion vector prediction for asymmetric texture and depth resolutions [Yi-Wen Chen, Jian-Liang Li, Yu-Wen Huang (MediaTek)] [miss] [late]**

[**JCT2-A0029**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=129)**/**[**m26100**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39261&id_meeting=153) **3D-CE5.a related: Cross-check report of JCT2-Axxxx on Samsung's proposal2 [Shinya Shimizu (NTT)]**

[**JCT2-A0046**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=38)**/**[**m25917**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39077&id_meeting=153) **3D-CE5.a related: Simplification on the disparity vector derivation for AVC-based 3D video coding [Jian-Liang Lin, Yi-Wen Chen, Yu-Wen Huang, Shawmin Lei (MediaTek)]**

In the AVC-based 3D video coding, a direction-separated MVP is utilized for the temporal and inter-view motion vector predictions in the inter mode. When the reference picture is an inter-view prediction picture, the inter-view motion vectors of the adjacent blocks are employed for the inter-view prediction. If an inter-view motion vector is unavailable, it is replaced by a disparity vector derived from a maximum depth value within the depth block associated with current block. This contribution proposes a simplification to derive the disparity vector from a maximum depth value of four corner depth samples instead of all depth samples within the associated depth block. With this simplification, the number of the depth samples to be accessed can be reduced from 256 to 4 and the number of the required comparisons can also be reduced from 255 to 3. The experimental results reportedly show that this proposed simplification does not cause any coding loss.

Discussion: It was remarked that this method could also be applied to HTM.

[**JCT2-A0128**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=144)**/**[**m26116**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39277&id_meeting=153) **3D-CE5.a related: Cross check of JCT2-A0046 on simplified derivation of disparity vector [X. Zhao (Qualcomm)] [miss] [late]**

[**JCT2-A0111**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=103)**/**[**m26073**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39233&id_meeting=153) **3DV-CE5.a: Modified DMVP for purposes of View Synthesis Prediction (Bug-fix) [Wenyi Su (USTC), Dmytro Rusanovskyy (Nokia), Miska M. Hannuksela (Nokia)]**

This contribution asserts that current ATM design utilizes two contradicting approaches to select VSP\_SKIP and VSP\_DIRECT modes. The first approach determines whether to select VSP\_SKIP or VSP\_DIRECT through a Depth-based Motion Competition (DMC). In this scheme a synthesized depth map is utilized for the mode derivation at the decoder side and no signaling is required. The second approach is the explicit signaling of VSP\_SKIP and VSP\_DIRECT modes with a flag for which the encoder performs mode selection using the Rate-Distortion Optimization. The latter scheme overwrites the decision making of the DMC and uses explicit signalling even if it is not required by the DMC design. To resolve these conflicting approaches it is proposed to disable the DMC for VSP. Simulation results show that proposed scheme provides less than 0.1% bit rate increase on the coded data, but it provides about 5% reduction in decoding time. This proposal is consistent with the information and results provided in JCT2-A0107.

[**JCT2-A0067**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=59)**/**[**m25991**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39151&id_meeting=153) **3D-CE5.a: Cross check on DMVP simplification of Nokia [Kwan-Jung Oh, Jin Young Lee (Samsung)]**

* + 1. **Conclusions**

There seems to be support for adopting JCT2-A0045. Revisit other contributions, i.e., whether to adopt some bug fixes and simplifications and whether other aspects need to be studied further in the CE.

* 1. ***CE5.h: Motion/mode parameter prediction***
     1. **Summary**

[**JCT2-A0076**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=68)**/**[**m26021**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39181&id_meeting=153) **CE5.h Summary Report: Motion/Mode Parameter Prediction [Sehoon Yea (LG Electronics)]**

Two options within the HTM reference software for disparity vector generation were made available as per the decisions at the previous meeting: (a) the PDM-based approach; and (b) inter-view motion vector-based approach which is the result of harmonization of m25024, m24989, m24937. The mandates of the CE included investigating the potential benefits of combining global disparity vector with the inter-view motion vector-based approach. In this investigation, the inter-view motion vector-based approach (i.e., option B above) is used as an anchor. The CE also aimed to compare the pros and cons of the two approaches (i.e., options A and B) for generating disparity vector in terms of coding efficiency and complexity.

The summary report notes that there is one CE contribution (JCT2-A0097) and 11 related proposals, which have been grouped as follows:

1. PDM-based approach (Option A): A0013, A0031, A0047, A0095
2. Interview motion-vector approach (Option B): A0097, A0126
3. Modification of Merge/AMVP-list construction: A0014, A0048, A0049, A0096, A0133, A0134
   * 1. **CE Contributions**

[**JCT2-A0097**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=89)**/**[**m26052**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39212&id_meeting=153) **3D-CE5.h: Disparity vector generation results [L. Zhang, Y. Chen, M. Karczewicz (Qualcomm)]**

In the current 3DV-HTM software, disparity vectors can be estimated by two methods, and are used for inter-view motion prediction and inter-view residual prediction. One method is to maintain a depth map for each picture of each view and the depth map is generated from disparity motion vectors and predicted by propagating the depth map to a different time instance with temporal motion vectors and propagating the depth map to a different view using view synthesis. The other method, as proposed in m24937, derives a disparity vector from spatial and temporal neighboring blocks, once a disparity motion vector in any of the blocks is identified, the disparity vector is derived. The coding efficiency of the two methods is analyzed. It is reported that deriving the disparity vector from neighboring blocks will significantly reduce the complexity with negligible impact on compression efficiency, where the complexity analysis includes required memory and implementation impact on hardware design. The proponents recommend adopting this proposal.

Discussion: The group appeared to express favorable support to adopt this proposal.

[**JCT2-A0156**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=173)**/**[**m26196**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39357&id_meeting=153) **3D-CE5.h: Cross check report on Disparity vector generation results of Qualcomm [Jaewon Sung, Sehoon Yea (LG Electronics)] [late]**

* + 1. **Related Contributions**

[**JCT2-A0013**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=19)**/**[**m25842**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39002&id_meeting=153) **3D-CE5.h related: Simplification of depth-based inter-view prediction [Tadashi Uchiumi, Tomohiro Ikai, Yoshiya Yamamoto (Sharp)]**

This contribution proposes a technique is for the PDM-based approach with disparity vector generation. The proposal decreases number of samples needed for deciding the disparity vector from a PDM block. Specifically, four corner samples in a PDM block are used regardless of the PU size. The simulation result reports that there is no coding loss on average.

[**JCT2-A0080**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=72)**/**[**m26026**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39186&id_meeting=153) **3D-CE5.h: Cross check on simplification of depth-based inter-view prediction of Sharp [Jin Young Lee (Samsung)]**

[**JCT2-A0014**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=20)**/**[**m25843**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39003&id_meeting=153) **3D-CE5.h related: Simplification of AMVP [Yoshiya Yamamoto, Tomohiro Ikai, Tadashi Uchiumi (Sharp)]**

This contribution presents a simplified motion vector candidate construction for AMVP. The proposed method adds a zero vector to the candidate list when first predictor (derived by inter-view motion prediction) is not available and changes the pruning combination to avoid the unnecessary candidate motion vector derivation process. It is reported that average BD-rate of the proposal is not changed from that of the anchor. This method decouples the inter-view candidate derivation and normal AMVP candidate derivation.

Discussion: It was asked whether other candidates were tested. The proponents mentioned that other candidates were tested, but the zero-vector candidate worked best.

[**JCT2-A0143**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=159)**/**[**m26151**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39312&id_meeting=153) **3D-CE5.h related: Cross-check report of JCT2-A0014 on simplification of AMVP [Y. Takahashi, S. Hattori, T. Suzuki (Sony)] [late]**

[**JCT2-A0031**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=23)**/**[**m25894**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39054&id_meeting=153) **3D-CE5.h related results on improved inter-view residual and motion parameter prediction [Jin Young Lee, Byeongdoo Choi, Jaehyun Kim, Jaejoon Lee, Jeonghoon Park, Du Sik Park (Samsung)]**

This proposal introduces an improved residual prediction based on the estimated depth image that uses the maximum disparity instead of the middle sample of an associated block. The proposed method achieves a bit reduction of 0.1% with no change in encoding and decoding time.

[**JCT2-A0141**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=157)**/**[**m26139**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39300&id_meeting=153) **3D-CE5.h related: Cross-check report of JCT2-A0031 on improved residual prediction [Shinya Shimizu (NTT)] [miss] [late]**

[**JCT2-A0047**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=39)**/**[**m25918**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39078&id_meeting=153) **3D-CE5.h related: Simplification on disparity vector derivation for HEVC-based 3D video coding [Jian-Liang Lin, Yi-Wen Chen, Yu-Wen Huang, Shawmin Lei (MediaTek)]**

In the HEVC-based 3D video coding, a disparity vector derived from the depth values is used to locate a corresponding block for the inter-view motion prediction in the merge, skip and inter modes, where the disparity vector is derived from a maximum depth value within the depth block associated with the current PU. In this contribution, a simplification is proposed to derive the disparity vector from a maximum depth value of four corner depth samples instead of all depth samples within the associated depth block. With this simplification, the number of the depth samples to be accessed can be significantly reduced from 256 to 4 and the number of the required comparisons can also be reduced from 255 to 3 when a 64x64 PU is coded. The experimental results also reportedly show that this proposed simplification can even achieve slight coding gain (0.2% BD-rate reduction for view 1). It was noted that the proposed method is similar to JCT2-A0013 (proposed by Sharp).

[**JCT2-A0160**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=170)**/**[**m26184**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39345&id_meeting=153) **3D-CE5.h related: Cross Check of Disparity Vector Derivation Simplification by MediaTek (JCT2-A0047) [J. Jung, K. Viswanathan, (Orange Labs)] [miss] [late]**

[**JCT2-A0048**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=40)**/**[**m25919**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39079&id_meeting=153) **3D-CE5.h related: Pruning process for inter-view candidate [Jian-Liang Lin, Yi-Wen Chen, Yu-Wen Huang, Shawmin Lei (MediaTek)]**

In the HEVC-based 3D video coding, a number of parallelizable motion information comparisons between the spatial merging candidates are performed for the redundancy removal in the candidate list of the merge and skip modes. This contribution proposes to make one additional parallelizable motion information comparison between the inter-view candidate and the first spatial candidate in the pruning process. This contribution also proposes to remove the check on the number of available candidates before the pruning process in the inter mode for simplification. The experimental results reportedly show BD-rate savings of 0.2% and 0.4% are achieved for texture view 1 and view 2, respectively, with this simple candidate comparison.

Discussion: Proposed simplification appears to be beneficial, and enables a small gain.

Discussion: Were comparisons made to JCT2-A0096? Both include the inter-view candidate in the pruning process. But, JCT2-A0096 requires five additional comparisons, while the proposed approach requires only one between inter-view and spatial candidate (A1). It is claimed that the processing latency is not increased and parallel processing capability is not affected with the proposed method.

[**JCT2-A0079**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=71)**/**[**m26025**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39185&id_meeting=153) **3D-CE5.h: Cross check on pruning process for inter-view candidate of MediaTek (JCT2-A0048) [Jin Young Lee (Samsung)] [miss] [late]**

[**JCT2-A0049**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=41)**/**[**m25920**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39080&id_meeting=153) **3D-CE5.h related: Inter-view motion prediction for HEVC-based 3D video coding [Jicheng An, Yi-Wen Chen, Jian-Liang Lin, Yu-Wen Huang, Shawmin Lei (MediaTek)]**

In this contribution, two methods are proposed to simplify and to improve the inter-view motion prediction in the merge, skip and inter modes in the HEVC-based 3D video coding. First, a constraint is applied to the inter-view motion prediction which only refers to one inter-view picture to derive the inter-view motion parameters. Second, it is proposed to improve the derivation of the inter-view merging candidate in the merge and skip modes. Following the concept for deriving the spatial merging candidate, the same motion parameters (prediction direction, reference pictures, and motion vectors) as those of the corresponding block in the inter-view picture are directly used as an inter-view merging candidate. When the two proposed methods are combined, 1.1% and 1.4% BD-Rate gains can be reportedly achieved for texture view 1 and view 2, respectively, and 0.3% total BD-Rate gain is reportedly achieved for coded and synthesized views. Moreover, the proposed constraint can provide a systematical way to manage the reconstructed motion data by synchronizing the reconstructed motion data buffer with the decoded picture buffer.

Discussion: It was remarked by the group that the first part of the proposal can be considered a bug fix, similar to JCT2-A0095.

[**JCT2-A0139**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=155)**/**[**m26137**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39298&id_meeting=153) **3D-CE5.h related: Cross check of Inter-view motion prediction of MediaTek [L. Zhang (Qualcomm)] [late]**

[**JCT2-A0095**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=87)**/**[**m26050**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39210&id_meeting=153) **3D-CE5.h related: Bug fix for independent estimated depth maps of non-base views in CTC [L. Zhang, Y. Chen, M. Karczewicz (Qualcomm)]**

In the current HTM, the estimated disparity map of the second non-base view depends on the estimated disparity map of the first non-base view. However, it was asserted that during the previous meeting there was agreement that the two non-base views, each with the base view corresponds to a stereo operation point, shall be independently decodable in the Common Test Condition (CTC), mainly due to the fact that no inter-view texture prediction between the non-base views is used. Therefore, the second non-base view depends on the first non-base view for decoding, which is considered a bug of the current HTM software by the proponents. In this contribution, this bug is fixed in a way that a first depth map frame associated with each frame in base view is maintained for the first non-base view while the second depth map frame associated with each frame in base view is maintained for the second non-base view and there is no interaction between them. Compression efficiency loss of 0.1% is reported.

Discussion: There was a question on whether the requirement for the two non-base views to have stereo compatibility is too strict as a requirement for the specification. It was clarified that this proposal applies to the reference software only and is done to satisfy the conditions of the CTC.

[**JCT2-A0132**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=148)**/**[**m26122**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39283&id_meeting=153) **3D-CE5.h related: Cross check of independent estimated depth maps of Qualcomm [Heiko Schwarz, Gerhard Tech (Fraunhofer HHI)]**

[**JCT2-A0142**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=158)**/**[**m26150**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39311&id_meeting=153) **3D-CE5.h related: Cross-check report of JCT2-A0095 on bug fix for estimated depth maps [Y. Takahashi, S. Hattori, T. Suzuki (Sony)] [late]**

[**JCT2-A0096**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=88)**/**[**m26051**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39211&id_meeting=153) **3D-CE5.h related: Improved merge mode for inter-view predicted motion [L. Zhang, Y. Chen, M. Karczewicz (Qualcomm)]**

When inter-view motion prediction is enabled, the current HTM design of the merging candidate list includes an inter-view candidate from a dependent view. However, an inter-view candidate might be identical to existing spatial merging candidates in the merging candidate list. It is proposed to remove duplicated motion vector candidates with one additional step of pruning. Compared to the current HTM design, the proposed method achieves compression efficiency gain of 0.2%, 0.1% and 0.1% for coded views, synthesized views, coded and synthesized views, respectively, in terms of BD-Rate.

This contribution is related to JCT2-A0048; see notes on comparison between the two approaches under JCT2-A0048.

[**JCT2-A0157**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=174)**/**[**m26197**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39358&id_meeting=153) **3D-CE5.h related: Cross check report on Improved merge mode for inter-view predicted motion of Qualcomm [Jaewon Sung, Sehoon Yea (LG Electronics)] [late]**

[**JCT2-A0126**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=142)**/**[**m26079**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39239&id_meeting=153) **3D-CE5.h: Simplification of disparity vector derivation for HEVC-based 3D video coding [Jaewon Sung, Moonmo Koo, Sehoon Yea (LG Electronics)]**

For inter-view motion parameter prediction and inter-view residual prediction, a disparity vector should be determined to specify a corresponding location in an inter-view reference picture. During the last meeting, a disparity vector derivation algorithm, which searches DCP blocks in spatial and temporally neighboring blocks, was included in the HTM software. This contribution proposes an efficient disparity vector derivation algorithm that reduces the number of accesses to temporal reference pictures, and extends the source of disparity information by including DV-MCP blocks, which used a disparity vector for its inter-view motion parameter prediction. Experimental result show that the proposed algorithm increased BD-Rate by 0.1% for texture views and no coding performance change for synthesized views. It is claimed that a key benefit of the proposed algorithm is that it reduces the number of accesses to temporal reference pictures from 18 positions to 2 positions, which are limited to only the co-located picture.

[**JCT2-A0137**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=153)**/**[**m26135**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39296&id_meeting=153) **3D-CE5.h related: Cross check of JCT2-A126 of LG [L. Zhang (Qualcomm)] [late]**

This cross-check reports a 0.1% bit rate increase in synthesized view, which is a slight mismatch with the results reported in JCT2-A0126.

[**JCT2-A0131**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=147)**/**[**m26120**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39281&id_meeting=153) **CE5.h related: Information on the impact of the merge candidate list pruning process on side views encoding [Thomas Guionnet, Laurent Guillo, Christine Guillemot (INRIA)]**

This is an informative contribution on the merge candidate list pruning process. In HEVC, the construction of the candidate vector list is normatively specified. A simplification of the candidate list construction process has been proposed in JCTVC-G593. The impact of this simplification on the HEVC coding performance is negligible while decreasing the complexity. It has been adopted and is implemented in the HM 6.1, hence also in the current HTM software. It is reported in this document that in the context of 3D video coding, the simplification of the candidate list construction has a non-negligible impact on the encoding performance of the side views (0.4% loss on average). The base view is unaffected, thus confirming that the simplification has a negligible impact on the HEVC coding performance.

[**JCT2-A0133**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=149)**/**[**m26123**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39284&id_meeting=153) **CE5.h related: Reducing the coding cost of merge index by dynamic merge candidate list re-ordering [Thomas Guionnet, Laurent Guillo, Christine Guillemot (INRIA)]**

HEVC implements a candidate vector list for merge and skip modes. When merge or skip modes are selected, a merge index is written in the bitstream. This index is first binarized using a unary code, then CABAC encoded. A CABAC context is dedicated to the first bin of the unary coded index while the remaining bins are considered as equiprobable. This strategy is efficient as long as the candidate list is constructed such as being ordered by decreasing index occurrence probability. In the context of 3D video encoding, an inter-view motion vector predictor is added at the first position of the candidate list according to the current HTM. It is reported in this document that the inter-view motion vector predictor is not always the most probable candidate since it generally depends on the video sequence characteristics. Therefore, a dynamic candidate vector list ordering is proposed. Coding gains of 0.1% on average are observed on side views and a maximum gain of 0.6% is obtained for the GTFly sequence view 2. It is proposed that this method be further studied in a CE.

[**JCT2-A0134**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=150)**/**[**m26124**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39285&id_meeting=153) **CE5.h related: Merge candidate list extension for disparity compensated prediction [Thomas Guionnet, Laurent Guillo, Christine Guillemot (INRIA)]**

The construction of the merge candidate list has been extensively studied in the JCT-VC group (e.g., see JCTVC-G039). It has been shown in JCTVC-I0293 that it is possible to improve the HEVC coding performance by adding copies in the merge list corresponding to the first candidate shifted by an arbitrary offset. This document proposes this approach for disparity compensation, whereby two new candidates are appended to the list. A gain of 0.4% is obtained on average for the dependent views with minimal impact on complexity. It is proposed that this method be further studied in a CE.

Discussion: There was a question on the status of JCTVC-I0293; it was mentioned that this proposal was not adopted in JCT-VC but that such techniques seem promising in the context of 3D video.

* + 1. **Conclusions**

BoG should be formed to consider potential adoptions and discuss future CE plans.

* 1. ***CE6.a: Depth intra prediction***
     1. **Summary**

[**JCT2-A0162**](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=184)**/m26268 CE6.a Summary Report: Depth Intra Prediction [M. M. Hannuksela (Nokia)]**

The software integration of coding tools into the latest version of the ATM software was not finalized and hence no simulation results were obtained. There was a desire by the proponent to continue the CE.

* + 1. **CE Contributions**
    2. **Conclusions**

Revisit whether to continue CE.

* 1. ***CE6.h: Depth intra prediction***
     1. **Summary**

[**JCT2-A0104**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=96)**/**[**m26061**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39221&id_meeting=153) **3D-CE6.h summary report: Depth intra prediction [Philipp Merkle (Fraunhofer HHI)]**

The goal of this core experiment is to test tools for depth intra prediction which are applied to HEVC compatible 3D video coding. The following summarizes key highlights and similarities of the proposal.

* JCT2-A0070 (LG) and JCT2-A0032 (Samsung) propose a depth intra coding method based on continuous contour partition of a block.
* JCT2-A0068 (LG) proposes a region-based intra prediction.
* JCT2-A0098 (Qualcomm) and JCT2-A0105 (HHI) propose methods for reducing complexity of the Wedgelet search used in DMM modes 1 and 3.
* JCT2-A0010 (Aachen) and JCT2-A0087 (LG) propose methods for depth intra coding without transmitting the residuum.
* JCT2-A0010 (Aachen) proposes a number of depth intra prediction modes together with depth look-up table based residual value coding. This approach enhances the deltaDC method used in the existing DMM.
* JCT2-A0088 (LG) proposes a skip mode for depth intra coding.
  + 1. **CE Contributions**

[**JCT2-A0068**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=60)**/**[**m26010**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39170&id_meeting=153) **3D-CE6.h: Simple region-based intra prediction for depth-map [Jin Heo, EunYong Son, Sehoon Yea (LG Electronics)]**

This contribution presents a region-based intra prediction method for depth map coding. The proposed method separates a block into two partitions using a straight line without any extra signalling bits by replacing the conventional intra prediction. The method is considered as a replacement for DMM modes 1 and 2. The proposal provides approximately 4% and 2.5% encoding and decoding complexity reduction with 0.1% BD-rate loss. It is asserted that the proposed method has two advantages: prediction mode reuse and less complexity compared to the existing DMM.

Discussion: It was suggested that some harmonization among the different proposals could be considered to achieve the complexity reductions and avoid the coding loss.

[**JCT2-A0114**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=106)**/**[**m26081**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39241&id_meeting=153) **3D-CE6.h: Cross check on region-based intra prediction of LG [Hunn Rhee, Philipp Merkle (Fraunhofer HHI)]**

[**JCT2-A0070**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=62)**/**[**m26012**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39172&id_meeting=153) **3D-CE6.h: Region boundary chain coding for depth-map [Jin Heo, Eunyong Son, Sehoon Yea (LG Electronics)]**

This contribution represents a region boundary chain coding method for the depth-map. The proposed method introduces an edge chain that separates the block into two regions and codes the chain explicitly. It is reported that the proposed method achieves a reduction of 0.2% in terms of BD-Rate.

Discussion: It was asked whether Intra only results are available. Proponents stated that the results could be made available during the week.

Discussion: It was asked where the gains come from relative to the existing DMM. It was stated by the proponents that the shape is determined directly from the depth signal and independent from the texture.

[**JCT2-A0081**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=73)**/**[**m26027**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39187&id_meeting=153) **3D-CE6.h: Cross check on LG proposal [Byung Tae Oh (Samsung)] [miss] [late]**

* + 1. **Related Contributions**

[**JCT2-A0010**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=16)**/**[**m25802**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=38962&id_meeting=153) **3D-CE6.h related: Model-based Intra Coding for Depth Maps using a Depth Lookup Table [Fabian Jäger (RWTH Aachen University)]**

Presenters not available (Saturday PM)

[**JCT2-A0030**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=22)**/**[**m25891**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39051&id_meeting=153) **3D-CE6: crosscheck of JCT2-A0010, "Model-based Intra Coding for Depth Maps using a Depth Lookup Table" [Imed Bouazizi, Giovanni Cordara, Lukasz Kondrad (Telecom Italia)] [miss] [late]**

[**JCT2-A0032**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=24)**/**[**m25895**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39055&id_meeting=153) **3D-CE6.h related results on depth intra prediction [Byung Tae Oh, Jaejoon Lee, Du Sik Park (Samsung)]**

A depth intra prediction method based on plane segmentation is proposed to improve the coding efficiency of depth images. This method is similar to that adopted for ATM. The proposed mode replaces the existing DMM mode 2. The results report a 0.4% bit rate reduction with similar complexity as the anchor. Additionally, an alternative configuration in which the proposed method is tested together with DMM modes 1, 3 and 4 are also presented, but results for this configuration have not been cross-checked.

[**JCT2-A0085**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=77)**/**[**m26036**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39196&id_meeting=153) **3D-CE6.h: Cross check on plane segmentation based intra prediction (PSIP) of Samsung [Jin Heo, Eunyong Son, Sehoon Yea (LG Electronics)]**

[**JCT2-A0087**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=79)**/**[**m26039**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39199&id_meeting=153) **3D-CE6.h related: Rate Distortion Optimized Selection between Non-Zero Residual and All-Zero Residual in Intra Coding of Depth [Hongbin Liu (LG Electronics)]**

This contribution proposes to perform rate distortion optimized (RDO) selection between non-zero residual and all-zero residual in intra mode coding, and proposed method is only applied to inter-picture of depth. The proposed method is expected to save bits spent on residual and is claimed to have a minor impact on the quality of synthesized views. This method is employed at the encoder only and does not change any syntax. It is reported that proposed method can achieve 0.1% bit rate reduction on synthesized views as well as coded and synthesized views.

Discussion: Favorable remark on this approach and support to adopt as a non-normative contribution in the reference software.

[**JCT2-A0127**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=143)**/**[**m26110**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39271&id_meeting=153) **Cross-check of JCT2-A0087 3D-CE6.h related: Rate Distortion Optimized Selection between Non-Zero Residual and All-Zero Residual in Intra Coding of Depth [Liang Zhao, Jicheng An, Shawmin Lei (MediaTek)] [late]**

[**JCT2-A0088**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=80)**/**[**m26040**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39200&id_meeting=153) **3D-CE6.h Intra Skip mode for depth map I-slices [Eunyong Son, Jin Heo, Hongbin Liu, Sehoon Yea (LG Electronics)]**

This contribution presents a technique for intra skip mode for depth map I-slices. The proposed intra skip mode does not transmit residual data and only sends the intra prediction modes for depth map coding. The proposed method does not achieve any gains for the 3-view case, but achieves a 0.1% bit rate reduction for the 2-view case.

[**JCT2-A0082**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=74)**/**[**m26029**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39189&id_meeting=153) **3D-CE6.h: Cross check on depth intra skip of LG [Jin Young Lee, Kwan-Jung Oh (Samsung)]**

[**JCT2-A0098**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=90)**/**[**m26053**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39213&id_meeting=153) **3D-CE6.h related: Depth Modeling Mode (DMM) 3 simplification for HTM [X. Zhao, Y.Chen, L.Zhang, M. Karczewicz (Qualcomm)]**

This contribution proposes a method to simplify DMM mode 3 in HTM, in which the Wedgelet pattern is not signalled, but derived by an exhaustive search from a large number of candidates at the decoder. In this proposal, it is firstly proposed that DMM mode 3 is disabled when the top-left 4×4 block in the Co-located Texture Luma Block (CTLB) is not coded as Intra. Furthermore, it is proposed that the Intra mode within the CTLB is used to derive the starting point for Wedgelet pattern searching with a fixed search range. It is asserted that the proposal significantly reduces the number of Wedgelet candidates to be searched at the decoder for DMM mode 3, without changing the coding efficiency of the current DMM. When DMM mode 3 is invoked, it was claimed that approximately 90% of the search patterns could be eliminated with the proposed approach.

Discussion: It would be interesting to also report Intra only results and check the impact on the proposed simplification.

[**JCT2-A0094**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=86)**/**[**m26049**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39209&id_meeting=153) **Crosscheck report for JCT2-0098 3D-CE6.h related: Depth Modeling Mode (DMM) 3 simplification of Qualcomm [H. Liu (LG Electronics), J. Jia (LG Electronics)]**

[**JCT2-A0105**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=97)**/**[**m26062**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39222&id_meeting=153) **3D-CE6.h related: Fast Wedgelet search [Philipp Merkle, Hunn Rhee, Karsten Müller, Thomas Wiegand (Fraunhofer HHI)]**

This contribution proposes a fast search method for the Wedgelet-based depth coding modes. It introduces a two-step search strategy as an alternative to the full search currently used in HTM 3.1. It is reported that this method reduces the encoder complexity to 95.7%; for the intra-only configuration, the encoder/decoder complexity reduces to 46.5%/78.3%. For instance, when DMM modes 1 and 3 are invoked, it was claimed that approximately 75% of the search patterns could be eliminated with the proposed approach for 32x32. For both configurations the BD-rate increases negligibly by less than 0.1%.

[**JCT2-A0084**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=76)**/**[**m26035**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39195&id_meeting=153) **3D-CE6.h: Cross check on fast wedgelet search of HHI [Jin Heo, Eunyong Son, Sehoon Yea (LG Electronics)]**

* + 1. **Conclusions**

BoG should be formed to consider potential adoption and discuss future CE plans.

* 1. ***CE7: Global depth and view prediction***
     1. **Summary**

[**JCT2-A0071**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=63)**/**[**m26013**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39173&id_meeting=153) **3DV CE7 summary on Global Depth and View Prediction [Takanori Senoh (NICT)]**

The goal of this CE is to investigate Global Depth and View Prediction (GDVP) based on a concept of Epipolar Plane Image (EPI) of depth and view, which is applicable to both AVC and HEVC-based codecs. The summary report indicates that one CE contribution has been submitted (JCT2-A0069) and summarizes the main result. A number of objective and subjective results are presented. The summary report recommends that a test model based on CE7 be established.

Discussion: It was remarked that the framework is quite different from that of other CEs and the numerical results reported cannot be easily compared or interpreted.

Discussion: There was a question on what would be standardized. The codec that is utilized in this framework is the existing AVC or HEVC-based codec, but the input format and pre/post-processing operations are different.

* + 1. **CE Contributions**

[**JCT2-A0069**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=61)**/**[**m26011**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39171&id_meeting=153) **3DV CE7.h results on Global Depth and View Prediction by NICT [T. Senoh, K. Yamamoto, R. Oi, Y. Ichihashi (NICT)]**

This contribution reviewed the details of the pre-processing operations to compute the global view and global depth and obtain the residual data, as well as the post-processing operations that are required to synthesize views from the reconstructed data. It was noted that the results are available for viewing and that anchors at comparable bit rates are also available.

Discussion: It was suggested that others not directly involved in this work are encouraged to cross-check the results.

**[JCT2-A0059](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=51)/**[**m25945**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39105&id_meeting=153) **Cross Check of 3D-CE7.h Results on Global Depth and View Prediction of NICT by NISRI [Kazuyoshi Suzuki, Masayuki Tanimoto (NISRI)]**

* + 1. **Related Contributions**

[**JCT2-A0072**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=64)**/**[**m26014**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39174&id_meeting=153) **Proposal on Simple Test Model for 3DV Coding based on CE7 [T. Senoh, K. Yamamoto, R. Oi, Y. Ichihashi (NICT), M. Tanimoto, K. Suzuki (NISRI)]**

The proposed test model includes (a) global view that is compatible with 2D codec, (b) global depth that is formed based on the depth maps from individual viewpoints, and (c) residual data, which is necessary for view synthesis. It is suggested that all components of the data format be coded in an access unit of AVC or HEVC, but these details have not been specified or implemented.

Discussion: It was suggested that perhaps this coding format could specified as an extension of MPEG-C Part 3 in which the residual information is added to the existing 2D+Depth format. Some additional signaling would need to be specified and informative annexes could provide descriptions of the pre-processing and post-processing operations.

* + 1. **Conclusions**

Viewing of CE7 results are planned for Tuesday evening.

Revisit proposal on establishing a test model that supports the proposed data format.

* 1. ***CE8: RD Optimization***
     1. **Summary**

[**JCT2-A0077**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=69)**/**[**m26022**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39182&id_meeting=153) **CE8 Summary Report: RD-Optimization [Sehoon Yea (LG Electronics)]**

CE8 was established to investigate quality fluctuations at various intermediate view positions and using different rendering algorithms when the view synthesis optimization (VSO) is enabled. Several proposals were also integrated into the reference software for evaluation with the aim to ultimately harmonize them. The summary report notes that five proposals have been submitted:

* JCT2-A0033 (Samsung/HHI)
* JCT2-A0057 (Zhejiang)
* JCT2-A0083 (PKU/LG)
* JCT2-A0093 (Samsung/HHI/LG/PKU)
* JCT2-A0119 (LG/Yonsei)
  + 1. **CE Contributions**

[**JCT2-A0033**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=25)**/**[**m25896**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39056&id_meeting=153) **3D-CE8.h results on view synthesis optimization [Byung Tae Oh, Jaejoon Lee, Du Sik Park (Samsung), Gerhard Tech, Karsten Müller, Thomas Wiegand (Fraunhofer HHI)]**

Modifications of VSO as reported in m24830 and m24865 are proposed to reduce encoder runtime and increase coding gains. Specifically, the following modifications are suggested: (a) run-time optimization of VSO algorithm implementation, (b) increase of number of views regarded for error computation by a factor of three, and (c) model-based view synthesis distortion estimation, i.e., the synthesis view distortion is computed without view rendering. It is reported that this configuration shows a 2.7% bit rate reduction on synthesized views with 90% decoding time.

Additionally an alternative VSO configuration using further modification to decrease runtime is presented. Specifically, the following changes were added: (d) distortion computation for luminance components only, and (e) no rendering model update for already coded blocks, i.e., the synthesized view distortion change is computed assuming uncoded depth data in all blocks apart from the depth block to be tested. It is reported that this configuration shows a 1.3% bit rate reduction on synthesized views with 73.6% decoding time. It was noted that results for this configuration have not been cross-checked.

The recommendation from the proponents is to adopt the first configuration since it is believed to offer a more favorable tradeoff in terms of coding efficiency and complexity reduction.

**[JCT2-A0057](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=49)/**[**m25935**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39095&id_meeting=153) **3D-CE8.h results on JRDO [Li Wang, Lu Yu (Zhejiang Univ.)] [late]**

This document evaluates a proposed Joint RDO (JRDO) scheme that has been implemented in HTM 3.1 and has been evaluated with two view synthesis tools (VSRS-1D-Fast and VSRS 3.5). This contribution proposes to harmonize the proposed JRDO and existing VSO scheme. The harmonized scheme reportedly achieves better coding efficiency than JRDO and VSO using both the VSRS and VSRS-1D-Fast rendering software modules. Further study of JRDO and the harmonized approach is suggested.

Discussion: It was asked whether complexity has been measured. The proponents noted the run times are not currently available, but will be provided in the future.

[**JCT2-A0083**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=75)**/**[**m26034**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39194&id_meeting=153) **CE8.h: Results of Simplification of View Synthesis Optimization by Detection of Zero Distortion Change in Synthesized View [S. Wang (Peking Univ.), S. Ma (Peking Univ.), H. Liu (LG Electronics), J. Jia (LG Electronics)]**

Presenters not available (Sunday AM)

[**JCT2-A0135**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=151)**/**[**m26125**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39286&id_meeting=153) **3D-CE8.h: Cross check on simplification of view synthesis optimization of PKU and LG [L. Zhang (Qualcomm)] [late]**

[**JCT2-A0093**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=85)**/**[**m26048**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39208&id_meeting=153) **3D-CE8.h results on view synthesis optimization by Samsung, HHI and LG-PKU [H. Liu (LG Electronics)]**

Presenters not available (Sunday AM)

* + 1. **Related Contributions**

[**JCT2-A0119**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=135)**/**[**m26106**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39267&id_meeting=153) **CE8.h Depth distortion metric with a weighted depth fidelity term [Jiwook Jung, Sehoon Yea (LG), Seungchul Ryu, Kwanghoon Sohn (Yonsei Univ.)]**

Under the Common Test Conditions (CTC) of 3D Video Coding, the quality of synthesized views at specified viewing positions has been used as a sole measure of coded depth fidelity, with which RD-mode decision was performed at the encoder when coding depth. In the current reference encoder implementation, a technique called VSO is being used to synthesize the intermediate views and calculate the distortion of coded depth indirectly in terms of the quality of those synthesized views.

In m25010, it was pointed out that use of such an indirect distortion metric for depth coding may introduce undesirable quality fluctuation in the synthesized views along intermediate viewing positions as well as noticeable artifacts in synthesized views when alternative view-synthesis algorithms, such as VSRS, are used at the receiver. It was asserted that the primary reason for such problems is that the fidelity of coded depth was not sufficiently high, especially around object boundaries where spurious depth values could often be created in the coded depth due to the inherent nature of the current depth coding metric.

This contribution proposes to add a depth-fidelity term in the distortion metric currently used for RD-optimization at the encoder for depth coding. Comparisons between the cases with and without the proposed depth-fidelity term are provided to highlight how the proposed change can mitigate the aforementioned problems. Using VSRS-1D-Fast, it is reported that an average bit rate increase on synthesized views is 1.6%. Using VSRS3.5, an average bit rate increase on synthesized views is 0.9%. A maximum bit rate reduction of 8.8% and 3.7% was reported for the Undo\_Dancer and GT\_Fly sequences, respectively. Subjective results were shown for sample frames that indicated cleaner depth maps and improved subjective quality improvements in the rendered views when VSRS software was used for rendering.

The recommendation from the proponent is to adopt the proposed depth fidelity term into the HTM reference software as an encoder only option.

Discussion: Favorable remark to support adding this option.

Discussion: It was asked whether there are examples available for other sequences. The proponent noted that complete results could be provided for viewing if there was interest within the group.

* + 1. **Conclusions**

Revisit adoptions and discuss future CE plans.

1. **Non-CE Technical Contributions**
   1. ***3DV Standard Development***
      1. **AVC related**

[**JCT2-A0074**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=66)**/**[**m26018**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39178&id_meeting=153) **3DV-ATM HP: Proposed HRD text for ISO/IEC 14496-10:2012/PDAM 2 MVC extensions for inclusion of depth maps [S. Hattori, T. Suzuki (Sony), Y. Chen (Qualcomm)]**

Presentation to be scheduled during the week.

[**JCT2-A0075**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=67)**/**[**m26019**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39179&id_meeting=153) **3DV-ATM HP Technical Input: A study on depth range based weighted prediction tool [S. Hattori, T. Suzuki (Sony)]**

Presentation to be scheduled during the week.

[**JCT2-A0144**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=160)[**/**](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=105)[**m26157**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39318&id_meeting=153) **3DV technical input: JMVC software integration of coding interlace texture with interlace depth [Ching-Chieh Lin, Fang-Chu Chen, Wen-Hao Chung (Industrial Technology Research Institute)] [late]**

Presentation to be scheduled during the week.

[**JCT2-A0164**](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=186)[**/**](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=105)**m26282 3DV: Cross check report of ITRI’s JMVC software integration of coding interlaced texture with interlaced depth (JCT2-A0144) [Chao-Hsiung Hung, Hsueh-Ming Hang (NCTU)] [late]**

* + 1. **HEVC related**

[**JCT2-A0012**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=18)**/**[**m25840**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39000&id_meeting=153) **Tentative working draft text for the HEVC compatible 3D video coding extension [Gerhard Tech, Philipp Merkle, Martin Winken, Heiko Schwarz, Karsten Mueller, Thomas Wiegand (Fraunhofer HHI)]**

Presentation to be scheduled during the week.

* 1. ***Clarification and Bug Fix Issues***
     1. **AVC related**
     2. **HEVC related**
  2. ***Test model settings and common test conditions***
     1. **General**

[**JCT2-A0073**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=65)**/**[**m26016**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39176&id_meeting=153) **Proposal of Depth-aware 3DV Test Condition and Evaluation [Takanori Senoh, Kenji Yamamoto, Ryutaro Oi, Yasuyuki Ichihashi (NICT), Masayuki Tanimoto, Kazuyoshi Suzuki (NISRI)]**

This contribution requests a depth-aware test condition and evaluation method for 3DV that provides depth maps of higher coding quality, especially for HEVC-based model. It is asserted that the currently decoded depth map quality, even at the highest bit rate, appear unacceptable for emerging 3D applications. It was suggested that to increase the longevity of our standards, the codec should be specified with greater consideration for depth map quality. To achieve this goal, it is proposed that the Common Test Conditions use the same QP values for both texture and depth map, and that the BD-Rate for depth maps also be evaluated in the evaluation reports. The contribution also suggests that down-scaling the depth maps with finer quantization provides a better trade-off in terms of depth map quality and bit rate, compared to coding at a coarse quantization at the full resolution.

Discussion: It was asked whether the quantization used by the codec is the main reason for degradation, or the source or optimizations prior to encoding lead to greater errors. It was remarked that main reason for degradation is the view synthesis optimization.

Discussion: It was noted that it has been a challenge to implement full-resolution texture coding with reduced-resolution depth in the HTM software. NICT mentioned that they have a software implementation that achieves this and could make it available to group members upon request. However, the gains of reduced-resolution depth map coding in HTM may not be as large as that in ATM. The benefits would need to be confirmed before this capability could be enabled.

Discussion: It was asked whether there is a need for a lossless or near-lossless mode for depth. It was remarked the current coding tools may be sufficient.

* + 1. **AVC related**
    2. **HEVC related**

[**JCT2-A0090**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=82)**/**[**m26046**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39206&id_meeting=153) **Impact of View Synthesis Optimization (VSO) on depth quality [Olgierd Stankiewicz, Krzysztof Wegner, Marek Domanski (Poznan Univ. of Technology)]**

This contribution considers the impact of VSO on depth quality. It is noted that VSO allows the encoder to discard depth information which appears to be irrelevant for the view synthesis process for the purpose of rate reduction. However, it is asserted that high-fidelity depth maps are required for a number of applications. Moreover, future encoders may not implement VSO or may have VSO implemented differently, and thus the current CTC may not resemble practical solutions. It is reported that VSO achieves approximately 12% bit rate reduction on synthesized views, but there is approximately 7dB drop in BD-PSNR for the depth data. It is suggested that the loss of depth information is not acceptable for some applications. Examples were shown that illustrate the serious degradation in the depth maps with VSO enabled. Several options were suggested: (a) disable VSO in some CEs related to depth coding only; (b) disable VSO in CTC to allow good evaluation of depth coding tools; or (c) use two variants: VSO enabled and disabled, to allow a wider perspective and is analogous to RDQ in HEVC.

Discussion: It was remarked by several members of the group that alternative metrics to improve the depth fidelity can be considered as part of the optimization process. It was suggested that this may be a better path than disabling the tool so that the gains can be maintained and the depth quality can also be preserved.

Discussion: It was also remarked that the proposed solution to evaluate all proposals with VSO enabled and disabled would require twice the number of encoding runs, which would be an additional burden for proponents.

Discussion: The group seemed more inclined to allow for VSO to be disabled in select CEs, in particular for those CEs that are evaluating the coding efficiency for depth maps.

Discussion: It was the consensus of the group to pursue improvements to VSO (e.g., as proposed in CE8) and allow CEs to also evaluate proposals with VSO disabled if there may be benefits in the evaluation of the tools being tested.

[**JCT2-A0091**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=83)**/**[**m26047**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39207&id_meeting=153) **Independent intra-period coding in 3D-HTM [Jakub Siast, Olgierd Stankiewicz, Krzysztof Wegner, Marek Domanski (Poznan Univ. of Technology)]**

This contribution proposed an HTM encoder software modification that aims to enhance the experimentation process in terms of parallel intra-periods and fast debugging functionality. Specifically, it is proposed to parallelize the encoding of the multiview video sequence by splitting the sequence into multiple runs, each with a different IntraPeriod. Each IntraPeriod would be encoded independently (in parallel) and then the results would be merged into a single concatenated bitstream. The resultant bitstream should be binary identical to the one produced with a single-pass of the encoder (without parallelization). The contribution also suggests an approach for verification of the deterministic operation of the encoder, and allowing stand-alone encoding/decoding of a selected IntraPeriod for debugging for easier tracking of errors.

Discussion: It was asked whether the proposed change impact the encoder only. The proponents confirmed that the resulting bitstream would be identical.

Discussion: The main change that is needed to the software is to ensure that CABAC is properly initialized at random access points in the dependent views so that each IntraPeriod can be independently encoded.

Discussion: It was remarked that some cross-checking of the software and reproduction of the results with parallel encoding would be desirable before agreeing to adopt the proposed changes.

[**JCT2-A0113**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=105)[**/**](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=105)[**m26075**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39235&id_meeting=153) **On coding configurations for 3DV-HTM development [Dmytro Rusanovskyy (Nokia)] [late]**

This contribution proposes a change to the HTM coding configuration that enables the generation of a bitstream with only high-level syntax changes to HEVC (i.e., slice-level and above). The contribution also proposes to update the Common Test Conditions document to allow comprehensive evaluation of tools targeting such configuration.

The contribution also provides simulation results with such a coding configuration, indicating about 8% bit rate increase on average for coded and synthesized views when compared to the 3DV-HTM according to the Common Test Conditions.

Discussion: The remarks from the group indicated that it is not necessary to impose such a configuration in the CTC. It would only be needed for proposed tools that target improvements to the simple multiview extension of HEVC.

* 1. ***Test model coding performance***
     1. **General**

[**JCT2-A0150**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=166)**/**[**m25818**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=38978&id_meeting=153) **3DV: Quality assessment of stereo pairs formed from two synthesized views [Philippe Hanhart (EPFL), Touradj Ebrahimi (EPFL), on behalf of Qualinet]**

Presentation to be scheduled during the week.

* + 1. **AVC related**
    2. **HEVC related**
  1. ***Other technical proposal contributions***

[**JCT2-A0003**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=9)**/**[**m25753**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=38913&id_meeting=153) **3DV: Test data and view synthesis software for warp coding and IDW-based view synthesis experiments [Nikolce Stefanoski, Aljoscha Smolic (Disney Research)]**

In this contribution, image warp data and binary view synthesis software are provided; the data is provided for the 2-view case only at this stage. The view synthesis software generates new views using multiview video plus warp (MVW) data as input. It generates new views by image-domain-warping-based rendering (IDWR). The IDWR software can be used for interpolation and extrapolation of views. The warp data and rendering software are provided to evaluate the benefits of warp coding in the scope of the 3D video coding extension development and establish suitable test conditions. The proponents mentioned that viewing results of uncompressed results are available at this meeting.

Discussion: There was a question on whether there was any difference in the new results relative to earlier viewings. The main difference is that the warp data is extracted at the encoder rather than at the decoder.

Discussion: Consider establishing an exploration experiment on coding and synthesis based on the warp data representation. It was remarked that the similarities to the existing depth/disparity format would also need to be studied.

Viewing planned for Tuesday evening

[**JCT2-A0004**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=10)**/**[**m25754**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=38914&id_meeting=153) **3DV: Results on coding of warps using HEVC [Nikolce Stefanoski, Can Bal, Aljoscha Smolic (Disney Research)]**

This contribution proposes to encode warps in order to use them at the decoder side for view synthesis with Image-Domain-Warping-based Rendering (IDWR). In particular, a warp coding method is proposed, which first quantizes the warps to obtain a YUV representation and then applies HEVC. It is noted that there is no dependency between texture and warp data. The warp data and IDWR software provided in JCT2-A0003 are used in the experiments. Warp coding results are reported for all 2-view input test sequences. It is reported that warp data can be coded at bit rates of 35kbit/s or below without introducing visible artifacts in comparison to a synthesis with original warp data. The proponents recommended establishing a CE on Warp Coding.

Discussion: As noted in the notes of JCT2-A0003, it was considered to establish an exploration experiment on coding and synthesis based on the warp data representation, where similarities to the existing depth/disparity format should also be studied.

Discussion: The group considered the type of experiments that may be conducted. One level of comparison would be comparisons of the warp framework to the existing depth framework, but a more detailed level of comparisons and analysis would be more desirable. The group was encouraged to consider drafting an experimentation plan as a break-out group activity.

[**JCT2-A0042**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=34)**/**[**m25892**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39052&id_meeting=153) **3D-AVC results on improved inside view motion prediction [Kwan-Jung Oh Jaejoon Lee Du Sik Park (Samsung)]**

Modifications to the existing IVMP tool are proposed to improve coding efficiency. In this proposal, the IVMP availability conditions and motion prediction method are changed. Other parts including syntax are unchanged. Coding results for these modifications suggest that this method achieves a 0.2% bit rate reduction without any impact on complexity. It was noted by the proponent that this improvement is approximately half of the gain that the existing IVMP provides.

Discussion: There is some level of interest within the group to study this proposal further. This technique does not fit within the scope of any existing CEs, so we may consider establishing new CE for further evaluation.

[**JCT2-A0027**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=127)**/**[**m26098**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39259&id_meeting=153) **Cross-check report of JCT2-A0042 on improved inside view motion prediction [Shinya Shimizu (NTT)]**

[**JCT2-A0044**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=36)**/**[**m25914**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39074&id_meeting=153) **Depth Quadtree Prediction for HTM [J. Jung, K. Viswanathan (Orange Labs)]**

This document presents a modification of the depth quadtree decoding process. For a given CTU, the quadtree of the depth is linked to the collocated CTU quadtree in the texture, in a way that a given CU of the depth cannot be split more than its collocated CU in the texture. The quadtree of the depth is predictively encoded relatively to the quadtree of the texture. A 62% runtime is reported compared to the reference, while bit rate reductions of 0.8% and 1.1% are observed for synthesized only, and coded and synthesized cases, respectively.

Discussion: Can the QT limitation be imposed as an encoder only option? Is there any normative change to the specification? It was agreed that it would be possible to impose the limitation in a non-normative way. However, with only this limitation, the gain drops from 0.8% to 0.1% bit rate reduction on synthesized views, and from 1.1% to 0.6% on coded and synthesized views.

Discussion: Is there a parsing dependency? The proponents clarified that the proposal assumes that the texture has already been parsed and is available.

Discussion: Revisit to discuss whether to establish further study on this topic.

[**JCT2-A0159**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=176)**/**[**m26199**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39360&id_meeting=153) **Cross-check report for JCT2-A044: Depth Quadtree Prediction for HTM [Jicheng An, Liang Zhao, Shawmin Lei (MediaTek)] [miss] [late]**

[**JCT2-A0112**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=104)**/**[**m26074**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39234&id_meeting=153) **Calculation process for parameters of Depth Range-based Weighted Prediction with fixed-point/integer operations [Dmytro Rusanovskyy (Nokia)] [late]**

Presentation to be scheduled during the week.

* 1. ***Non-normative contributions***

[**JCT2-A0151**](http://phenix.int-evry.fr/jct2/doc_end_user/current_document.php?id=167)[**/**](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=105)[**m25966**](http://phenix.int-evry.fr/mpeg/doc_end_user/current_document.php?id=39126&id_meeting=153) **3D-HEVC - Rate control for 3D multi-view video coding [W. Lim, H. Choi, J. Nam, (KWU), D. Sim, Ivan V. Bajić (SFU)] [late]**

Presentation to be scheduled during the week.

* 1. ***Withdrawn, topically unclear and missing contributions***

**JCT2-A0005 Withdrawn**

**JCT2-A0017 Withdrawn**

**JCT2-A0116 Withdrawn**

**JCT2-A0149 Withdrawn**